

Effect of age, gender, and education on MMSE performance among healthy older adults

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Abstract

Objectives: To examine the relationship and predictive influence of age, gender, and education on Mini-Mental State Examination (MMSE) performance among healthy older adults.

Methodology: A cross-sectional, correlational-predictive study was conducted on 60 community-dwelling, cognitively healthy older adults (60–80 years; MMSE $\geq$ 24) selected using pre-defined inclusion and exclusion criteria. Socio-demographic details were recorded, and cognitive functioning was assessed using the MMSE. Spearman's rank-order correlation, an independent-samples t-test, and multiple linear regression were used to examine associations and predictors (SPSS-26; $p < .05$).

Results: The mean MMSE score of the sample was 25.87 ± 1.79 . Age showed a strong, statistically significant negative correlation with MMSE scores ($\rho = -0.658$, $p < .001$), while education showed a moderate positive significant correlation ($\rho = 0.317$, $p = .013$). Gender was not significantly associated with MMSE performance ($\rho = -0.106$, $p = .422$). Multiple regression showed the overall model was significant, $F(3,56) = 16.38$, $p < .001$, explaining 46.7% of the variance ($R^2 = .467$); age was the only significant independent predictor ($\beta = -0.710$, $p < .001$).

Conclusions: Age is the strongest determinant of MMSE performance among healthy older adults, while education is positively but not independently associated, and gender has no significant effect. Age-adjusted normative data are recommended for interpreting MMSE scores in this population.

Keywords: Mini-Mental State Examination; cognitive functioning; ageing; education; gender; older adults.

1. INTRODUCTION:

Cognitive health refers to how the brain can learn, remembers and thinks clearly. It is a significant part of the brain. The Centres for Disease Control and Prevention (2007) define a healthy brain is who can perform all the cognitive processes like language, judgment, learning and memory. Normal ageing is often associated with deficits in cognitive and physical functioning. Maintaining healthy cognition allows older-age population to carry out day-to-day activities effectively and helps distinguish normal healthy cognitive ageing from pathological dysfunction.

Ageing often brings difficulties such as slow or reduced physical function but the ability to think, learn and remember called as cognitive health remains vital for day-to-day functioning. Getting older comes with real difficulties such as losing physical strength or losing relatives and friends along the way. But remaining psychologically sharp - being able to think clearly, learn new things and remember what matters is significant and it helps individuals to live an independent life well.

The old-age population globally is growing extremely fast. United Nation (2019) study explained that India is expected to have 323 million normal aging people aged 60 and above by 2050. By 2030, nearly 8.6% of the Indian population will be over 65, reflecting this rapid demographic shift.

It was clearly stated that over 3.7 million people were significantly affected by dementia by 2010 and expected to be double by 2030 in India. The proportion of old age population is projected that above the age of 65 years rise from 10% in 2022 and will be rising to 16% in 2050 (United Nations, 2022).

2. LITERATURE REVIEW:

Salthouse (1996) proposed that normal old-age population involves gradual dysfunction in working memory, reasoning and processing speed, without major loss day-to-day functioning. It is different from pathological decline, where dysfunction is so severe which interfere daily living activities. His research work supported to establish a strong boundary between expected age-related changes and conditions such as dementia or MCI.

Though the idea of mild cognitive impairment came back in 1960s but Petersen et al. (1997) who fully characterized mild cognitive impairment (MCI) as a borderline state between healthy ageing and early dementia at mayo clinic. The original criteria proved inadequate information that patients with MCI usually do not lead to dementia. The decline often extended beyond memory alone, prompting a broader definition.

Although normal ageing naturally brings few changes in cognitive functioning whereas dementia and other cognitive dysfunctions display pathological conditions. Dementia leads to significant decline in intellectual functioning, memory, thinking, behaviour, and everyday functioning of life and making it different from normal age-related cognitive changes. Over the period of time, it clearly showed that dementia did not develop to every patient with MCI. This led experts to rethink and widen the definition of MCI to better capture its various presentations.

