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*Original Research Article*

# The Development of a New Screening Tool for Cognitive Impairment in India: The Universal Memory and Cognitive Exam (UMACE)

**Kardile, Mangal S[1]; Luscombe, Georgina M[2]; Peisah, Carmelle[3]**

[1]"Mental Health Aims", Nasik, India,
[2]The School of Rural Health, Sydney Medical School, University of Sydney, New South Wales, Australia,
[3]University of New South Wales; University of Sydney, Sydney, Australia,

Corresponding Author: Kardile, Mangal S

## ABSTRACT

**Background:** Screening instruments for cognitive impairment (CI) have been developed in Western settings based on samples with adequate education and literacy. However, it is of prime importance that such screening tools are developed locally, are culturally sensitive and appropriate to populations with lower levels of literacy and education, as are commonly found in less developed countries. The Universal Memory and Cognitive Exam (UMACE) screening tool was developed in India for use in both literate and illiterate populations, and in persons with neurological conditions resulting in disability.
**Aims:** To assess the psychometric properties of the UMACE in different populations, including non-clinical and clinical adult samples.
Setting and design: The UMACE was administered in three adult samples: a non-clinical sample (n = 78); a sample with or without psychiatric disorders (n = 70) and a sample with and without neurological disorders (n = 207).
**Methods:** The psychometric properties of the UMACE were examined by administering the 12 item UMACE and the 11 item MMSE.
Statistical analysis: ROC curve analysis assessed the utility of UMACE as a cognitive screen compared with the MMSE.
**Results:** The UMACE has utility in the detection of cognitive impairment in all samples. In the largest sample (including 20% illiterate subjects) a cut-off of 28.5out of 40 had an AUC 92.5% (95% CI 88.9% to 96.2%)a sensitivity of 89.7% and specificity of 77.0%.
Conclusions: The UMACE is a useful, simple screen for CI appropriate for use in various clinical and non-clinical situations in both literate and illiterate persons.
***Keywords:*** cognitive impairment, screening, cognitive testing, literacy, neurological

## INTRODUCTION

The burgeoning rise in global dementia prevalence particularly in developing countries has yet to be matched by a corresponding rise in dementia diagnosis in such settings. [1,2] This is in part attributable to the large numbers of illiterate elderly populations residing in developing countries, rendering the diagnosis of dementia by conventional instruments which are better suited to urban, educated populations, particularly challenging. This has led to an urgent call for the development of cognitive screening instruments appropriate for use in developing countries. [3]

The Mini Mental State Examination (MMSE) is the most commonly used brief

evaluation of orientation, registration, attention, recall, language and constructional praxis. [4] One main advantage of the MMSE is that it is quick to administer and consequently a valuable test for simple bedside screening and for serial assessments of cognitive function. However, it has been criticised for a lack of sensitivity in screening for mild cognitive impairment (MCI) and for lacking diagnostic specificity. [5] Several studies have examined the validity of the MMSE in neurological samples (e.g. patients with stroke) and concluded that, due to relative insensitivity to impairments in single cognitive domains, it is sub-optimal as a cognitive test. [6-9] Further work is needed to identify suitable instruments for cognitive screening across a range of disorders characterised by MCI and dementia. [10]

Other have criticised the MMSE because it can be affected by levels of education and literacy as well as cultural factors and preferred language. [11] Attempts to address these deficits have included modification of cut-points in scoring and replacement of culture specific items with questions less dependent on skills obtained during formal education. For example, some twenty years ago, [12] developed a Hindi adaptation of the MMSE suitable for the Ballabgarhelderly population; adapting specific itemsthat might be otherwise incomprehensible to this population. Notwithstanding such modified versions of the MMSE, another major limitation of the instrument is that it cannot be used in persons with impaired hearing or vision. [13-15] Notably, part of the standardized, evidence-based approach for assessing cognition in older persons is to determine whether or not to proceed with testing, if barriers that might impact on test results such as vision or hearing loss, language, literacy, or aphasia have been identified. [14] To date, there is no consensus regarding how best to use the MMSE in light of these issues. The Rowland Universal Dementia Assessment Screen (RUDAS) was developed for use in culturally and linguistically diverse populations and a recent meta-analysis indicates it is less subject to a language or education bias than the MMSE. [16] However, there are no published data on the psychometric characteristics or the acceptability of the RUDAS in persons with a physical disability (e.g. vision or hearing impairment, hemiparesis, aphasia), and the scoring guide advises caution in the interpretation of low RUDAS scores (<22) in these individuals. [17]

The current study aimed to develop and test a cognitive screening instrument for use in people with differing levels of education/literacy and neurological disability, to screen for cognitive deficits at an early stage in a developing country, India. It was hypothesized that (i) a cognitive screening tool minimizing literacy bias with validity for use in a range of populations, both normal and clinical, could be developed; and (ii) that patients with neurological disorders assessed with such a tool will have cognitive impairment.

