ORIGINAL RESEARCH ARTICLE

# Correlation of Body Mass Index and Age with Mild Cognitive Impairment (MCI) In Elderly of Guwahati City, India

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**DOI:** 10.55489/njcm.140520232737

## ABSTRACT

**Introduction:** Obesity is on rise globally and may have a impact on cognition. Very limited research was done on the association of weight with neurocognition among the elderly. The study purpose was to determine the correlation between BMI and age with MCI and after stratifying for BMI and socio-demographic characteristics.

**Methods:** This cross-sectional study was conducted among 576 elderly (≥60 years) in Guwahati city using a multi-stage sampling technique. Hindi Mini-Mental State Examination (HMMSE) tool was used for screening for dementia and MCI.

**Results:** HMMSE scores were not significantly correlated with BMI (r =0.07). However, when stratified, a significantly negative correlation of BMI with HMMSE scores was seen for illiterates (r =-0.21), primary school education (r =-0.48) and unskilled workers (r =-0.49). There was a significant negative correlation between age and cognition for elderly belonging to OBC, (r =-0.21), Lower middle (III), (r =-0.39), Upper Lower (r =-0.17), Lower (V), (r =-0.26), Graduate, Post Graduate,(r = -0.23), Middle School, (r =-0.36), Illiterate, (r =-0.34), Clerical, (r =-0.60), Semi Professional, (r =-0.62), skilled worker (r=-0.68), Unemployed, (r =-0.15) and Obese, (r =-0.30).

**Conclusion:** Various factors like age, category, socioeconomic status, and Body Mass Index (BMI) were found to be predictors of cognition among the elderly.

**Keywords:** Old age, geriatrics, BMI, cognition, cognitive decline, India

## ARTICLE INFO

**Financial Support:** None declared
**Conflict of Interest:** None declared
**Received**: 26-01-2023, **Accepted**: 09-04-2023, **Published**: 01-05-2023
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**How to cite this article:**
Rajendran V, Saikia AM, Bharali MD. Correlation of Body Mass Index and Age with Mild Cognitive Impairment (MCI) In Elderly of Guwahati City, India. Natl J Community Med 2023;14(5):300-307. DOI: 10.55489/njcm.140520232737


*www.njcmindia.com | pISSN09763325 | eISSN22296816 | Published by Medsci Publications*

## Introduction

Dementia is not a normal process of ageing, though it is seen mostly among the elderly. It is a syndrome in which there is deterioration in memory, thinking, behaviour, and the ability to perform everyday activities. Approximately 55 million people have dementia all around the world and there are nearly 10 million new cases of dementia every year.[1] The most common dementia is Alzheimer's dementia (AD), which is an irreversible, progressive neurodegenerative disorder and contributes to 60–80% of cases.[2]

Mild cognitive impairment is a syndrome characterised by a cognitive decline that is greater than would be expected for an individual's age and educational level but that does not significantly interfere with daily activities.[3] While some persons with moderate cognitive impairment appear to stabilise or gradually get better, more than half develop dementia within five years.[3] Mild cognitive impairment (MCI) is a stage between normal ageing and Alzheimer's disease (AD), with 10% to 15% of MCI patients transitioning to overt AD each year.[3–5] MCI is much more prevalent among older adults and it ranges from 3% to 19% in population-based epidemiological studies.[3–8] Some people with MCI seem to remain stable or return to normal over time, but more than half progress to dementia within 5 years.[3,9]

Various studies have reported risk factors like diabetes mellitus (DM), hypercholesterolemia, hypertension, and overweight/obesity.[2,10] Increased Body Mass Index (BMI) at midlife may have a higher risk for age-related diseases such as Alzheimer's disease.[6,11–13] Neuronal and/or myelin abnormalities, primarily in the frontal lobe were associated with greater BMI.[10] Regarding accelerated ageing with adiposity, the white matter in the frontal lobes is more susceptible to the effects of ageing than the white matter in other lobes.[10] Furthermore, increased BMI in middle age has been linked to dementia diagnosis a few decades later, especially in women, according to several epidemiological studies.[10]

