

# To Establish Normative Data of Montreal Cognitive Assessment Test (MoCA) Scale in Middle-Aged Adults (40-60 years) of Indian Population Residing in Mumbai - A Cross-Sectional Study

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## ABSTRACT

**Background:** Cognitive decline is among the most feared aspects of growing old. Assessing cognitive functioning is important in determining the level of impairment. Montreal Cognitive Assessment Test (MoCA) has been used as a rapid screening tool to assess cognitive function.

**Objective:** This study was conducted to establish normative data in the adult population of Mumbai (40-60 years of age) using the MoCA scale.

**Materials and methods:** The Institutional Ethics Committee (IEC) approval was obtained and a cross-sectional study was conducted in a metropolitan city in India, from November 2022 to December 2022. Adults were screened using The Saint Louis University Mental Status Examination (SLUMS) out of which 107 participants were recruited, ranging from 40-60 years of age. Montreal cognitive assessment test (MoCA) was used to capture normative data on the age, gender, and education demographics.

**Results:** The composite mean score of MoCA was found as 24.12 with a standard deviation of  $\pm 3.525$  giving a range of 20.595 - 27.645. There was no significant difference in despite of scores between the two age groups and the gender variant. However, education had an impactful difference. The mean score on MoCA for graduates and primary education was 25.39 and 21.80 respectively. It showed a statistically highly significant difference with higher values in graduates.

**Conclusion:** The MoCA scores were directly correlated with educational status. Hence, this study helped us to understand the subtle cognitive impairments in early adulthood. Population-based normative data is essential for early screening and diagnosis.

**Keywords:** Montreal cognitive assessment test MoCA, Normative data, Middle-aged adults, cognitive assessment.

## INTRODUCTION

India is going through a phase of rapid demographic aging. <sup>[1]</sup> By 2050, people over 60 years of age are predicted to constitute 19.1% of the total population. This aging of the population is expected to be accompanied by a dramatic increase in the prevalence of dementia. <sup>[2]</sup>

Cognition consists of interrelated processes including the ability to perceive, organize,

assimilate, and manipulate information to enable the person to process information, learn and generalize. <sup>[3]</sup>

Cognitive impairment can result in significant activity limitations and participation restrictions in all aspects of the individual's life. <sup>[3]</sup> As cognitive decline is among the most feared aspects of growing old and increases personal and societal burdens, it is important to detect early

cognitive changes hence cognitive screening has become the need of the hour. [4] There are a variety of tools available in the literature for cognitive assessment however since MoCA has shown better sensitivity and specificity than other cognitive tests and is easy to administer, it was chosen to collect the data. [5] Despite the wide-based use of the scale in India, there is not enough literature on the normative findings pertaining to any city or state.

Ever since, it was understood that populations differing in their demographic characters show differences in test performance, it is mandatory to use relevant normative data to understand the cognitive status of an individual with respect to sociocultural variables. [6] Normative data will also help us find cut off scores for the Indian population. Therefore, the findings of this study can be used to understand subtle cognitive impairments in early adulthood and may slow down the progression with appropriate therapy and management.

## **MATERIALS & METHODS**

**Ethical consideration:** The protocol and research tools were reviewed by the Institutional Ethics Committee (IEC) and approval was granted with an IEC number - EC/OA - 132/2022. The data collection tools were administered only after obtaining the participant's written consent and the test was administered in the language of interest of the participant.

### **Study design:**

A cross-sectional research study was conducted in Mumbai, a metropolitan city in India, over a span of 1 month between November 2022 to December 2022. The purposive sampling technique was used on a total of 107 samples of individuals between the age group of 40-60 years, out of which 53 samples were females and 54 samples were males and representing all levels of formal education.

### **Selection and Description of the participants -**

### **Inclusion criteria:**

1. Adults who were willing to participate in the study.
2. Adults who kept an understanding of English, Hindi, or Marathi.
3. Adults who had a SLUMS score of or more than 27 for people with a High school education or 25 for people with less than a high school education, were considered.

