The effect of aging on cognitive function in a South Indian Population

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Abstract- Although it is known that there is a change in cognitive function with aging, different views exist on the extent, type of cognitive function involved, age of onset and the factors affecting it. We undertook this preliminary study with an aim of determining the effect of aging on cognitive function in a normal non-demented South Indian population. A simple bedside screening test, the Mini-Mental State Examination (MMSE) was administered to 50 controls aged 20-50 years (Group I), 50 normal non-demented subjects aged 60-75 years (Group II) and 50 subjects aged above 75 years (Group III) of both sexes. It was found that there was a significant difference ($p = 0.02$) between the MMSE scores of controls (28.12 ± 1.22) versus that of the subjects (27.43 ± 1.88) and that there was a significant difference ($p = 0.003$) only in the orientation subset which tests recent memory, with the controls having a mean $\pm$ SD of 9.90 ± 0.30 and the subjects having a score of 9.63 ± 0.60. Education had an effect on the MMSE scores. Males had higher scores in the attention and calculation subset and hypertensive subjects had significant differences in the language subset. Limitations of this study include possible inclusion of subjects who are not truly disease free; use of a simple screening test in view of the general literacy level and socio-economic status of the population studied and the fact that the results of this study may not therefore be representative.

Index Terms- Aging, cognitive function, Mini-Mental State Examination (MMSE), normal

I. INTRODUCTION

Our society is an aging society where people are living longer. Cognition refers to the thinking processes through which knowledge is gained, stored, manipulated and expressed and cognitive functions include attention, language, memory, constructional ability and higher cognitive functions like calculation. Attention and memory have been found to be the two cognitive functions that are affected the most by aging, although variations exist in age-related cognitive functions in different individuals and domains in terms of susceptibility to the effects of aging.[1]Researchers however have consistently noted several 'normal' cognitive changes with aging like slowing of reaction time, deterioration of fluid intelligence and impairment in certain aspects of short term memory.[2]However, Salthouse states that assumptions that the effects of aging on cognition are small and limited to memory, begin later in life only in some individuals have been proven to be incorrect in his research-he found that scores in vocabulary test were higher with increased age until about the mid-50s, after which they remained stable or declined slightly and similar negative trends were noted in speed, reasoning and memory.[3]He however found that age-related effects were apparent before age 50.A longitudinal study of cognitive decline over ten years involving results from the Whitehall II prospective cohort study showed that cognitive decline occurs at all ages between 45 and 70, even among those aged 45-49 at baseline.[4]

The Mini-Mental State Examination (MMSE)[5] is a widely used, simple, bedside screening test for assessing global cognitive function.[6]The results of a 5-year longitudinal study of the MMSE score in 2,537 non-demented French subjects aged 65 years and older showed that the MMSE score declines very slightly in non-demented subjects, and suggested that the cognitive processes involved are spared by the aging process.[7] These researchers state however that they could not rule out the possibility that some MMSE sub-scores may improve with time while others decline.

Other studies have found that MMSE scores are affected by age, education[6,8]and cultural background.[6]Magazinger et al have even proposed the use of age-and education- specific equations and a shorter version of the MMSE to predict performance.[9]In addition, socio-economic status also has an effect.[10] However the patient's sex has not been found to have an effect on MMSE scores[11,12],though race and functional status did have an effect.[11]Baseline systolic and diastolic blood pressure have been found to be positively and significantly associated with baseline MMSE scores in a community based Swedish cohort study.[13]Another study initiated after other researchers found mid-life high blood pressure levels are related to late cognitive decline did not find a linear association of blood pressure with cognitive decline although the relationship was thought to be more complex.[14]In a 11 year follow up study of four successive age cohorts, interestingly, a significant impact of the generation factor was found leading the investigators to conclude that cognitive performance depends not only on aging but also on generation specific factors.[15]

In view of the findings of the above studies, the present study was done in order to determine the cognitive changes if any that occur with aging in a normal non-demented South Indian population using the Mini-Mental State Examination (MMSE).

II. AIM

The aim of our study was to determine the effect of aging on cognitive function of a normal non-demented South Indian population, using the Mini-Mental State Examination (MMSE) and to determine the effect of factors like sex, educational status, systolic blood pressure, diastolic blood pressure and co-existing systemic hypertension on cognitive function scores.

III. MATERIALS AND METHODS

This study was done in the Institute of Physiology and Experimental Medicine, Madras Medical College, Chennai and the Department of Geriatric Medicine of Government General Hospital, Chennai after the due permission and consent was obtained. 50 controls aged 20-50 years (Group I), 50 subjects aged 60-75 years (Group II) and 50 subjects aged above 75 years (Group III) of both sexes with a minimum 6^{th} standard education took part in the study. Individuals with history or clinical evidence of neurological diseases including dementia, stroke, transient ischaemic attacks, depression, Parkinsonism, epilepsy, head injury, brain tumors or brain surgery and individuals with un-corrected visual or auditory defects were excluded.