The relationship between nutritional status like underweight, overweight, and obesity with cognition has not been consistent and it depends on the nutritional status in various stages of life. [14] Obesity in middle age is related to an increased risk of dementia and Alzheimer's disease later in life.[14] The risk of vascular disease is increased in an additive manner when vascular risk factors are clustered together.[15] The role of weight loss in dementia prevention needs to be investigated further.[15] Obesity-related neurocognitive impairment has a complex mechanism. Prior research has consistently shown that the pathophysiological mechanisms of obesity-related cognitive impairment include vascular changes, impaired insulin and glucose regulation, inflammation, oxidative stress, and endothelial dysfunction. Notwithstanding the aforementioned results, it is still uncertain and limited how BMI affects neurocognitive function.[16] This study was conducted to determine the correlation between BMI and age with MCI. Furthermore, the correlation was seen after stratifying for socio-demographic characteristics like gender and socio-economic status of the elderly. We hypothesized that abnormal BMI and an increase in age have a negative correlation with MCI and would be associated with more rapid cognitive decline.

## Methodology

This community-based, cross-sectional study was conducted among the elderly who are belonging to the age group of 60 years or above in Guwahati City, Assam, from July 2018 to August 2019. It includes elderly of both sexes, who were permanently residing in the study area for more than 1 year preceding the study. The elderly who was critically ill, severely depressed, elderly in old age homes and nursing homes and elderly who failed to comprehend the question due to severe hearing loss were excluded. The elderly who consented to participate were included in the study. This study was approved by the Institutional Ethics Committee of Gauhati Medical College and Hospital (No. MC/190/2007/pt-1/IEC/34 dated on 05.04.2018). Written informed consent was obtained from all participants.

**Sample size calculation:** Since the study is focused on the correlation coefficient (r), the previously published "r" is taken for sample size calculation. ($r = 0.32$).[17] The sample size is calculated with the formula $n = [(Z\alpha+Z\beta)/C]^2+3$, where the two-tailed alpha value ($Z_\alpha$) is taken as 1.96, two-tailed beta value ($Z_\beta$) is taken as 0.8416 and $C = (0.5 * \ln[(1+r)/(1-r)])$.[18] Thus, the sample size is 74,[19] and considering a 10% loss, estimated to be 82 for any group tested for correlation. Since the study had various subcategories such as gender and age groups, all elderly were included from the earlier study.[20,21] Since the study had various subcategories such as age groups and gender, all the elderly were included from our earlier study.[21] Out of thirty-one wards in Guwahati Municipal Corporation, 50% of the total wards, i.e., sixteen wards, were selected randomly using random number table. From each ward thirty-six elderly were selected and the final sample size was taken as 576 for this study. From each selected ward, the first house was selected randomly, later, door to door survey was done from each ward assuming that each household would have one elderly. In each household, all the elderly who were fulfilling the inclusion criteria were included in this study.

The data were collected using a predesigned and pretested schedule. The variables like height, weight, age, and sociodemographic characteristics were included in this study. Height and weight were measured by using a standardized stadiometer and weighing machine, respectively. Weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm. For the elderly with spinal curvature, arm length was used to estimate height.[22] The vernacular adaptation of HMMSE was used after validation for screening MCI. [23] Initially, the elderly were screened for depression and dementia or severe cognitive impairment using Geriatric Depression Scale (GDS-15),[24,24,25] those who scored <5 in GDS-15 and <17 in HMMSE were excluded from enrolling in the study. The HMMSE is a 30-point scale which has been used for assessing cognitive function. It consists of 11-question measure covering five domains of cognitive function namely; orientation, registration, attention and calculation, recall, and language. A cut-off score of 27 was taken for detecting mild cognitive impairment.[26] Socio-economic status was classified using the Modified pupusa scale.[27] The nutritional status of the elderly was classified as per the WHO classification of BMI.[28–30]

The numerical variables were expressed as the mean and standard deviation. On Kolmogorov–Smirnov test, there was a statistically significant deviation from normality for the variables of BMI and MCI.

Spearman's test was applied for the statistical analysis of the data. The correlation is considered significant at the 0.05 level (2-tailed). The data collected were analyzed using the IBM SPSS Statistics version (Version 23.0, IBM Corp., Armonk, NY).