### **Exclusion criteria:**

1. Adults with no formal education
2. Adults with any visual impairment, hearing impairment, or those who are mute were not included in the study.

Depending upon inclusion and exclusion criteria, adults were recruited for the study. All the participants were tested individually in a quiet room.

All participants took part in the study on a voluntary basis after having provided their written informed consent and without receiving any reward.

They were then screened using SLUMS. Saint Louis University Mental Status Examination (SLUMS) is an assessment tool for mild cognitive impairment and dementia. [7] It took approximately seven minutes to administer. It had 11 questions. Q1-Q3 assessed attention, immediate recall, and orientation. Q4 and Q7 assessed delayed recall with interference, and Q5 assessed numeric calculation and registration. Q6 assessed memory: immediate recall with interference (time constraint). Q8 assessed registration and digit span. Q9 assessed visual-spatial function. Q10 assessed visual-spatial and executive functions. Q11 assessed executive function plus extrapolation. Scores range from 0 to 30. According to the interpretation of the SLUMS scores, for an individual with a high school education, a score of 27 to 30 is considered normal, scores between 21-26 suggest a mild neurocognitive disorder and scores between 1-20 suggest dementia. Whereas, for an individual with less than a high school education, a score of 25-30 is

considered normal, scores between 20-24 suggest mild neurocognitive disorder and scores ranging from 1-19 suggest dementia.

After this, MoCA was administered to the adults in their respective languages to collect the normative data.

The Montreal Cognitive Assessment Test (MoCA) was developed by Dr. Ziad Nasreddine. [5] It was a one-page, 30-point test performed in approximately 10 minutes for a patient.

The authors completed the mandatory training provided by the MoCA team for administering and scoring the MoCA test.

It assessed short-term memory recall, visuospatial abilities, and different aspects of executive functions, phonemic fluency, verbal abstraction, attention, concentration, working memory, orientation, and language. The total MoCA score is 30 out of which 26-30 was considered normal, individuals with scores ranging from 18-25 fell under the category of mild cognitive impairment, and those with scores of 10-17 fell under the category of moderate cognitive impairment and less than 10 fell under the category of severe cognitive impairment. A standard procedure correction entails adding one point to the total score if the test taker has  $\leq$  12 years of education. [8]

Administration of both tests was done in accordance with the guidelines provided by the author.

Data gathered using MoCA was statistically analyzed and interpreted.

### STATISTICAL ANALYSIS

Data collected was compiled on an MS (Microsoft) Office excel worksheet and was subjected to statistical analysis using an appropriate package like SPSS (Statistical Package for the Social Sciences) software.

Inter-group comparison (2 groups) was done using t-test.

Intergroup comparison ( $>2$  groups) was done using one-way ANOVA (Analysis of Variance) followed by pairwise comparison using a post hoc test.

Descriptive statistics like frequency (n) & percentage (%) of categorical data, and mean and standard deviation of numerical data in each group were depicted.

Keeping alpha error at 5% and Beta error at 20%, power at 80%,  $p < 0.05$  was considered statistically significant.

### RESULT

155 participants were screened for this study out of which 107 participants were eligible according to the inclusion criteria. The descriptive statistics of demographic characteristics of age and gender are depicted in Tables 1 and 2 respectively.

Table 1

AGE	FREQUENCY
40-50	63
51-60	44
Total	107

Demographic distribution of the sample as per age.

