Cognitive function and disability in late life: An ecological validation of the 10/66 battery of cognitive tests among community dwelling older adults in South India

Key words: Late life, cognitive function, disability, validation, 10/66 Dementia Research

Key Points

- 10/66 cognitive tests are well suited for identification of older adults with cognitive and functional impairment at a population level in LMIC setting.
- Lower scores on individual domains of the 10/66 battery of cognitive tests are associated with higher levels of disability and functional impairment.
- It is feasible to administer 10/66 cognitive assessments in participant's own homes in India.
- 10/66 cognitive tests are education and culture fair, suitable for use in population based research in India.

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This study was funded by the Wellcome DBT India Alliance as an Early Career Research Fellowship to Dr Murali Krishna. Word count: 3045

Background

Neurocognitive disorders are a major cause of disability and mortality in late life and are associated with high costs for health systems and society (Mathers & Matilde 2000; WHO 2004; Dementia India Report 2010; WHO Report 2001). Population based studies in India report 7.5% and 10.6% prevalence for dementia in those aged above 60 yrs in urban and rural areas respectively (Dementia India Report 2005; Prince 2005**).** The proportion of persons with dementia is expected to increase two-fold by 2030 because of the steady growth in the older population and stable increments in life expectancy (Dementia India Report 2010; World Alzheimer Report 2009; Ferri et al., 2006). Although neurocognitive disorders are the second highest source of burden after tropical diseases, research in India remains minimal (Murray & Lopez1996).

The Global Burden of Disease report identifies cognitive impairment as one of the main causes of disability and this has a disproportionate impact on capacity for independent living in later life. Comorbidity with cardiometabolic disorders is common and interacts in complex ways to create disability, and dependence (Lozano et al., 2012). Therefore, it is important to understand the contribution of cognitive disorders, relative to that of other chronic diseases, to disability and dependence.

The population based studies by 10/66 Dementia Research Group have assessed the impact of dementia and mild cognitive impairment on disability and dependency in late life in low and middle income countries (LMIC) including India (Sousa et al.,2009; Sosa et al.,2012). Those with greater disability and need for care were characterised by co-morbidity between cognitive impairment and physical and mental disorders. Dementia emerged as the leading independent cause of both disability and dependency, followed by limb weakness, stroke, depression, eyesight problems and arthritis. Neither ischaemic heart disease nor hypertension, or even chronic obstructive pulmonary disease was associated with disability or dependency (Sousa et al., 2009; Sosa et al., 2012).

A culture and education fair battery of cognitive tests was developed, validated and normed for use in LMICs (including South India) by the 10/66 Dementia Research Group. This is suitable for use in people with little or no education (Prince et al., 2003). The 10/66 battery of cognitive tests is comprised of: the Community Screening Instrument for Dementia (CSID) incorporating the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) animal naming verbal fluency task, the modified CERAD 10 word list learning task with delayed recall and an informant interview for evidence of cognitive and functional decline (Prince et al., 2003; Prince et al., 2007). In the 10/66 pilot studies, the CSID, informant interview and the modified CERAD 10 word list-learning task were independently able to predict the diagnosis of dementia (Prince et al., 2003).

The ecological validity and relationship between the individual domains of the 10/66 battery of cognitive tests and disability has not been examined in community dwelling older adults in India**.** Ecological validity refers to the extent to which the findings of a research study are able to be generalised to real-life settings.

This study examined the association between individual domains of the 10/66 battery of cognitive tests [word list memory and recall (WLMR), verbal fluency (VF) and a global cognitive function score derived from the Community Screening Instrument for Dementia (CSI'D' COGSCORE)] and 'disability' and 'functional impairment' in community dwelling older adults in the city of Mysore, South India. The mediating effect of self reported chronic non-communicable diseases is examined. In addition, we explored the feasibility of administering the 10/66 battery cognitive tests to an older person and a reliable informant in their own homes.

Methods

Design and Setting

This single phase cross sectional validation study was carried out at the Epidemiology Research Unit, Holdsworth Memorial Hospital, Mysore, South India. The study was approved by the Ethics and Research Committee at Holdsworth Memorial Hospital.