**Data availability:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

# RESULTS

A total of 576 elderly aged ≥ 60 years (67.9 ± 7.2) years had a mean BMI of 24.2 ± 4.4 kg/m$^2$. Of the total sample, 55.9% had a BMI of ≤ 24.9 kg/m$^2$ (low and normal BMI group), while 44.1% had a BMI of ≥25.0 kg/m$^2$ (overweight and obese BMI group). The mean age for the elderly with a low BMI was 69.3±7.9 years, whereas the mean age for those with a high BMI was 66.2 ± 5.8 (p <0.01). The distribution of the elderly based on the socio-demographic variables and BMI has been shown in Table 1.

**Table 1: Distribution of the elderly based on the socio-demographic variables and BMI**

| Socio-demographic variables | Age (Mean ± SD) | BMI (Mean ± SD) | MMSE (Mean ± SD) |
|---|---|---|---|
| **Age** | | | |
| 60-69 year, (n=360) | 63.4 ± 3.0 | 24.6 ± 4.7 | 25.6 ± 3.1 |
| 70-79 years, (n=171) | 73.1 ± 2.7 | 24.1 ± 3.8 | 25 ± 3.2 |
| ≥ 80 years, (n=45) | 84.8 ± 4.0 | 22.1 ± 2.2 | 25.1 ± 3.1 |
| **Gender** | | | |
| Female, (n=288) | 66.5 ± 6.5 | 24.9 ± 4.6 | 25.3 ± 3.2 |
| Male, (n=288) | 69.3 ± 7.7 | 23.6 ± 4.0 | 25.5 ± 3.0 |
| **Category** | | | |
| General, (n=336) | 67.9 ± 7.0 | 23.4 ± 4.2 | 25.6 ± 3.0 |
| OBC, (n=150) | 69.3 ± 8.3 | 24.8 ± 4.2 | 25.7 ± 3.3 |
| SC, (n=24) | 65.6 ± 6.4 | 24 ± 2.9 | 25.8 ± 3.5 |
| ST, (n=66) | 65.9 ± 4.8 | 27.3 ± 4.5 | 23.4 ± 2.6 |
| **Education** | | | |
| Graduate, PG, (n=175) | 70.3 ± 6.6 | 24.6 ± 3.9 | 26.5 ± 2.5 |
| Illiterate, (n=105) | 65 ± 5.9 | 24.3 ± 5.0 | 23.7 ± 3.0 |
| Intermediate, (n=33) | 70.9 ± 8.3 | 23.2 ± 3.5 | 26.6 ± 2.3 |
| Middle School, (n=135) | 66.1 ± 6.4 | 23.9 ± 4.3 | 25.6 ± 2.9 |
| Post high School, (n=48) | 66.9 ± 8.2 | 25.4 ± 6.2 | 26.2 ± 2.4 |
| Primary School, (n=63) | 68.7 ± 7.9 | 23.3 ± 2.8 | 23.6 ± 4.1 |
| Profession, (n=17) | 70.8 ± 8.5 | 25.1 ± 4.6 | 25.1 ± 2.8 |
| **Occupation** | | | |
| Clerical, (n=15) | 78 ± 12.1 | 26.3 ± 5.2 | 25.6 ± 2.8 |
| Professional, (n=12) | 75.3 ± 7.0 | 24.4 ± 3.0 | 26.8 ± 1.4 |
| Semi skill, (n=54) | 64.2 ± 4.7 | 23.9 ± 5.3 | 27.1 ± 2.9 |
| Semi-Professional, (n=12) | 72 ± 4.9 | 27.2 ± 5.0 | 27.8 ± 1.9 |
| Skilled worker, (n=18) | 62.8 ± 5.6 | 24.5 ± 2.5 | 27.7 ± 2.4 |
| Unemployed, (n=441) | 68.3 ± 6.8 | 24.2 ± 4.3 | 25.2 ± 2.9 |
| Unskilled, (n=24) | 61 ± 1.8 | 22.3 ± 4.1 | 21.8 ± 4.4 |
| **Socio-economic status** | | | |
| Upper middle (II), (n=55) | 69.7 ± 6.6 | 27 ± 4.5 | 26.7 ± 2.0 |
| Lower middle (III), (n=45) | 73.7 ± 10.2 | 24 ± 3.1 | 27.3 ± 2.4 |
| Upper lower (IV), (n=362) | 67.5 ± 6.6 | 23.7 ± 4.2 | 25.7 ± 2.9 |
| Lower (V), (n=114) | 66.3 ± 6.9 | 24.5 ± 4.7 | 22.9 ± 3.1 |
| **Body Mass Index (BMI)** | | | |
| Underweight, (n=37) | 64.7 ± 6.2 | 16.6 ± 1.6 | 26.2 ± 2.1 |
| Normal, (n=288) | 69.8 ± 7.9 | 21.9 ± 1.6 | 25 ± 2.9 |
| Overweight, (n=210) | 66.2 ± 5.8 | 26.8 ± 1.2 | 25.4 ± 3.6 |
| Obese, (n=41) | 66.6 ± 6.2 | 34.5 ± 2.7 | 26.9 ± 1.5 |