Table 2

		Frequency	Percent
	<b>F</b>	<b>53</b>	<b>49.5</b>
	<b>M</b>	<b>54</b>	<b>50.5</b>
	<b>Total</b>	<b>107</b>	<b>100.0</b>

Demographic distribution of sample as per gender

Table 3 depicts the frequency of individuals from different levels of education. A Pearson product-moment correlation was run to determine the relationship between SLUMS and MoCA. (Table 4) There was a statistically highly significant moderate and positive correlation between MoCA and SLUMS ( $p=.000$ )

Table 3

	Frequency	Percent
<b>GRADUATE</b>	<b>49</b>	<b>45.8</b>
<b>HIGHER SEC</b>	<b>13</b>	<b>12.1</b>
<b>LESS THAN HIGHER SEC</b>	<b>1</b>	<b>0.9</b>
<b>LESS THAN PRI</b>	<b>2</b>	<b>1.9</b>
<b>LESS THAN SEC</b>	<b>2</b>	<b>1.9</b>
<b>PHD</b>	<b>3</b>	<b>2.8</b>
<b>POST GRADUATE</b>	<b>3</b>	<b>2.8</b>
<b>PRIMARY</b>	<b>5</b>	<b>4.7</b>
<b>SEC EDUCATION</b>	<b>29</b>	<b>27.1</b>
<b>Total</b>	<b>107</b>	<b>100.0</b>

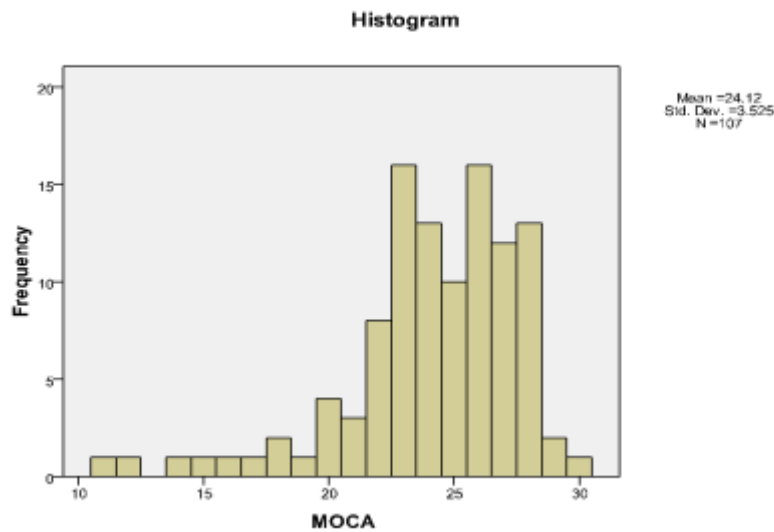
Demographic distribution of sample as per education

Table 4

		AGE	SLUMS
SLUMS	Pearson Correlation r value	-.041	
	p value	.676	
	N	107	
MOCA	Pearson Correlation r value	.068	.645**
	p value	.488	.000
	N	107	107

On plotting the 107 MoCA scores that were obtained in this study sample, the following histogram was seen. [Figure 1].

Figure 1

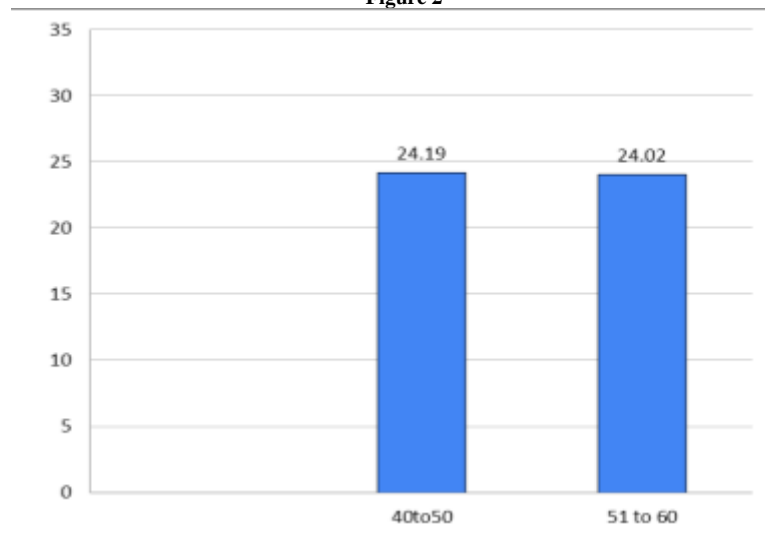


Histogram showing a mean score of MOCA of the samples

The mean was thus found to be 24.12 with  $SD \pm 3.525$  giving a range of 20.595 - 27.645. On calculation, 85% (n=91) of the samples were found to be within the range of 21-28 with 59.8% of the samples on the higher end of the range (scores between 24-28) 59% of the participants fell under the age group of 40-50 years and the remaining