## METHODS

### *UMACE CI screening instrument development*

The study was carried out in Nasik city, Maharashtra state, India. The development of the UMACE was based on a two-phase process: (i) an item development phase; (ii) a testing phase using a normal population; psychiatric clinic population; and a neurology clinic population.

The first phase of the development of UMACE test involved the structuring of items that could be useful to test all populations. The UMACE has been structured on the same foundation as the MMSE and comprises several primary and complex cognitive tasks. Various examination models help to assess a broad range of complex cognitive domains including visuospatial working memory and visuospatial motor coordination. [18] Items were chosen to minimise confounding literacy bias, and adaptations developed for confounding neurological deficit.

***UMACE Testing***

In the second phase the UMACE tool was tested in a "normal" group (N=78) which comprised patients referred to a private psychiatric clinic and a neurology clinic found to have no diagnoses on assessment, including both literate and illiterate subjects aged 35 and above [Group 1]; and a clinical group of patients aged 35 and above, with varied psychiatric disorders referred to the same private psychiatric clinic (N=70) [Group 2]; and a neurology group of patients with various neurological disorders (N=207) attending a private neurology out-patient clinic [Group 3]. Performance on the UMACE in each group was compared with performance on the Mini Mental State Examination [4] for test validation. Demographic information was collected for all populations. Data relating to the clinical neurological diagnoses and duration of illness was obtained from the clinical population. Literacy was based on years of education, such that those with 0-4 years of education were classified as illiterate. Literacy was rated as both a continuous measure (years of education) and a dichotomous measure (literate/illiterate).

Informed consent was obtained from every participant or their proxy (usually family members).

***Statistical analyses***

Where continuous data were normally distributed, as assessed using the one-sample Kolmogorov Smirnov test, means and standard deviations are presented. For continuous data with significantly skewed distribution, medians and interquartile ranges are used as descriptive statistics. Subjects were compared on demographic characteristics using the Mann-Whitney U z test for skewed continuous data (the non-parametric equivalent of the Independent samples t test) and chi-squared analyses for categorical data.

The relationship of UMACE and MMSE scores to demographics characteristics (age, gender, literacy, years of education) was assessed using Pearson's (r) and Spearman's ($r_s$) correlations, Independent samples t tests and Mann-Whitney U z tests. The effect sizes of the associations of the cognitive measures with literacy are reported as partial eta squared values.

In order to assess the utility of the UMACE as a cognitive screen, receiver operating characteristic (ROC) curve analysis was conducted. The Area Under the Curve (AUC) and 95% confidence interval (CI) was produced, with MMSE (education adjusted) cognitive impairment as the gold standard comparator. Cognitive impairment was determined using both the standard cut-off for the MMSE (23 or lower), and then cut-offs adjusted for level of education as per the Framingham Heart Study. [19] More specifically, for education of $7^{th}$ grader or lower: MMSE 22 or lower indicated cognitive impairment; $8^{th}$ grade to $11^{th}$ grade: 24 or lower; $12^{th}$ grade: 25 or lower; College or tertiary education: 26 or lower. In addition, UMACE cut-off scores for the highest sensitivity and specificity were also calculated.

All statistics were conducted using SPSS version 21 and alpha was set at $p < 0.05$.

## RESULTS

***The UMACE tool***

A UMACE tool kit was developed including a questionnaire and other model-based equipment for the different cognitive tasks. The total number of 12 items comprising verbal and non-verbal items was finalized with corresponding descriptors and question guide (see Table 1 for item descriptions). The potential total raw score is 40 for 12 items.

The UMACE test does not have a time limit and average time to completion was 12 minutes encompassing all cognitive domains. However, individual testing time varied for patients with different neurological disorders.

The UMACE test was administered in various languages in consideration of the different cultural backgrounds of

participants. For seven of the 355 participants the test was administered in a non-regional language (n = 5 using English and n = 2 using Hindi language). For the rest of the participants the UMACE was administered with the regional language Marathi.