Note: Note: Values are presented as number (%) or mean ± standard deviation. OBC = Other Backward Class; SC = Scheduled Castes; ST = Scheduled Tribes; BMI = Body Mass Index; SD = standard deviation.

**Table 2: Correlation of age and BMI with HMMSE score among the elderly**

| Socio-demographic variables | Age with HMMSE Score | | BMI with HMMSE Score | |
|---|---|---|---|---|
| | Correlation coefficient (r) | p-value | Correlation coefficient (r) | p-value |
| **Age** | | | | |
| 60-69 year, (n=360) | 0.06 | 0.25 | 0.07 | 0.16 |
| 70-79 years, (n=171) | -0.05 | 0.54 | -0.02 | 0.76 |
| ≥ 80 years, (n=45) | 0.02 | 0.87 | 0.41** | 0.01 |
| **Gender** | | | | |
| Female, (n=288) | -0.04 | 0.50 | 0.07 | 0.27 |
| Male, (n=288) | -0.05 | 0.38 | 0.11 | 0.07 |
| Category | | | | |
| General, (n=336) | 0.00 | 0.98 | 0.06 | 0.31 |
| OBC, (n=150) | -0.21* | 0.01 | 0.26** | 0.00 |
| SC, (n=24) | -0.03 | 0.91 | 0.47* | 0.02 |
| ST, (n=66) | 0.01 | 0.96 | 0.08 | 0.53 |
| **Socio-economic status** | | | | |
| Upper middle (II), (n=55) | -0.17 | 0.21 | 0.33* | 0.01 |
| Lower middle (III), (n=45) | -.039** | 0.01 | 0.24 | 0.11 |
| Upper lower (IV), (n=362) | -0.17** | 0.00 | 0.06 | 0.23 |
| Lower (V), (n=114) | 0.26** | 0.01 | -0.03 | 0.74 |
| **Education** | | | | |
| Profession, (n=17) | -0.45 | 0.07 | 0.22 | 0.40 |
| Graduate, PG, (n=175) | -0.23** | 0.00 | 0.22** | 0.00 |
| Illiterate, (n=105) | 0.34** | 0.00 | -0.21* | 0.03 |
| Intermediate, (n=33) | 0.04 | 0.82 | 0.18 | 0.31 |
| Middle School, (n=135) | -0.36** | 0.00 | 0.15 | 0.09 |
| Post high School, (n=48) | 0.18 | 0.22 | 0.08 | 0.57 |
| Primary School, (n=63) | -0.08 | 0.53 | -0.48** | 0.00 |
| **Occupation** | | | | |
| Professional, (n=12) | 0.33 | 0.29 | 0.78** | 0.00 |
| Semi-Professional, (n=12) | -0.62* | 0.03 | 0.21 | 0.52 |
| Clerical, (n=15) | -.0.60* | 0.02 | 0.76** | 0.00 |
| Skilled worker, (n=18) | -0.68** | 0.00 | 0.81** | 0.00 |
| Semi skill, (n=54) | 0.00 | 0.98 | 0.04 | 0.79 |
| Unskilled, (n=24) | 0.26 | 0.23 | -0.49* | 0.02 |
| Unemployed, (n=441) | -0.15** | 0.00 | 0.06 | 0.19 |
| **Body Mass Index (BMI)** | | | | |
| Underweight, (n=37) | 0.16 | 0.35 | 0.13 | 0.44 |
| Normal, (n=288) | 0.03 | 0.66 | -0.05 | 0.42 |
| Overweight, (n=210) | 0.13 | 0.06 | -0.01 | 0.88 |
| Obese, (n=41) | -0.30 | 0.05 | 0.31* | 0.05 |

Note: **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). OBC = Other Backward Class; SC = Scheduled Castes; ST = Scheduled Tribes; BMI = Body Mass Index; SD = standard deviation.