41% belonged to the category of 51-60 years. On intergroup comparison of the MoCA scores with the two age groups, we found that the age group of 40 to 50 years (n= 63) showed a mean score of 24.19 with  $SD \pm 3.311$  and the age group of 50 to 60 years (n=44) showed a mean score of 24.02 with  $SD \pm 3.849$ . [Figure 2].

Figure 2



Bar graph showing intergroup comparison of MOCA with two age groups

Although the mean value decreased as age increased, the p-value of the t-test was found to be .810 which showed that there

was a statistically non-significant difference between the MoCA scores of the two age groups. (Table 5)

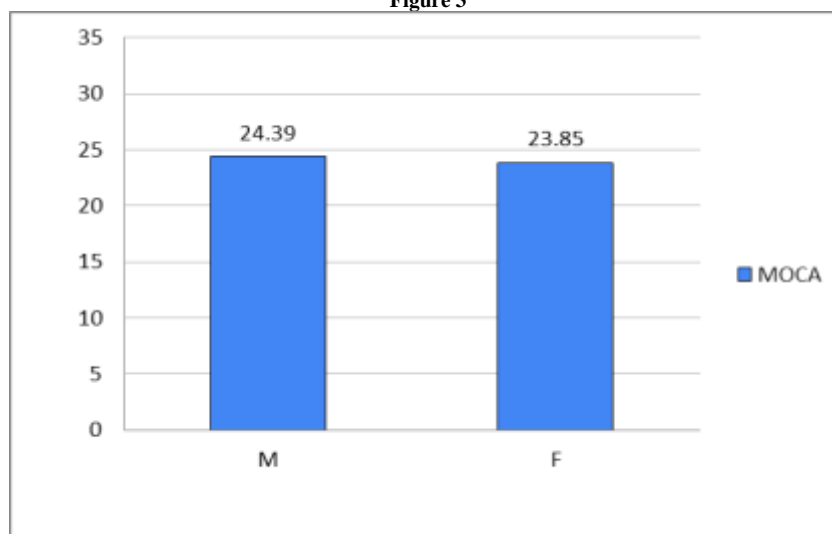
**Table 5**

	Age	N	Mean	Std Deviation	Std.Error Mean	T value	p value of t test
MOCA	40 to 50	63	24.19	3.311	.417	.241	.810#
	51 to 60	44	24.02	3.849	.580		

There was no drastic difference between the mean score of the two age groups 40-50 and 51-60, which shows that cognitive decline in these age groups is comparatively low. There was an almost equivalent distribution of the samples in regard to gender with

50.4% of male samples and 49.5% of female samples. The mean score of male participants (n= 54) was found to be 24.39 with SD ± 3.080 and for females (n=53), was 23.89 with SD ± 3.939. (Figure 3)

**Figure 3**



Bar graph showing intergroup comparison of MOCA with gender

An intergroup comparison of MoCA scores between the two genders showed a statistically non-significant difference. (P-value = 0.431) [Table 6].