**Table 1: UMACE items, scores and domain**

| Items and instructions | Score | Cognitive domain |
|---|---|---|
| 1. What is your city's name?<br>What day is it?<br>What season is it?<br>(*One score for each correct answer. Can be presented in written form for patients with aphasia)* | 3 | Orientation.<br>Written option minimizes bias for patients with aphasia. |
| 2. The examiner reads out the names of three unrelated objects and asks the participant to repeat the names.<br>(*Named only once, one score for each correctly repeated word)* | 3 | Registration.<br>Words used in the memory recall task are commonly used and easy to pronounce, thereby minimizing bias for illiterate test recipients. |
| 3. Ask the participant to count backwards from number 25 by subtracting four digits: 25, 21, 17, 13, 9<br>Note the speed and put in remarks column.<br>(*Alternate version for minimal or elementary education* – ask participant to subtract six from 55; observe five steps: 49, 43, 37, 31, 25) | 5 | Number backward counting task (working memory and concentration).<br>The alternative version for subjects with minimal or elementary education has uniform administration and scoring criteria. |
| 4. What area are we in at the moment?<br>Name the place we are presently in? | 2 | The items test cognitions such as orientation, association, visual imagery, phonological loop (Logie, 1995), rehearsal loop, learning capacity, attention disengagement (while the neural processing of the new location is enhanced) (Galotti, 2007).<br>N.B. Illiterate people often have no knowledge about state, county or district so they will say roughly the area where they are at present. Place might be the clinic or hospital. |
| 5. Ask the participant to repeat the three actions as directed (taking paper in right hand, folding two times and putting on the floor with left hand)<br>(*Speak only once, score one for each action*) | 3 | This item tests encoding, memory recall and motor control. The instructions are flexible for post-stroke patients and for other patients with motor disability considering hemiparesis, for e.g. the instructions for hand may be different. |
| 7. Sentence repeat, in three groups of two words each (*using regional language with local accent where possible*). *(Score one point for each group of words correctly repeated. Record any sequence problems- note in remarks column).* | 3 | Questions are modified to the understanding level of the participant and should be asked in the regional language if necessary. This is particularly relevant for tribal and dialect variations. |
| 6. Ask the participant to select coins as directed (e.g. select three 2 Rupee coins; two 1 Rupee coins, and four 50 Paisa coins) and place them in a money bank box.<br><br>*Instructions are given once.*<br>*Score one point for each correct response.* | 3 | Currency coin counting task:<br>This task uses currency of the participant's particular region. The instructions are to select a particular number of three different coins from a box and place them into another money bank box. The original box contains different coins that enforce retaining instructions for a longer time until the participant seeks for particular coins, which tests short term, long term and working memory. Different design for currency coins for e.g. two different designs for one rupee (old and new design), purposely have been mixed up to encourage cognitions as pattern recognition and featural analysis (Galotti, 2007). If the participant chooses different designs for a single currency coin the score is valid but the reason behind choosing different or same design is analyzed and noted in the test sheet. |
| 8. Ask the participant to identify three differentlycoloured objects.<br><br>*(Score one point for each object correctly identified/selected.*<br>*Colour deficits, if any, are to be noted in the remarks column.)* | 3 | Object and colour recognition task:<br>This task involves word recognition and assesses cognitive abilities for interpreting the visual information. Deficits in delayed recall and encoding specificity (Galotti, 2007) are prominently detected in this task. |
|  <br>9. Ask the participant to repeat the sequence of the placement of five figures as shown by the examiner.<br><br>*Allow 10 seconds to review the original arrangement.*<br><br>*Note any incorrect sequencing or upside down placement of figures in the remarks column.* | 5 | The shapes used in the five figure sequence task are universally recognized playing card shapes (diamonds, hearts, spades, clubs) and a basic kite shape. The figures are mono colored and presented equally spaced on a sheet of paper kept in a closed box. The participant is instructed to look at the shapes for 10 seconds and then arrange the sequence with a separate set of larger multicolored figures.<br>Multiple complex cognitions are assessed in this task including visuospatial perception (distal stimulus and proximal stimulus) and visual memory, colour and pattern recognition (segregation of figure, form perception, subjective contours) and prototype matching (Galotti, 2007; Logie, 1995). |