**Table 3: MMSE scores and BMI characteristics of all elderly in the study**

| Characteristics | HMMSE Mean (SD) |
|---|---|
| Overall BMI (24.2 ± 4.4) | 25.2 (3.9) |
| BMI ≤ 24.9 kg/m2 (21.2 ± 2.3) | 24.8 (4.3) |
| BMI ≥ 25.0 kg/m2 (28.1 ± 3.3) | 25.7 (3.4) |

**Mann-Whitney U-Test value** 44972.5, **P value** 0.04*

Note: Values are presented as number (%) or mean ± standard deviation. Mann-Whitney U Test. *p values were calculated and indicated significant association when values were <0.05.

Association between HMMSE scores and Body Mass Index (BMI): The average HMMSE test score was 25.4 ± 3.1 among the elderly, with scores ranging from 16 to 30. The correlation of BMI and age with HMMSE score was assessed overall and based on socio-demographic variables. The HMMSE scores were not significantly correlated with BMI (r = 0.07, p = 0.11). However, a significantly positive correlation of BMI with HMMSE scores were seen for ≥ 80 years elderly(r= 0.41, p=0.01), OBC category (r= 0.26, p<0.01), SC category (r= 0.47, p= 0.02), Upper middle class (II) (r= 0.03, p=0.01), Graduate, PG (r= 0.22, p<0.01), skilled workers (r= 0.81, p<0.01), clerical workers (r=0.76, p<0.01) and Professional workers(r=0.78, p<0.01). BMI correlated negatively with the HMMSE scores among illiterates (r= -0.21, p= 0.03), primary school educated elderly (r= -0.48, p<0.01) and unskilled workers (r= -0.49, p= 0.02). Furthermore, when categorized for gender, no significant correlation was seen between BMI and HMMSE score. (Table 2) The distribution of the HMMSE score based on the Body Mass Index (BMI) of all elderly is shown in figure 1.

The correlation was between age and HMMSE score overall and based on sociodemographic variables and BMI status of the elderly. (Table 2) An inverse correlation of age with HMMSE score was found but it was not statistically significant (r = -0.80, p=<0.06).

**Table 4: Regression analysis of various risk factors with MMSE scores**

| Predictor | Estimate | SE | 95% Confidence Interval | | t-value | p-value |
|---|---|---|---|---|---|---|
| | | | Lower | Upper | | |
| **Age** | -0.06 | 0.1 | -0.09 | -0.02 | -3.34 | <0 .001 |
| **Gender** | | | | | | |
| Male (ref)[a] | | | | | | |
| Female | 0.29 | 0.3 | -0.19 | 0.78 | 1.19 | 0.236 |
| **Socio-economic status** | | | | | | |
| Lower (V) (ref)[a] | | | | | | |
| Upper Middle (II) | 3.48 | 0.5 | 2.5 | 4.45 | 6.99 | <0 .001 |
| Upper Lower (IV) | 2.66 | 0.3 | 2.02 | 3.3 | 8.17 | <0 .001 |
| Lower Middle (III) | 4.68 | 0.5 | 3.656 | 5.7 | 8.99 | <0 .001 |
| **Category** | | | | | | |
| ST (ref)[a] | | | | | | |
| General | 1.5 | 0.4 | 0.69 | 2.31 | 3.62 | <0 .001 |
| OBC | 1.18 | 0.5 | 0.3 | 2.07 | 2.64 | 0.009 |
| SC | 1.92 | 0.7 | 0.59 | 3.25 | 2.84 | 0.005 |
| **Body Mass Index (BMI)** | 0.08 | 0 | 0.03 | 0.14 | 2.82 | 0.005 |

Note: R2: 0.226, SE: standard error, OBC = Other Backward Class; SC = Scheduled Castes; ST = Scheduled Tribes; SE = standard error. (ref)[a] Represents reference level