Craik & Salthouse (2008) explained that individuals with ageing is somehow linked with decline in episodic memory while semantic memory stays relatively preserved. Attention also displays reduced control especially in selective or divided attentional activities, with sustained attention comparatively spared (McDowd & Shaw, 2000). Salthouse (1996) proposed a paper where he discussed that old aged impairment in processing speed leads to various cognitive dysfunctions. Age related dysfunctions in various executive functioning include flexibility, planning and inhibition has been associated with reduced frontal and pre-frontal lobes consistent with Frontal Ageing Hypothesis (West, 1996).

Individuals with normal ageing are evaluated by six major neurocognitive domains that are complex language, executive functioning, attention, memory, learning, perceptual motor and social cognition based on the standardized tests. The most common tools include MMSE (global cognition), TMT-A (complex attention), TMT-B (executive function), CVLT (learning/memory), HVL (language), and Number Comparison (perceptual motor). A dysfunction in one single domain, falling between normal ageing and dementia is called as Mild Cognitive Impairment (Petersen et al., 1999; Sachdev et al., 2014). Mild Cognitive Impairment also called MCI is known for clinical stage between healthy aging and dementia and may also have as an early sign of neuro-degenerative disease.

Folstein et al., (1975) developed Mini Mental State Examination (MMSE) is a widely administered screening tool to measure cognitive functioning. It measures attention, time and place orientation, registration, calculation, language, recall, and visuospatial abilities such as copying and intersecting pentagons. It demonstrates good validity and reliability detecting moderate-to-severe impairment and is useful to monitor cognitive changes over time (Tombaugh & McIntyre, 1992; Lopez et al., 2005). To detect and identifying MCI is limited by MMSE and must not to be used as standalone instrument for the diagnosis of dementia. Its brevity and standardization make it a practical, though not standalone, clinical screening measure in older adults.

Although, the effects of age and education on MMSE have been extensively documented but the relationship between gender and MMSE performance has been less consistently characterized by various populations. Thus, the present study aims to assess cognitive functioning using the MMSE and examine its relationship with selected socio-demographic factors, with particular emphasis on gender, to contribute to improved interpretation of MMSE scores among older age population.

Crum et al. (1993) found that MMSE performance was significantly associated with educational level, with individuals having higher educational attainment generally obtaining higher scores of MMSE. Similarly, Tombaugh and McIntyre (1992) reported that the scores of MMSE greatly were influenced by education and age which highlighted the importance of educational background when analysing and taking MMSE performance. Again, Ganguli et al. (1995) and Das et al. (2006) also confirmed the prediction of education positively linked with MMSE scores with old aged population.

Lee et al. (2012) did a study on 7,452 Korean older age population where they found female population scored slightly lower than male population even after adjusting for age or education.

3. OBJECTIVES :

To examine the relationship and predictive influence of age, gender, and education on MMSE performance among healthy older adults.

1. To evaluate the MMSE scores of healthy older persons to determine their level of cognitive functioning.
2. To investigate how MMSE scores in healthy older individuals relate to age.
3. To investigate how MMSE scores in healthy older persons relate to educational attainment.
4. To investigate how MMSE scores in healthy older individuals relate to gender.
5. To use regression analysis to ascertain whether age, gender, and educational attainment significantly predict MMSE performance among healthy older persons.

Hypotheses

H0: There is a significant relationship between age and MMSE scores among healthy older adults.

H1: There is a significant relationship between educational level and MMSE scores among healthy older adults.

H2: There is a significant association between gender and MMSE performance among healthy older adults.

H3: Age, gender, and educational level significantly predict MMSE performance among healthy older adults.

4. RESEARCH METHOD :

Research Design

The study used a cross-sectional, quantitative, correlational-predictive design to examine how age, gender, and education relate to MMSE performance among healthy older adults. Data were collected from all participants at a single time point. The study aimed to (1) determine whether age, education, and MMSE performance were significantly correlated, (2) examine whether MMSE performance differed significantly by gender, and (3) determine whether age, gender, and education significantly predicted MMSE performance.