Adults aged 60 yrs and above and residing at Karunapura (colony number 1), a mainly Christian community in the inner city of Mysore were eligible to participate. All households in the study area (n=186) were approached by a door to door survey and study information was provided. 151 individuals aged 60 yrs and above were identified from 138 households. 129 of them agreed to participate and were recruited along with a reliable informant after obtaining written consent. Individuals who were close to the subjects and knew them for most of their lives (spouse, relative or a friend) were considered reliable informants. If the participant was illiterate, verbal consent was obtained, which was witnessed and signed by a relative. If individuals were unable to consent (due to severe cognitive problems) assent was obtained from their nearest/authorised relative and was witnessed.

Instruments

a. Cognitive function tests: Cognitive functioning as a continuous measure was obtained by administering the Kannada (local language) version of the 10/66 cognitive assessment battery. This is drawn principally from the Community Screening Instrument for Dementia (CSID) developed by the Ibadan-Indianapolis study group (Hall et al., 2000) specifically for use in cross-cultural research, and in low education settings, and from the CERAD (Morris et al., 1989). The aim of the translation process was to achieve a Kannada version of the English 10/66 battery of cognitive tests that was conceptually equivalent to the study setting and practically perform in the same way. The focus was cross-cultural and conceptual, rather than on linguistic or literal equivalence. This was achieved by using forward translation (by author MK) and back translation (by authors EB and SA) methods. This battery comprises:

i) Global Cognitive Function measured by administering the Community Screening Instrument for Dementia (CSI 'D') to the subjects (Hall et al., 2000). This includes a 32 item cognitive test assessing orientation, comprehension, memory, naming and language expression, which generates a global cognitive score (CSID COGSCORE).

The CSI 'D' was from the outset intended to be used across cultures with the minimal adaptation. It was developed and first validated among Cree American Indians (Nath et al., 1993; Hendrie et al., 1995), further validated and used in population-based research among Nigerians in Ibadan, African-Americans in Indianapolis, white Canadians in Winnipeg and in Jamaica in conjunction with the CERAD battery (Hendrie et al., 1995; Hall et al., 2000; Unverzagt et al., 1999). The CSI 'D' test score distributions among those with dementia and controls, and the degree of discrimination provided was remarkably consistent across the aforementioned cultural settings (Unverzagt et al., 1999).

ii) Verbal fluency (VF) measured by the animal naming verbal fluency task from the CERAD (Hall et al., 2000; Morris et al., 1989). After a brief practice, naming items from another category (clothing), participants are encouraged to name as many different animals as they can in the space of one minute. The instructions read out to the participant stipulate: 'think of any kinds of animal in the air, on land, in the water, in the forest, all the different animals'. If the participant stops before the allotted time has elapsed they are encouraged to continue. The score is one point for each valid name.

iii) Memory is measured by the modified Word List Memory and Recall (WLMR) test to evaluate immediate and delayed recall respectively. WLMR has been reported to be of particular value in distinguishing early dementia from normal aging (Welsh et al., 1991). WLMR is taken from the adapted CERAD ten word list learning task used in the Indo-US Ballabgarh dementia study (Ganguli et al., 1996). Six words- butter, arm, letter, queen, ticket and grass were taken from the original CERAD battery English language list (Guruje et al., 1995). Pole, shore, cabin, and engine were replaced with corner, stone, book and stick, which were deemed more cross-culturally applicable (Prince et al., 2003). In the learning phase, the list is read out to the participant from a green card, who is then asked to recall straight away the words that they remember. This process is repeated three times, giving the subject a score out of 30. Approximately five minutes later, after a series of unrelated CSI'D' questions (name registration, object naming, object function and repetition) the participant is again asked to recall the 10 words with prompting that they were read from a green card, giving a recall score out of 10. This makes the total WLMR score of 40.

iv) The CSI'D' informant interview: In the informant section of the CSI'D', a reliable informant is asked about declining memory in general, and the frequency of six specific and characteristic memory lapses; forgetting where s/he has put things, where things are kept, names of friends, names of family, when s/he last saw informant, and what happened the day before. If the subject was receiving care, the primary caregiver was considered as a reliable informant. The 26 items from the interview seek for evidence of cognitive and functional decline (Nath et al., 1993; Hendrie et al., 1995; Prince et al., 2003). The response to each item is weighted and for the purpose of this study, a summative score (CSI'D" RELSCORE) of more than 2 was considered as indicative of cognitive decline resulting in 'functional impairment'. The 10/66 battery cognitive tests in English is provided as an appendix and the Kannada version will be shared upon request by interested readers.