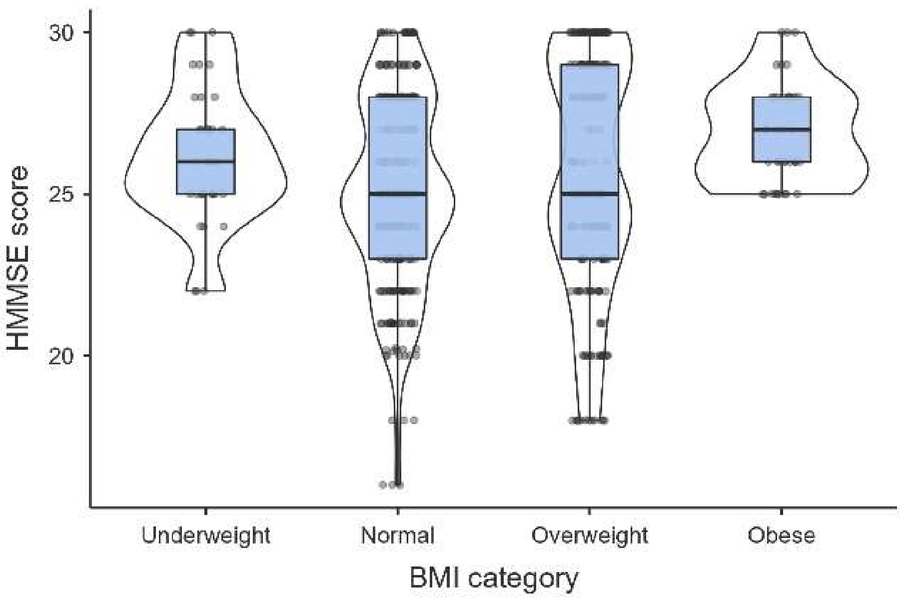


**Figure 1: Violin plot showing MMSE score based on Body Mass Index (BMI) of all elderly.**

There was a significant negative correlation between age and cognitive decline for elderly belonging to category OBC, (r = -0.21, p<0.01), Lower middle (III), (r = -0.39, p=0.01), Upper Lower (r = -0.17, p<0.01), Lower (V), (r = -0.26, p=0.01), Graduate, Post Graduate,(r = -0.23, p<0.01), Middle School, (r = -0.36, p<0.01), Illiterate, (r = -0.34, p<0.01), Clerical, (r = -0.60, p=0.02), Semi-Professional, (r = -0.62, p=0.03), skilled worker (r = -0.68, p<0.01), Unemployed, (r = -0.15, p<0.01) and Obese, (r = -0.30, p=0.05) (Table 2). The non-parametric, independent-Samples Mann-Whitney U Test showed there is a significant difference in HMMSE scores for category (test statistic=36.0, p<0.01), Socioeconomic status (test statistic=98.7, p<0.01), education (test statistic=74.9, p<0.01) and occupation (test statistic=62.0, p<0.01) whereas no significant association was seen for age and gender. The Mann-Whitney U Test found that individuals with a lower BMI compared to those with a higher BMI had a significantly lower performance score on the HMMSE test (24.8 ± 4.3 vs 25.7 ± 3.4, p=0.04) (Table 3). On regression analysis, age, category, socio-economic status and Body Mass Index (BMI) was found to be significantly associated with HMMSE score. (Table 4) The Correlation of socio-demographic variables and Body Mass Index (BMI) with HMMSE score based on the regression model is shown in figure 2.

## Discussion

With the data available in the literature, the association between BMI and the risk of cognitive decline is still a subject of controversy. Additionally, there are only a few studies available on the correlation between BMI and age with MCI.