**Table 6**

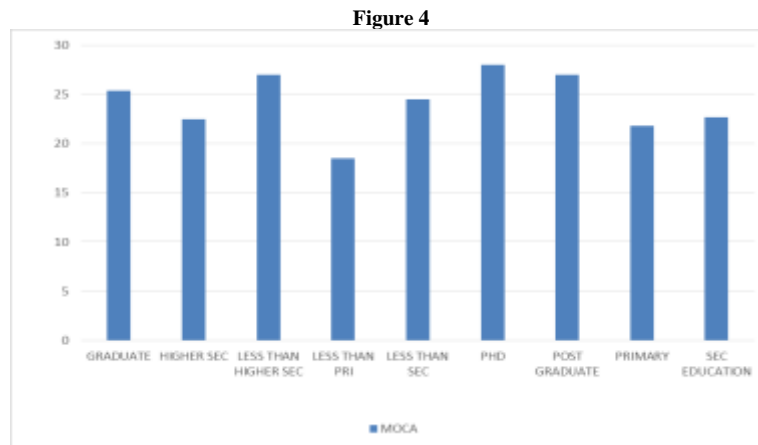
	Gender	N	Mean	Std.Deviation	Std.Error Mean	T value	p value of t test
MOCA	M	54	24.39	3.080	.419	.791	.431#
	F	53	23.85	3.939	.541		

The participants varied in education level ranging from those having less than a primary level of education to those having a Ph.D. level of education. There was a statistically highly significant difference seen in the intergroup comparison of MoCA between the different levels of education

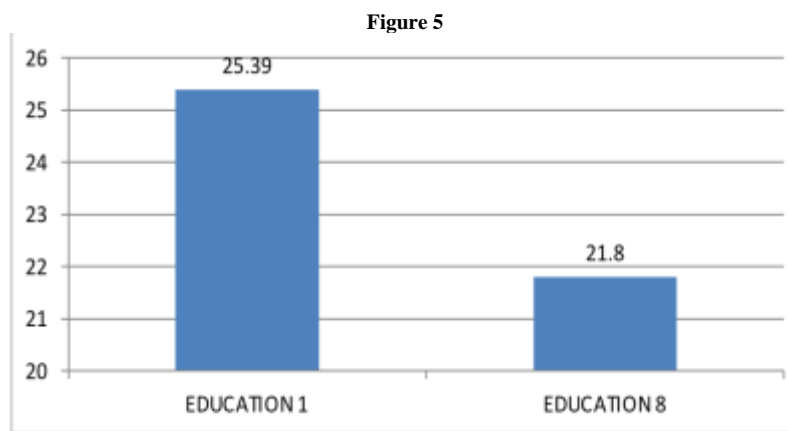
(p=.001). (Table 7) A mean score of 25.39 with SD ± 2.281 was seen in graduates (n=49) which was higher than that seen in participants with a primary level of education (n=5) .i.e., a mean of 21.80 with ± SD 2.168. (Figure 4 and figure 5)

**Table 7**

	EDUCATION	N	Mean	Std. Deviation	Std. Error Mean	T value	p value of t test
MOCA	1	49	25.39	2.281	.326	3.364	.001**
	8	5	21.80	2.168	.970		



Bar graph showing intergroup comparison of MOCA with education

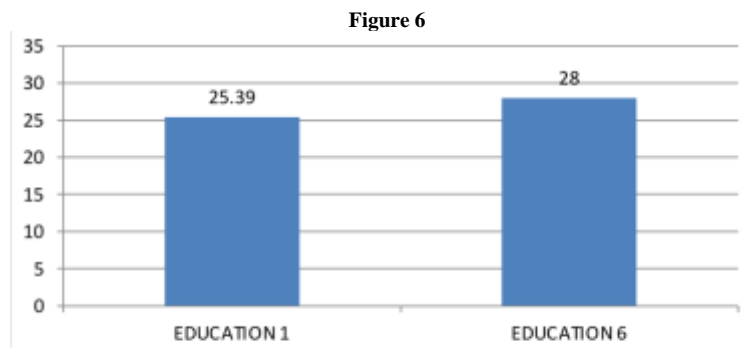


Bar graph showing an inter-group comparison of MoCA with education i.e., graduate (Education 1) vs. primary (Education 8)

The mean score of graduates was also compared with the participants having a Ph.D. (n=3). Although the mean score of participants with Ph.D. increased to 28, there was seen to be a statistically non-significant difference in scores between these groups. (Table 8) (Figure 6)