The following instruments were administered to the participant and if they were unable to provide accurate information (for example due to cognitive problems or following a stroke), they were administered to the reliable informant.

a. Socio-demographic questionnaire collecting information on age, sex, marital status, level of education (none; some, but did not complete primary; completed primary; completed secondary; completed tertiary or further education) and living circumstances (living with children, yes/no) (Prince et al., 2007).

b. Medical history questionnaire: Hypertension and diabetes were ascertained by a positive answer to the question "have you ever been told you had diabetes or hypertension?" The ascertainment of previous episodes of stroke or ischaemic heart disease (IHD) was based on self-report ("have you ever been told by a doctor that you had a stroke/angina/heart attack?"). Stroke was coded only if there was a clear history of sudden onset of unilateral paralysis, loss of speech, or blindness lasting for more than 24 hours, hence excluding previous episodes of transient ischemic attack. Chronic obstructive airway disease (COAD) was diagnosed in people who responded "yes" to the question "do you usually cough up phlegm from your chest first thing in the morning?" and whose answer to the question "for how many months of the year does this usually happen?" was 3 months or more. (Prince et al., 2007)

c. Physical Health Impairment Schedule: This is a self-reported list of twelve commonly occurring physical impairments, a measure of health impairment (Duke University 1978). They include arthritis/rheumatism, eyesight problems, hearing difficulty or deafness, persistent cough, breathlessness/asthma, high blood pressure, heart trouble/angina, stomach problems, intestine problems, faints/blackouts, skin disorders and paralysis/ weakness or loss of one leg or an arm. Impairments were rated as present if they interfered with activities "a little" or "a lot", as opposed to "not at all".

d. WHO Disability Schedule-II: The degree of disability was measured by administering the WHO Disability Schedule-II (WHO DAS II) (Rehm et al., 2000). It was developed by the WHO as a culture-fair assessment tool for use in cross-cultural comparative epidemiological and health services research to measure activity limitation and participation restriction. The 12-items assess five activity limitation domains (communication, physical mobility, self-care, interpersonal interaction, life activities and social participation). Each domain is covered by two questions, with scores ranging from 0 (no difficulty) to 4 (extreme difficulty or cannot do), yielding a total score between 0 and 48.

Data collection

A clinical psychologist (EB) was trained by MK, a member of the 10/66 Dementia Research Group to administer the instruments in subjects' own homes. The interviews for participants and a key informant were carried out separately, but this was not always feasible. The data were manually collected on paper and then entered into the Epidata (version 3) driven database developed by the 10/66 Dementia Research Group. These files have in built checks to minimise errors and thereby assist in the cleaning of data. The data were double entered, cleaned and directly exported to SPSS version 19 for analysis.

Statistics

a. A power calculation was not carried out before commencing the study, as no study had previously examined the association between individual domains of the 10/66 cognitive battery and disability in an older adult population from this region. A post hoc power calculation indicated that our sample size had more than 90% power to detect a correlation of at least 0.20 between disability and exposure variables (WLMR, VF and CSI'D' COGSOCRE) significance at the 5% level (table 1).

Table 1 here see below

b. Descriptive statistics were done to calculate mean, standard deviation and proportions. Independent samples t-tests were used to test for differences in socio-demographics, cognitive function, health impairment and disability scores between men and women. Multiple linear regression was used to examine the association between the dependent variables (WHO DAS II score) and independent variables/predictors (WLMR, VF and CSI'D' COGSCORE). The cognitive scores were adjusted for age, education and gender. The regression analyses were adjusted to examine the mediating effect of self reported chronic non communicable disorders (diabetes, hypertension, stroke, COAD and IHD).

Results

The 129 participants included 42 men and 87 women aged between 60 and 90 yrs of age. Table 2 shows their characteristics. The women had significantly lower levels of literacy and were more likely to be widowed when compared to men (p=<0.001). Table 2 provides mean scores on individual cognitive tests, health impairment and disability for men and women.

Table 2 here see below

The CSI'D informant interview identified 33 of the 129 subjects as having cognitive decline severe enough to cause 'functional impairment' (i.e. CSI'D' RELSCORE of 2 or more). The associations of functional impairment and cognitive function score are provided in table 3.