Sample

The sample comprised 60 community-dwelling healthy older adults aged 60–80 years, selected based on the inclusion and exclusion criteria below. All participants were assessed for cognitive functioning using the standardised MMSE.

Inclusion Criteria

Participants who: (1) were 60–80 years of age; (2) were community-dwelling healthy older adults; (3) included both male and female participants; (4) were able to communicate in English; (5) obtained an MMSE score of 24 or above, indicating normal cognitive functioning; (6) were able to understand and follow study instructions; (7) were willing to participate voluntarily; and (8) provided written informed consent before participation.

Exclusion Criteria

Participants were excluded if they: (1) were below 60 or above 80 years of age; (2) had a history of any neurological disorder; (3) had a diagnosis of a severe psychiatric disorder; (4) had a diagnosis of any cognitive impairment such as MCI or dementia; (5) had severe visual, hearing, or speech impairment interfering with MMSE administration; (6) had a severe medical illness or physical disability preventing completion of the assessment; (7) were unwilling to participate or did not provide informed consent; or (8) provided incomplete or invalid responses during assessment.

Tools

Socio-demographic Checklist: Socio-demographic information was collected using a semi-structured proforma developed for this study, covering age, gender, educational qualification, and occupation.

The Mini-Mental State Examination (MMSE): Developed by Folstein, Folstein, and McHugh (1975), the MMSE is a widely used 30-item tool assessing attention, orientation, language, registration, calculation, recall, and visuospatial ability, with a maximum score of 30. A score of 24 or above is generally considered indicative of normal cognitive functioning, although interpretation may vary by age and educational level. The MMSE has demonstrated satisfactory test-retest reliability (typically 0.80–0.95) and good inter-rater reliability (often exceeding 0.80) across diverse populations.

Procedure

Ethical approval for the study was obtained from the concerned Institutional Ethics Committee prior to data collection. The study was conducted at two old-age homes. Community-dwelling healthy older adults were approached, and the aim and purpose of the study were explained to them. Participants meeting the inclusion criteria were selected, and written informed consent was obtained after explaining the nature, purpose, procedure, and confidentiality of the study.

Participants then completed the socio-demographic data sheet (age, gender, qualification, educational level, occupation, marital status, and other relevant details), followed by administration of the MMSE using standard instructions. Responses were scored per standard MMSE procedure, and participants scoring 24 or above were retained for final analysis. Data were coded, entered into SPSS, and statistically analysed to examine the relationship and predictive effect of age, gender, and education on MMSE performance.

Statistical Analysis

Descriptive statistics (frequency, percentage, mean, and standard deviation) were computed to summarise sociodemographic characteristics and MMSE scores. Spearman's rank-order correlation was used to examine the association of age and of educational attainment with MMSE scores. As gender is a two-category variable, an independent-samples t-test was used to examine its association with MMSE scores. Multiple linear regression analysis was used to determine whether age, gender, and educational attainment significantly predicted MMSE performance. Data were analysed using SPSS-26, with statistical significance set at $p < .05$.

5. FINDINGS:

Data from all 60 participants were tabulated and analysed using SPSS version 26 with descriptive and inferential statistics.

Table 1: Descriptive Statistics of the Socio-Demographic Characteristics of the Participants (N = 60)

Variables	Category	Number	%
Age	60–70 yrs	42	70.0
	70–80 yrs	18	30.0
Education	Graduation	30	50.0
	Post-graduation	20	33.3
	Ph.D.	10	16.7
Gender	Men	32	53.3
	Women	28	46.7
Occupation	Govt. job (retired)	16	26.7
	Private job (retired)	14	23.3
	Private job	13	21.7
	Homemaker	13	21.7
	Business	4	6.7

As presented in Table 1, the majority of participants (70.0%) were aged 60–70 years, while 30.0% were aged 70–80 years. The sample comprised 32 male (53.3%) and 28 female (46.7%) participants. Regarding education, 50.0% were graduates, 33.3% postgraduates, and 16.7% held a Ph.D. Regarding occupation, 26.7% were retired government employees, 23.3% retired private-sector employees, 21.7% employed in private jobs, 21.7% homemakers, and 6.7% engaged in business.