Screening of the subjects and controls consisting of history and clinical examination was done and data recorded. Systolic and diastolic blood pressure was measured in the right upper limb using a sphygmomanometer in the sitting posture after a ten minute rest.

The Folstein Mini-Mental State Examination (MMSE),[5] which is the most widely used bedside screening measure for global cognitive functioning[6] was administered in the same systematic manner to all the subjects and the controls. The MMSE has a maximum score of 30 points. 5 points are for the question on orientation to time, 5 for orientation to place, 5 for attention, 3 for registration of three items, 3 for recall of the three items after five minutes, 2 for naming objects, 1 for repeating a phrase, 3 for following a three stage command, 1 for following a printed command, 1 for writing a sentence and 1 for copying a diagram. Orientation to time and space is given a total of 10 points and is the most thoroughly tested area in the MMSE. Naming objects, repeating a phrase, following a 3 stage command and a written command and finally writing test different aspects of language and are given 8 points totally. Immediate memory or registration is tested by asking the subject to repeat all three unrelated words said by the examiner and recall or short term memory is tested by asking the subject to recall the same three unrelated words after 5 minutes, each carrying 3 marks. As a test of attention and calculation, the subject is asked to serially subtract 7 from 100 or to spell world backwards to test attention. Visual, spatial and constructional abilities are tested together in the MMSE by asking the subject to copy a figure of intersecting pentagons. In general, scores below 24 are taken as indicating cognitive impairment. However, there is a grey area of scores of 24 to 28 where generally adjustment needs to be made for age, education and socio-economic status.

Based on the clear scoring instructions of the MMSE, scores were given to each of the 100 subjects and the 50 controls. Means and standard deviations were determined for each group using SPSS and comparison of the MMSE scores of subjects and controls and then separately of all three groups was done using ANOVA and Bonferroni method. The same procedure of comparison was followed for the subset scores also. Finally, the effect of sex, educational status, systolic blood pressure, diastolic blood pressure and co-existing systemic hypertension on the MMSE cognitive function scores was determined using logistic regression.

IV. RESULTS

Analysis of the MMSE score of controls (Group I) and subjects (Group II+ Group III) showed that there was a significant difference in scores(Table 1).

Table 1 - Comparison of the Mini-Mental State Examination (MMSE) scores of controls (Group I) &subjects (Group II + Group III)

Group I (n = 50)	Group II & Group III (n = 100)	p Value
28.12 ± 1.22	27.43 ± 1.88	0.02

Results are expressed as mean and standard deviation of the total MMSE scores, the maximum score being 30.p< 0.05=significant

Although the MMSE score of controls (Group I) versus Group II was not significant, the comparison of the MMSE score of controls (Group I) versus Group III and Group II versus Group III was found to be very highly significant and significant respectively (Table 2).

Table 2 - Comparison of the Mini-Mental State Examination (MMSE) scores of the three groups

Group I	Group II	Group III	Category	p Value
28.12 ± 1.22	27.94 ± 1.43	26.92 ± 2.13	I vs II	1.000
			I vs III	0.001
			II vs III	0.007

Results are expressed as mean and standard deviation of the total MMSE scores, the maximum score being 30. p> 0.05= not significant, p < 0.05= significant, p < 0.001= highly significant.

Comparison of the MMSE subset score of Group I versus Group II + Group III showed a significant difference(p=0.003) only in the Orientation subset with Group I having a mean ± SD of 9.90 ± 0.30 and Group II + Group III having a score of 9.63 ± 0.60 out of the possible maximum score of 10.

Comparison of the MMSE subset scores of the 3 groups is shown in Table 3 in the Appendix. Analysis of the frequency distribution of MMSE score of the controls (Group I) and subjects (Group II + Group III) using class intervals of ≤ 23, 24-28 and 29-30 was not significant, with a p value of 0.223.

Results of analysis of the influence of various factors on the MMSE score showed that education did have an effect on the score. Males had higher scores on the attention and calculation subsets. There was no relationship between MMSE scores and systolic and diastolic blood pressure measured concurrently, although there was a significant difference in the language subset in subjects with history of hypertension.

V. Discussion

The present study done to assess the effect of aging on cognitive function showed that the Mini-Mental State Examination (MMSE) scores were affected with aging, with there being a significant difference in the MMSE score of controls and subjects. This is in agreement with the findings of other studies[6,8,9], but differs from the5-year longitudinal study of the MMSE on aging[7]which suggested that the cognitive processes involved are spared by the process of aging. However there appears to be evidence of only a late decline in cognitive function in the subjects of our study as comparison of score of controls (Group I) versus Group III subjects aged above 75 years was very highly significant while there was no significant difference in MMSE score of controls (Group I) versus Group II who were aged 60-75 years. These findings are to be compared with those of the Whitehall II study [4] , that unlike other studies found that cognitive decline occurs at all ages between 45 and 70, even among those aged 45-49 at baseline.