Table 3 here see below

The association between cognitive function and disability score (WHO DAS II) was examined in regression analyses (see table 4). The analyses were adjusted for age, education and gender. There was a significant inverse association between WHO DAS II score and WLMR (p=0.004), VF (0.006) and CSI'D' COGSCORE scores (P<=0.001) even after adjusting for self-reported IHD, stroke, COAD, hypertension and diabetes.

Table 4 here

Discussion

Lower scores on individual domains of the 10/66 battery of cognitive tests are associated with higher levels of disability and functional impairment in community dwelling older adults in Mysore, south India. This is the first population-based ecological validation study of the 10/66 instruments in India to examine these associations. The association between

CSI'D' COGSCORE, VF, WLMR scores and disability were strong and independent of self-reported chronic non-communicable disorders. The associations between lower cognitive function scores and disability in late life were not attenuated after adjusting for chronic non communicable disorders. Our finding is similar to the observation by the 10/66 Dementia Research Group that dementia and amnesic mild cognitive impairment independently predict disability in late life (Sosa et al., 2012). Unlike the previous 10/66 research reports from India that examined the impact of diagnostic categories of cognitive impairment (amnesic mild cognitive impairment and dementia) on disability, this study examined cognitive function as a continuous variable.

Independently, all three cognitive function tests were able to identify individuals with 'functional impairment' due to cognitive problems in this sample of community dwelling older adult population where nearly a third of them were illiterates. This reconfirms 'culture and education fair' properties of the 10/66 cognitive tests and that these are well suited for identification of older adults with cognitive and functional impairment at a population level in LMIC setting.

In this study, women had significantly lower global cognitive function score (CSI'D'COGSCORE) than men. This may be due to lower education levels attained by the women in the study. Interestingly, despite lower attained educational levels and lower CSI'D'COGSCORE, there were no significant gender differences in disability. This may be partly explained by the fact that health impairment between men and women were the same, but this needs to be examined further.

It was feasible to administer the 10/66 instruments in participants' own homes and all assessments were completed. Administering a battery of cognitive tests to an older adult and interviewing an informant in their own homes has its strengths and weaknesses. It was a challenge to administer cognitive tests in a standardised manner while strictly adhering to the test protocol. The reasons include: limited physical space, lack of privacy, poor lighting, noise levels and in some instances family members and friends attempting to prompt or answer for the subject despite clear instructions not to do so. However, being at the participants' own home provided an opportunity to observe them in familiar surroundings and identify reliable informants. The informants were generally reluctant to report certain information like toileting needs, getting lost in the neighbourhood and needing assistance with personal care out of respect to their elders. This may have potentially resulted in underreporting of cognitive and functional decline by the informants.

Strengths: This study was carried out in an inner city area of the district with even distribution of families across various socioeconomic classes. Therefore the sample is likely to represent normal community dwelling older adults in Mysore. A reliable informant was interviewed for all the participants. In those who were receiving care, the main 'hands on' caregiver was interviewed. The few refusals to participate were mainly due to social inconvenience (e.g. visitors at home, festivities and ceremonies) and not genuine unwillingness to participate. The clinical psychologist was supervised to ensure that tests were administered in a standardised manner. There were no missing data and all analyses are complete.

Limitations: The major limitation of this validation study is that no diagnostic interview schedule was administered to determine if the participants had a diagnosable mental disorder particularly depression and dementia. Depression is a common comorbidity with cognitive disorders and enhances the resulting impairment and disability in late life. This limitation was partly overcome by administering a CSID informant interview that generated a final score indicating if the subjects' cognitive problems were severe enough to impair the subject's activities of daily life and any other functional impact. All chronic diseases were self-reported with a negligible few having any medical records to verify.

Abbreviations

a. CSI'D': Community Screening Instrument for Dementia
b. WHO DAS II: WHO Disability Assessment Score version II
c. CSID'I': Community Screening Instrument for Dementia-Informant Interview
d. COAD: Chronic Obstructive Airway Disease.
e. VF: Verbal Fluency
f. WLMR: Word List Memory Recall
g. CERAD: The Consortium to Establish a Registry for Alzheimer's Disease

Conflict of Interest
None of the authors have any conflict of interest to declare.