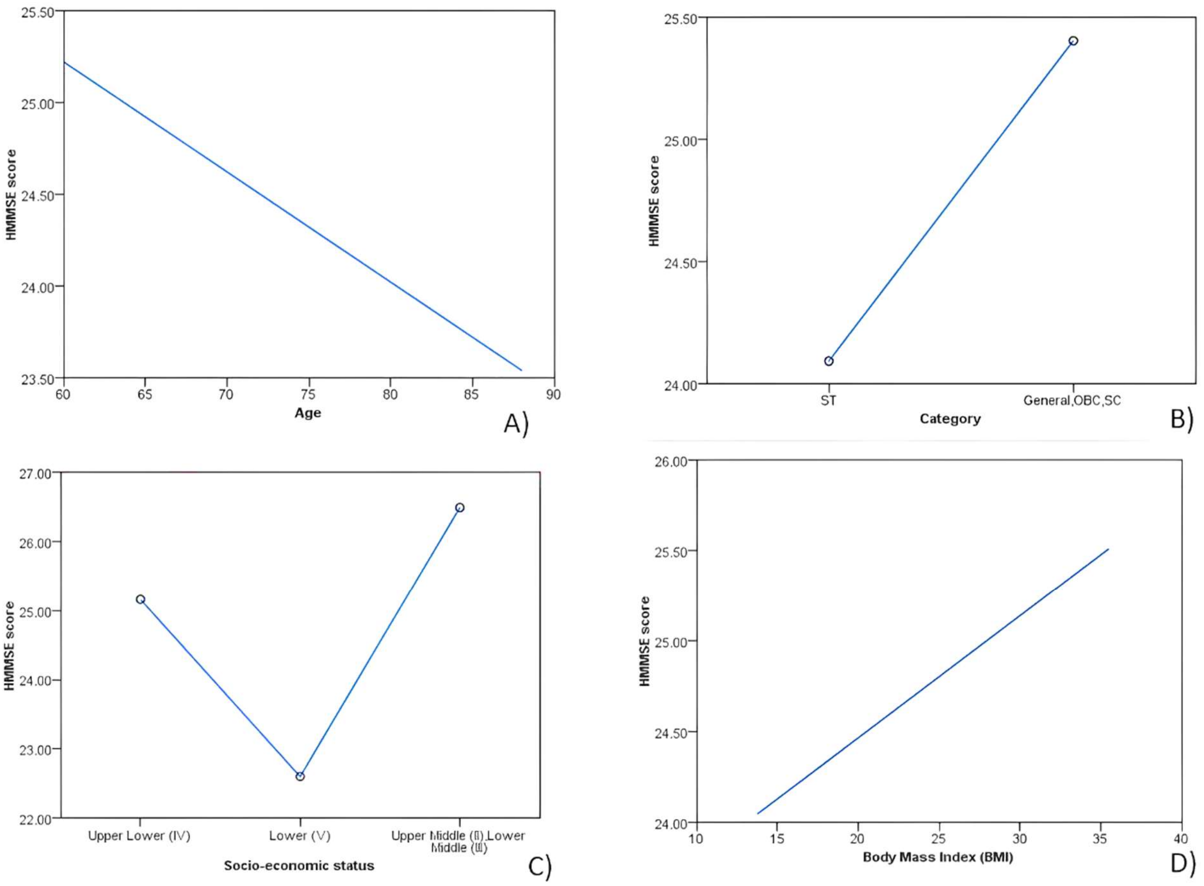


**Figure 2: Correlation of A) age with HMMSE score B) Category with HMMSE score C) Socio-economic status with HMMSE score D) Body Mass Index (BMI) with HMMSE score based on regression model**

This cross-sectional study allowed us to identify the relations of interdependency between the variables BMI and age with MCI for each socio-demographic characteristic. An insignificant relationship between BMI with MCI in the current study overall, but after stratification according to age group, the elderly of ≥ 80 years had a significant association of BMI with cognition, this may be due to the cross-sectional design of the study which estimated only the present status of BMI. Similarly, studies showed that there was a difference in the effect of BMI on the onset of dementia according to age. Obesity in midlife is associated with incident AD, whereas being underweight in the elderly is associated with an increased risk of dementia.[31,32] Various researchers have stated that the elderly with high BMI scores experience a slower decline in cognitive function in comparison to middle-aged adults with high BMI scores.[4–6,3] On the dose-response relationship, Yi Qu et al. study showed that excess body mass among middle-aged adults has a higher risk for dementia, whereas among the elderly increasing body mass has a lower risk for dementia, implying that the elderly could increase their body weight to prevent dementia.[32] Obesity in middle age (COR = 1.88) was linked to a higher probability of developing incident AD dementia later in life.[33] It has also been stated as a potential risk factor for AD dementia is a midlife increase in body mass index (BMI). Increases in midlife BMI by one unit were associated with 6.7 months of earlier AD dementia onset [34]. Additionally, among people over the age of 60, being overweight or obese was linked to a 70% increased risk of developing amnestic mild cognitive impairment compared to people with a normal weight.[34,35]