| **Table 1 to be Continued…** | | |
|---|---|---|
| 10. Identify the time on a clock and draw another clock with this time.<br>*The task allows equal scoring if the participant cannot draw the clock numbers but is capable of telling the time, drawing the circle and showing the hour and minute hands in association with the centre of the circle. The task allows equal scoring if the participant cannot draw the clock numbers but is capable of telling the time, drawing the circle and showing the hour and minute hands in association with the centre of the circle*. | 3 | Clock interpretation and clock drawing:<br>The tasks involved in motor coordination are administered applying uniform scoring methodology. Visuo-spatial association and spatial recognition in this task are assessed on the same scoring criteria as for those who can draw the clock numbers. The task does not depend upon levels of literacy but assesses spatial relationships. |
|  <br>11. Copy complex figure<br>*(The figure is drawn by the administrator and the participant is asked to copy on the same paper to allow comparison. Score for only the entangled and five diamond shapes.)* | 1 | The task assesses pattern recognition, repetition, spatial recognition, form perception (schemas) and subjective contours (Galotti, 2007). |
| 12. Rewriting 12 letters without touching black borders.<br>*(Score for completion, writing clarity and time taken to complete task.)* | 6 | The "Rewriting letters without touching black borders" task is specially designed for spatial-motor coordination. The 12 English alphabet letters are provided in both lower and upper case and printed on a white sheet in bold contour form (b, O, W, k, p, j, Q, S, g, y, R, n). Participants are instructed to draw a single line inside each letter without touching the borders. |
| Additional test - path finding<br>*Total time and confusion in finding paths is noted.* | Total time for both tasks<br>No score recorded. | The sheet has the illustration of two houses and two curved paths and the participant has to follow the number 1 path that leads to number 1 house and the same instructions are followed for number 2. While finding the path the participant is instructed to get two things placed on different locations on the path and then reach the house. On some locations the path is closed and the participant has to take reverse.<br>This item tests executive function. |

Note: In case of aphasia/speech disorder, motor disability, hearing disability and low vision additional assessment feature could be used.

### *The sample*

Demographic details for the N=355 subjects included in the study are presented in Table 2. There were no differences in age or gender distribution between those with or without a psychiatric diagnosis (Group 2). However, those with a psychiatric diagnosis had significantly fewer years of education ($p < 0.001$) and 37% were classified as illiterate compared with none in the subjects without a psychiatric diagnosis ($p < 0.001$). Within the Group 3 sample, those without a neurological condition were more likely to be female (73% vs 46%, $p = 0.003$), but otherwise the sub-groups did not differ on age, years of education or proportion illiterate.

**Table 2: UMACE Testing Samples characteristics**

| | **Group 1**<br>**NON-CLINICAL**<br>***N* = 78** | **Group 2**<br>**PSYCHIATRIC**<br>***N* = 70** | **Group 3**<br>**NEUROLOGICAL**<br>***N* = 207** |
|---|---|---|---|
| **Clinical, % diagnosed** | n/a | 50.0 (35) | 82.1 (170) |
| **Age, median (IQR)**<br>**range** | 49.5 (19)<br>36 - 77 | 45.5 (20)<br>36 - 77 | 44.0 (22)<br>36 - 81 |
| **Gender, % female (n)** | 65.4 (51) | 64.3 (45) | 50.7 (105) |
| **Years education, median (IQR)**<br>**Range** | 6 (11)<br>0 - 17 | 11 (8)<br>0 - 17 | 10 (6)<br>0 - 18 |
| **Illiterate, % (n)** | 50.0 (39) | 18.6 (13) | 20.8 (43) |
| **MMSE, median (IQR)**<br>**Range** | 20.5 (14)<br>10 - 30 | 26.0 (16)<br>9 - 30 | 22 (17)<br>6 - 30 |
| **MMSE, cognitive impairment % (n)*** | 51.3 (40) | 38.6 (27) | 57.5 (119) |
| **MMSE, education adjusted**<br>**cognitive impairment % (n)†** | 57.7 (45) | 48.6 (34) | 70.5 (146) |
| **UMACE , mean (SD)**<br>**Range** | 31.9 (3.4)<br>23 - 38 | 31.1 (4.1)<br>20 - 38 | 24.0 (7.3)<br>6 - 38 |

* using the cut-off of a score of 23 or less to indicate cognitive impairment.
† using various cut-off scores according to level of education.