Table 2: Mean and Standard Deviation of MMSE Scores According to Age, Gender, and Education (N = 60)

Variables	Category	Number	MMSE Mean $\pm$ SD
Total sample	—	60	25.87 $\pm$ 1.79
Age	60–70 yrs	42	26.36 $\pm$ 1.86

	70–80 yrs	18	24.72 ± 0.89
Education	Graduation	30	25.47 ± 1.48
	Post-graduation	20	25.50 ± 1.61
	Ph.D.	10	27.80 ± 1.87
Gender	Male	32	26.09 ± 1.94
	Female	28	25.61 ± 1.59
Occupation	Govt. job (retired)	16	25.13 ± 1.45
	Private job (retired)	14	24.93 ± 1.38
	Private job	13	28.08 ± 1.19
	Homemaker	13	25.08 ± 1.32
	Business	4	26.75 ± 1.26

Table 2 shows that the overall mean MMSE score was 25.87 ± 1.79 . Male participants had a slightly higher mean MMSE score (26.09 ± 1.94) than female participants (25.61 ± 1.59). Participants aged 60–70 years scored higher (26.36 ± 1.86) than those aged 70–80 years (24.72 ± 0.89). By educational level, participants with a Ph.D. showed the highest mean MMSE score (27.80 ± 1.87), followed by postgraduates (25.50 ± 1.61) and graduates (25.47 ± 1.48).

Table 3: Spearman's Correlation Between Age, Education, Gender, and MMSE Scores (N = 60)

Variable	Spearman's rho (ρ)	p value	Interpretation
Age	−0.658	< .001*	Strong negative, significant
Education	0.317	.013*	Moderate positive, significant
Gender	−0.106	.422	Very weak negative, not significant

* $p < .05$.

Table 3 shows a strong, statistically significant negative correlation between age and MMSE scores ($\rho = -0.658$, $p < .001$), indicating that MMSE performance tended to decrease with increasing age. Education showed a moderate, statistically significant positive correlation with MMSE scores ($\rho = 0.317$, $p = .013$), indicating that higher educational attainment was associated with higher scores. Gender showed a very weak, non-significant correlation with MMSE scores ($\rho = -0.106$, $p = .422$).

Table 4: Multiple Linear Regression Analysis Predicting MMSE Scores from Age, Education, and Gender (N = 60)

R	R ²	Adjusted R ²	F	df	p
.684	.467	.439	16.38	(3,56)	< .001*

Predictor	B	SE B	β	t	p	Tolerance
Constant	42.17	3.52	—	11.98	< .001	—
Age	−0.278	0.049	−0.710	−5.667	< .001*	.606
Education	−0.037	0.289	−0.016	−0.129	.898	.630
Gender	0.246	0.364	0.069	0.676	.502	.910

* $p < .05$.

A multiple linear regression analysis was conducted to examine whether age, education, and gender predicted MMSE scores. The overall model was statistically significant, $F(3, 56) = 16.38$, $p < .001$, explaining 46.7% of the variance in MMSE scores ($R^2 = .467$, Adjusted $R^2 = .439$; $R = .684$). Age emerged as the only significant predictor ($B = -0.278$, $\beta = -0.710$, $t = -5.667$, $p < .001$): after controlling for education and gender, each one-year increase in age was associated with an average decrease of approximately 0.28 points in MMSE score. Education ($B = -0.037$, $\beta = -0.016$, $t = -0.129$, $p = .898$) and gender ($B = 0.246$, $\beta = .069$, $t = 0.676$, $p = .502$) were not significant independent predictors. Tolerance values (.606–.910) and VIF values (1.099–1.651) indicated no evidence of multicollinearity among predictors.

6. DISCUSSION

The present study examined the effect of age, gender, and educational level on MMSE performance among healthy community-dwelling older adults aged 60–80 years, and whether these socio-demographic variables significantly predicted MMSE performance.