There is no significant correlation between the two variables BMI and MCI when the participants were stratified according to gender. This insignificant relationship between BMI and MCI, when subcategorized based on gender was in contrast to other studies where an association was observed between being underweight and progression to AD in females,[31,36] and certain lifestyle-related factors' effects on the amyloid burden and cognitive function modified by gender.[37] This difference may be due to the different study designs and age groups of the subjects included in the study. Although a significant difference was not found in the current study, stratifying subjects by age and gender is important since increasing age and gender are independent risk factors for MCI. Although there is an insignificant correlation between BMI and MCI in the present study, while stratifying in terms of socio-economic status, among the Upper Middle (II) class, the positive correlation between BMI and cognitive function infers that with high BMI, cognitive function is better. It proves that the relationship between BMI and MCI varies with socioeconomic status. This difference in the relationship between BMI and MCI according to socio-economic status demands further evaluation as it could become a potential factor in impeding the progression to AD. In the current study, no significant correlation was seen between age and MCI but on the regression analysis age was negatively associated with HMMSE scores, indicating that a lower mean score on the HMMSE neurocognitive test is associated with increasing age in the elderly. Our finding is consistent with previous studies which reported that increasing age is inversely related to neurocognitive function and hence proving that age is an important independent risk factor of cognitive function.[31,36] These findings were similar to the studies where they found that the increase in the incidence of MCI with age is not unexpected, as MCI represents a pre-dementia stage in many cases,[38–40] and the incidence of dementia itself also increases with age.[41,42] According to a meta-analysis done by Pedditzi et al., obesity had a positive association with incident dementia in people under 65 years of age (risk ratio = 1.41) but a negative association with incident dementia in those over 65 years of age (risk ratio = 0.83).[43]

The inverse correlation of age with MCI in females implies that the correlation of age with MCI varies with gender, but it was not statistically significant. On the contrary, different studies have shown gender differences in dementia risk factors, stating that Apolipoprotein E epsilon 4 genotype status has a deleterious effect on gross hippocampal pathology and memory performance in women when compared with men.[10,31] Further, hormonal factors like lower estrogen levels are potentially associated with AD. This controversy could be due to the different study designs and the inclusion of elderly above 60 years of age in the study. Among the Lower middle (III) and Upper lower (IV) socio-economic classes, an inverse correlation between age and MCI implies that they belong to a high-risk group and are more prone to develop MCI as their age increases and there is a difference in correlation of age with MCI while stratified. Similarly, the meta-analysis done among the elderly population in China showed that socioeconomic class greatly influence the development of mild cognitive impairment.[36]

While stratifying based on BMI showed that among the obese elderly, there is an inverse correlation of age with the HMMSE score. However, among overweight, normal, and overweight individuals, no such relationship has been found. Hence, the correlation between age and cognition varies among the different BMI values. Similarly, the meta-analysis revealed that in late life, being underweight was associated with a higher risk of dementia and cognitive impairment, while being overweight, obese, and having a high BMI were attributed to a lower risk of dementia and cognitive impairment. On the contrary, the meta-analysis revealed that in midlife, there was a greater risk of dementia and cognitive decline in people who were underweight, obese, or had a high BMI, while there was no such correlation in people who were overweight. The discrepancy may be due to different BMI measurements or a lack of relationship, resulting in coincidental findings. MCI may be a common endpoint for a variety of etiological pathways that differ between men and women, which may be influenced by endocrinological factors as well as environmental hazards.[32,36]

## Limitations

The study has some limitations, including the exclusion of tools with higher diagnostic accuracies, such as the Addenbrooke's Cognitive Examination-3 (ACE-3) and Montréal Cognitive Assessment (MoCA), and the inability to reliably diagnose MCI using imaging techniques due to resource constraints.

## Conclusion

Body Mass Index (BMI) may influence cognition in late life and obesity in the elderly may be a protective factor for cognitive decline. The relationship between age and BMI with HMMSE score varies with socio-demographic variables and BMI. Further studies are needed to evaluate the correlations between age, BMI, and cognitive decline. Various factors like age, category, socioeconomic status, and Body Mass Index (BMI) were found to be predictors of cognition among the elderly.

**Data Statement:** The data has not been previously presented orally or by poster at scientific meetings.

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