Those in Group 2 with psychiatric diagnoses included patients with schizophrenia or non-specific Psychoses (n =16), Mood disorders (n =11), Anxiety disorders (n = 6), and Somatization disorders (n = 2).The neurological patient population in Group 3hadseven categories of neurological disorder. These included (i) Migraine with and without Aura (n = 38, mean age = 39.3, SD 3.9); (ii) Vertigo (n = 18, mean age = 49.0, SD 11.8); (iii) Epilepsy and Seizure disorder (n = 25, mean age = 40.7, SD 6.5); (iv) Stroke (n = 34, mean age = 57.8, SD 12.0); (v) Parkinson's Disease (n = 20, mean age = 61.2, SD 10.5); (vi) Brain disorders (n = 20, mean age = 48.9, SD 14.5); and (vii) Peripheral Nervous System disorders (n = 15, mean age = 57.8, SD 9.8). The latter group of patients had a range of common neurological diseases including Demyelinating Polyneuropathy, Cervical Myelopathy, Motor Neuron Disease, Dystonia, Fibromyalgia and other rare disorders as Tolosa Hunt syndrome and Cauda Equina syndrome.

### *Relationship between UMACE and MMSE scores and demographic characteristics*

For each of the three samples the total UMACE score and the MMSE score were significantly associated with years of education and literacy, but with smaller effect sizes for the UMACE (correlations 0.47-0.65; partial eta squared 0.11 to 0.13) than for the MMSE (correlations 0.73-0.90; partial eta squared 0.40-0.91) (see Table 3). Scores were not associated with gender, however for the Neurology sample (Group 3)there were correlations between age and both UMACE total score and MMSE.

Participants with a psychiatric diagnosis had significantly lower scores on both the UMACE (mean 29.2, SD 3.5 vs no diagnosis 33.0, SD 3.8; $t_{68} = 4.30$, $p<0.001$) and the MMSE (median 12, IQR 15 vs no diagnosis 28, IQR 2; Mann-Whitney U z = -6.23, $p < 0.001$). Duration of psychiatric illness was only significantly correlated with the MMSE, not the UMACE.

Participants with a neurological disorder had significantly lower UMACE scores (mean 22.3, SD 6.7 vs no neurological disorder 32.0, SD 3.8; unequal variance $t_{92} = 12.0$, $p < 0.001$) and MMSE scores (median 20, IQR 17 vs no disorder 27, IQR 20; Mann-Whitney U z = -3.83, $p < 0.001$).Neither UMACE nor MMSE were significantly correlated with duration of neurological illness.Almost all of the neurological patient population (n =205) were found to have mild to severe cognitive impairments, the exceptions were two patients with Peripheral Nervous System disorder. The major cognitive domain problem areas observed in Migraine patients were attention, visuospatial coordination and working memory, which may be affected by prominent symptoms such as "pain" and "insomnia".

**Table 3: Associations between UMACE and MMSE scores and demographic characteristics, presented by study group**

| | UMACE | | | MMSE | | |
|---|---|---|---|---|---|---|
| | Group 1 NON-CLINICAL N=78 | Group 2 PSYCHIATRIC N=70 | Group 3 NEUROLOGY N=207 | Group 1 NON-CLINICAL N=78 | Group 2 PSYCHIATRIC N=70 | Group 3 NEUROLOGY N=207 |
| Age | r = -0.15 | $r_s$ = -0.09 | $r_s$ = -0.20† | $r_s$ = -0.07 | $r_s$ = -0.02 | $r_s$ = -0.18† |
| Gender | $t_{76}$ = 0.86 | $t_{68}$ = 0.15 | $t_{205}$ = -1.82 | z = -1.66 | z = -1.23 | z = -1.50 |
| Literacy | $t_{76}$ = -2.98† | $t_{68}$ = -3.15† | $t_{205}$ = -5.03‡ | z = -7.64‡ | z = -4.69‡, | z = -8.41‡ |
| Years of education | $r_s$ = 0.47‡ | $r_s$ = 0.65‡ | $r_s$ = 0.47‡ | $r_s$ = 0.90‡ | $r_s$ = 0.73‡ | $r_s$ = 0.78‡ |
| Duration of illness | n/a | $r_s$ = 0.17 | $r_s$ = -0.13 | n/a | $r_s$ = 0.38* | $r_s$ = -0.04 |

* p< 0.05
†p < 0.01
‡ p< 0.001
N.B. z refers to statistic from Mann-Whitney U z test; n/a not applicable

### *ROC curve analyses*

Regardless of the sample, the UMACE total score and both section scores demonstrated good capacity for screening for cognitive impairment when the original MMSE cutoffs and the education adjusted

MMSE cutoffs were used as the gold standard measure of cognitive impairment, with AUCs ranging from 0.74 to 0.93 (see Table 4).Cut-off scores maximizing the sensitivity and specificity of the UMACE total score to detect cognitive impairment ranged from 28.5 (in the Group 3 'Neurology' sample) to 32.5 (in the Group 1 Non-Clinical sample). The greatest sensitivities to detect cognitive impairment were observed in the Group 3 sample (89.7-93.3%) and the greatest specificity in the Phase 2 sample (74.4-83.3%).