**Table 8**

	EDUCATION	N	Mean	Std. Deviation	Std. Error Mean	T value	p value of t test
MOCA	1	49	25.39	2.281	.326	-1.966	.055#
	6	3	28.00	.000	.000		



Bar graph showing an inter-group comparison of MoCA with education i.e., graduate (Education 1) vs. Ph.D. (Education 6)

## DISCUSSION

On analysis, the mean of total MoCA scores were found to be 24.12. This mean was lower than the mean score for the normal control in the original study conducted by Dr. Zaid N .i.e.27.4. [5] Similar findings were obtained in a study conducted in Tamil Nadu by Abdul Karim and Venkatachalam in which the mean was found to be 20.9 and the optimal cut-off score to detect mild cognitive impairment was 24 which is also in contrast to the original study. [9] A study carried out by Maryse Hayek in a Lebanese older adult population was in support of this study which showed a mean MoCA score of 24.2. [10] The findings of this study suggested that cultural differences are evident in cognitive testing.

The relatively lower scores observed in the present sample were in accordance with the previous normative studies which showed that the MoCA score is significantly affected by education. A study conducted in Tamil Nadu by Abdul Karim stated that the level of education affected their MoCA scores between primary and higher levels as well as primary and graduates. [9] A parallel result was observed in our study in relation to the mean obtained for graduates and individuals with a primary level of education wherein, the graduates showed a significantly higher mean.

Likewise, Eddy Larouche, in his study suggested, that the total MoCA score was higher with higher education level which is again consistent with previous normative studies using the MoCA. [11]

### **Unlike previous studies, MoCA scores in this study were not influenced by age.**

In a study conducted by Elisabet Classon and others, on the cognitively healthy Swedish older adult population, higher age was associated with lower performance irrespective of education. [8] However, our small sample size along with a small age group of 20 years may be the reason a significant difference was not seen in middle-aged adults. Moreover, there was an over-representation of highly educated

individuals i.e. Ph.D. in the second group of 50 to 60-year-olds which may have also increased the mean score.

Notwithstanding, a study conducted on middle-aged and elderly Quebec-French people aged between 41-98 years, showed that the total MoCA score was lower as age increased. [11]

The lack of effect of gender on the total MoCA score was also consistent with most of the previous normative studies conducted in different ethnic groups. A disparity was seen in the study conducted by Eddy Larouche where sex was associated with total MoCA score. However, they state that their large sample could be responsible for this significant sex effect as its relative contribution to prediction is small. [11]

### **The strength of this study is that the MoCA scores were not influenced by gender.**

Also, in view of the authors, this normative data will help to understand subtle cognitive impairments and start screening in early adulthood. If detected early, this could indirectly help to slow down the progression and be managed with appropriate therapy, specifically for the Indian population. This in turn may also aid in reducing the overall burden on society.

Although some limitations must be considered while interpreting the results. The participants were evenly distributed by gender but not by age range which led to disproportionality.

Also, the number of adults with PhDs (Doctor of Philosophy) was concentrated in the second age group leading to a rise in mean.

Even though a sample size of 107 cannot be representative of the entire population, this study provided insight into the discrepancies seen in MoCA performance in different geographical, demographic, and educational variations and highlights the need for normative data in multi-center and multi-state trials for increased efficiency.



## CONCLUSION

The mean total MoCA score of 24.12 found in our study was lower than the mean score for the normal control in the original study (27.4). This sensitizes the clinicians or researchers to use and evaluate patients for screening the Indian population with caution while using the original cut-off.

It is essential to have normative data on the population with respect to age, gender, education, and occupation for better screening and early diagnosis. Such studies will help clinicians to use gold-standard international scales such as MoCA with raw and original data that will help prevent over diagnosis and will enhance the use of tools for assessment.

### *Declaration by Authors*

**Ethical Approval:** Approved

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**Conflict of Interest:** The authors declare no conflict of interest.

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