Even though there was a significant difference in MMSE scores of controls and subjects, further analysis of the MMSE subset scores in the three groups was done keeping in mind the findings of the 5-year longitudinal study of the MMSE score in non-demented French subjects aged 65 years and the researcher's statement that they could not rule out the possibility that some subset scores could improve while others decline.[7] Our study revealed that subjects showed significant decline only in the orientation subset of the MMSE that tests recent memory. These results are to be taken in the context that orientation is the most thoroughly addressed area in the MMSE and accounts for one third of the total MMSE score. It has also been found that the MMSE is not sensitive for discriminating between age-related cognitive change, mild cognitive impairment and early dementia.[16]

In our study, there was no significant difference in performance of controls and subjects in the registration (immediate memory), 5 minute recall (that tests short term auditory memory) and language subsets of the MMSE. The lack of significant difference in 5 minute recall scores does not agree with the findings of previous researchers who found impairment in short term memory with aging.[1,2] Language processing has been stated to be generally unaffected with age, although processing speed may become slower[1],which could explain the findings of our study. It is also important to remember that the language subset of the MMSE tests only naming, repetition, reading, auditory comprehension and writing.

An interesting finding of our study was that subjects aged 60-75 years of Group II had the highest scores in the attention and calculation subset (Table 3 in Appendix) and although the difference between the controls(Group I) and them was not significant, the difference between them and Group III aged above 75 years was significant. The probable reason for this high score in calculation could reflect childhood training and lack of dependences on calculators or could be the result of greater exposure to simple mental calculations in day to day life. In the visual-constructional ability subset it was found that there were significant changes between Group I and Group III and also between Group I and Group III.

Like other studies[6,8], our study also showed that education had an effect on the MMSE scores, even though we had taken care to only enroll subjects with a minimum 6th standard education. Our finding that males had higher scores in the attention and calculation subset of the MMSE which differs from other studies that did not find any effect of sex on MMSE scores[11,12] could be explained by possible greater exposure of males to situations involving calculation and education. However our finding that hypertensive subjects had significant differences only in the language subset of MMSE is in contradiction to other studies where researchers have proved that mid-life high blood pressure levels are related to late cognitive decline.[14]Adequate hypertensive control could be a possible explanation. Our finding that there was no relationship between MMSE scores and systolic and diastolic blood pressure measured concurrently differs from the Swedish cohortstudy[13]which found that it was positively and significantly associated with baseline MMSE scores.

In conclusion, our study confirms that cognitive function changes with aging with recent memory showing a decline ; there being no change in certain cognitive functions like short term auditory memory, immediate memory and language; while attention and calculation seemed to be somewhat enhanced in later periods of life - which though not statistically significant, could possibly be clinically significant. Education had an effect on MMSE scores. Males had higher scores in the attention and calculation subset and hypertensive subjects had significant differences only in the language subset of the MMSE.

A major limitation of this study, which is common to all cross sectional studies, is the possible inclusion of subjects with occult dementia. This study used the MMSE that is commonly used in Indian institutions keeping in mind the general literacy level and socio-economic status of subjects attending government hospitals, further studies can be done using more specific psychometric tests on a more varied South Indian population to

be more representative.

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APPENDIX

Table 3 - Comparison of the Mini-Mental State Examination (MMSE) subset scores of the 3 groups

MMSE subsets	Group I (Mean ± SD)	Group II (Mean ± SD)	Group III (Mean ± SD)	Statistical Analysis		
				Category	p Value	Significance
Orientation (Max. Score=10)	9.90 ± 0.30	9.70 ± 0.58	9.56 ± 0.61	I Vs II	.165	NS
				I Vs III	.004	S
				II Vs III	.534	NS
Registration (Max. Score = 3)	3.00 ± 0.00	3.00 ± 0.00	3.00 ± 0.00	I Vs II	1.00	NS
				I Vs III	1.00	NS
				II Vs III	1.00	NS
Attention and Calculation (Max. Score = 5)	4.40 ± 0.73	4.66 ± 0.72	4.10 ± 1.25	I Vs II	.601	NS
				I Vs III	.265	NS
				II Vs III	.009	S
Recall (Max. Score = 3)	1.96 ± 0.97	1.84 ± 1.08	1.78 ± 1.04	I Vs II	1.00	NS
				I Vs III	1.00	NS
				II Vs III	1.00	NS
Language (Max. Score=8)	8.00 ± 0.00	7.96 ± 0.20	7.96 ± 0.20	I Vs II	.654	NS
				I Vs III	.654	NS
				II Vs III	1.00	NS
Visual-constructional ability (Max. Score = 1)	0.82 ± 0.39	0.78 ± 0.42	0.56 ± 0.50	I Vs II	1.00	NS
				I Vs III	.011	S
				II Vs III	0.40	S

Results are expressed as mean and standard deviation
Group I = 20 – 50 Years
Group II = 60 – 75 Years

Group III	=	> 75 Years
MMSE	=	Mini-Mental State Examination
NS	=	Not Significant ($p > 0.05$)
S	=	Significant ($p < 0.05$)
HS	=	Highly significant ($p < 0.001$)

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