**Table 4:** Utility of the UMACE: the Area under the curve (AUC), sensitivity and specificity for the three testing samples compared to the original MMSE and the education adjusted MMSE criteria for cognitive impairment

| Group | AUC | 95% CI AREA | *p* | CUT-OFF SCORE* | SENSITIVITY (%) | SPECIFICITY (%) |
|---|---|---|---|---|---|---|
| NON-CLINICAL(*N* = 78) | | | | | | |
| vs MMSE | 0.738 | 0.624 – 0.853 | <0.001 | 32.5 | 70.0 | 68.4 |
| vs education adjusted MMSE | 0.793 | 0.684 – 0.902 | <0.001 | 32.5 | 71.1 | 75.8 |
| PSYCHIATRIC(*N* = 70) | | | | | | |
| vs MMSE | 0.879 | 0.797 – 0.961 | < 0.001 | 31.5 | 88.9 | 74.4 |
| vs education adjusted MMSE | 0.889 | 0.807 – 0.971 | < 0.001 | 31.5 | 85.3 | 83.3 |
| NEUROLOGICAL (*N* = 207) | | | | | | |
| vs MMSE | 0.900 | 0.861 – 0.939 | < 0.001 | 28.5 | 93.3 | 61.4 |
| vs education adjusted MMSE | 0.925 | 0.889 – 0.962 | < 0.001 | 28.5 | 89.7 | 77.0 |

* UMACE 'test positive' if less than or equal to this value

## DISCUSSION

We have demonstrated that a cognitive screening tool, the UMACE test provides a means for assessing a wide range of cognitive functions and is an adequate screen of cognitive impairment in both normal and clinical populations, including a neurological disorder population, with or without literacy, when using the MMSE as a benchmark. Although UMACE is not entirely free of education and literacy effects, the influence was much smaller than that of the MMSE and the UMACE is applicable to a broader population.

The UMACE tool has the flexibility to be administered in a diverse range of cultural and socioeconomic settings. Tasks such as word recall and counting coins use local references for unbiased clinical assessment to enable its use in illiterate populations. Similarly, the design methodology of the verbal tasks was based on clinical studies which suggest that these tasks test memory retrieval and processing capacity in cognitive domains such as attention, categorization, word recognition, language comprehension and coding specificity, independent of academic learning. [20] Of interest was that those with a psychiatric diagnosis had significantly lower scores on both the UMACE and the MMSE, possibly implicating neurodegenerative co-morbidities.

As hypothesized, those with a neurological disorder had significantly lower scores than the non-clinical group on both the UMACE and the MMSE. Notably, this was a relatively young group, and performance on both instruments was not correlated with duration of illness. We have demonstrated the potential use of the UMACE in a patient group with neurological disorders such as epilepsy [21] and Parkinson's disease [22] where comorbid cognitive deficits are well-recognized, although perhaps less frequently in developing countries such as India, where the emergence of a hitherto "hidden" epidemic of neurologic disability in the absence of corresponding neurology care has been noted. [23-26]

We concede several limitations to this study. Firstly, while the UMACE has demonstrated acceptability in persons with poor literacy, performance on the UMACE as with the MMSE remains associated with both literacy and years of education, albeit to a lesser extent. Secondly, the UMACE was developed and tested predominantly in English (but mostly administered using local languages such as Marathi and Hindi), and in an Indian population. Validation of

translated versions of the tool in different languages and populations needs to be undertaken to testify a truly "universal" status.

Neuropsychiatric conditions are major contributors to the burden of disease in India, with the poor, the homeless, and the illiterate or lowly educated particularly at risk, [27] the very group in whom identification of such conditions and associated cognitive impairment remains fraught. One of the major problems identified has been in conceptualizing and measuring mental disorders, arriving at the extent of morbidity [27] and "paying attention" to these disorders. We have developed a tool that overcomes, at least to a greater extent than existing tools, many of the barriers to the assessment of cognition in the very people most at risk for impairment in cognition that is those with sensory impairment, neurological and psychiatric disorders and those who are illiterate with low education.

***Conflict of interest declaration:*** None

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