Acknowledgements

This study was funded by the Wellcome DBT India Alliance as an Early Career Research Fellowship to Dr Murali Krishna. Our sincere thanks to the participants and their families for taking part in this study. We thank Mr Kiran K Nagaraj, CSI Holdsworth Memorial Hospital for his assistance with data management.

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Table 1. Post hoc power calculation

Dependent Variable	Independent	R-Square	Effect Size	Number of Predictors	Alpha	Sample Size	Power
Disability	Word list memory recall (WLMR)	0.245	0.32450	8	0.05	129	0.9987834
	Verbal fluency (VF)	0.292	0.41243	8	0.05	129	0.9999228
	CSI'D' COGSCORE	0.281	0.39082	8	0.05	129	0.9998448

CSI'D': Community Screening Instrument for Dementia

Table 2. General characteristics of the study participants.

Characteristics	Male (N=42)	Female (N=87)	p value
Age mean(SD)	67.81 (6.64)	69.46 (7.30)	0.22
Education			
None	1 (2.4%)	28 (32.2%)	<=0.001
Some, but did not complete primary	5 (11.9%)	5 (5.7%)	
Completed primary	5 (11.9%)	18 (20.7%)	
Completed secondary (metric)	15 (35.7%)	24 (27.6%)	
Completed tertiary (college)	16 (38.1%)	12 (13.8%)	
Marital Status			
Never married	-	4 (4.6%)	<=0.001
Married/Co-habiting	31 (73.8%)	27 (31.0%)	
Widowed	11 (26.2%)	56 (64.4%)	
Religion			
Roman Catholic	3 (7.1%)	2 (2.3%)	
Anglican / Protestant	23 (54.8%)	39 (44.8%)	0.304
Muslim	2 (4.8%)	6 (6.9%)	
Hindu	14 (33.3%)	40 (46.0%)	
Job			
Paid full-time work	3 (7.1%)	3 (3.4%)	<=0.001
Paid part-time work	4 (9.5%)	0 (0%)	
Housewife/husband	4 (9.5%)	45 (51.7%)	
Retired	30 (71.4%)	35 (40.2%)	
Hypertension	6 (14.3%)	11 (12.6%)	0.834
Ischemic heart disease	6 (14.3%)	11 (12.6%)	0.834
Stroke	2 (4.8%)	1 (1.1%)	0.197
Diabetes	16 (38.1%)	27 (31.0%)	0.478
Chronic obstructive airway disease(COAD)	4 (9.5%)	6 (6.9%)	0.641
Smoking (ever)	7 (16.7%)	2 (2.3%)	0.007
Alcohol (ever)	5 (11.9%)	0 (0%)	
Alcohol (Present)	5 (11.9%)	0 (0%)	
Cognitive Function			
CSI'D' COGSCORE	37.46 (4.27)	34.61 (5.10)	0.002
Verbal fluency (VF)	13.76 (4.0)	12.03 (4.85)	0.047
Word list memory recall (WLMR)	19.43 (7.23)	17.56 (6.70)	0.150
Physical health impairment schedule score	12.48 (1.90)	13.18 (1.90)	0.05
WHO Disability II score	1.76 (5.09)	2 .29 (3.01)	0.464

CSI'D' : Community Screening Instrument for Dementia

Table 3. Association between cognition and functional impairment

Cognitive Function	Functional impairment n=23	No functional impairment n=106	P
CSI'D ' COGSCORE	32.82 (5.61)	36.47 (4.44)	<0.01.
Verbal fluency (VF)	11.0 (4.52),	13.4 (4.52),	0.03
Word list memory recall (WLMR)	15.94 (6.38)	18.94 (6.94)	0.03

Table 4. Association between cognition and disability

Dependent Variable	Predictors	Beta coefficient	95% CI value	p values
	CSI'D ' COGSCORE	-0.282	-0.408, -0.155	<=0.001
WHO DAS II score	Verbal fluency (VF)	-0.215	-0.366, -0.064	0.006
	Word list memory and recall (WLMR)	-0.150	-0.25, -0.05	0.004

Predictors are adjusted for age, education and gender. The regression analyses were adjusted for IHD, stroke, COAD, hypertension and diabetes. CSI'D': Community Screening Instrument for Dementia