Effect of Age on MMSE Scores

A strong, statistically significant negative relationship was found between age and MMSE scores ($\rho = -0.658$, $p < .001$). Participants aged 60–70 years scored higher (Mean = 26.36 ± 1.86) than those aged 70–80 years (Mean = 24.72 ± 0.89), indicating cognitive decline with increasing age. Regression analysis confirmed age as the only significant predictor of MMSE scores ($\beta = -0.710$, $p < .001$), explaining a substantial proportion of the variance. This is consistent with Crum et al. (1993), who examined more than 18,000 adults in the USA and found significant cognitive decline in MMSE scores with age, and with Tombaugh and McIntyre (1992), who similarly concluded that advancing age significantly influences MMSE performance and recommended age-adjusted normative values.

Bleecker et al. (1988) reported a more modest age effect and suggested education exerted a stronger influence than age; however, the present study found age to be the strongest predictor after controlling for education and gender. Ganguli et al. (1995), using the Hindi Mental State Examination, also reported lower cognitive scores with increasing age among older adults.

Effect of Education on MMSE Scores

A moderate, statistically significant positive correlation was found between educational level and MMSE scores ($\rho = 0.317$, $p = .013$), with participants holding a Ph.D. obtaining the highest mean scores, followed by postgraduates and graduates. This is consistent with Crum et al. (1993), who found that higher education was associated with better MMSE performance, and Tombaugh and McIntyre (1992), who recommended education-adjusted normative values.

Although education showed a significant bivariate relationship with MMSE scores, it did not emerge as a significant independent predictor in regression analysis ($p = .898$), suggesting that its influence diminished after controlling for age and gender, and that age accounted for a greater proportion of variance in MMSE performance in this sample.

Effect of Gender on MMSE Scores

No statistically significant relationship was found between gender and MMSE scores ($\rho = -0.106$, $p = .422$). Although male participants obtained a slightly higher mean score than female participants, this difference was minimal and non-significant, and gender did not significantly predict MMSE performance in the regression model. This is consistent with Crum et al. (1993), who found gender differences in MMSE performance became negligible after controlling for age and education, and Tombaugh and McIntyre (1992), who reported little independent influence of gender on MMSE performance.

Predictors of MMSE Performance

The overall regression model was statistically significant, explaining 46.7% of the variance in MMSE scores ($R^2 = .467$). Age emerged as the only significant predictor, while education and gender did not significantly predict MMSE performance after adjustment. These findings suggest that while education contributes to cognitive performance, the influence of advancing age is substantially stronger in determining MMSE scores among healthy older adults. The results reinforce recommendations that clinicians interpret MMSE scores using age-adjusted normative values and exercise caution when interpreting cognitive screening results in older populations.

8. CONCLUSION :

The present study examined the effects of age, gender, and education on MMSE performance among 60 healthy older adults aged 60–80 years. Age was the strongest factor influencing cognitive performance, with MMSE scores declining significantly with increasing age. Education was positively associated with MMSE scores but did not independently predict performance after controlling for age and gender. Gender showed no significant effect on MMSE performance. These findings highlight the importance of considering age and educational background when interpreting MMSE scores in older populations and support the need for age-adjusted, culturally appropriate normative data for cognitive screening in the Indian population.

9. LIMITATIONS:

The study was limited by its small, cross-sectional, community-based sample of cognitively healthy older adults aged 60–80 years, which may restrict generalisability. Only age, gender, and education were examined; other potentially relevant factors such as socioeconomic status, health status, lifestyle, occupation, and psychological factors were not included. The use of a single screening measure (MMSE) and non-probability sampling may have limited comprehensive assessment of cognition and the representativeness of the findings.

10. RECOMMENDATIONS:

MMSE scores in older adults should be interpreted alongside age and educational background rather than used in isolation. Where clinically indicated, screening results should be supplemented with a comprehensive assessment and culturally appropriate normative data. Future studies should use larger and more diverse samples and examine additional health, lifestyle, and psychosocial variables.

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