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Research Article

Cognitive function and its association with level of education and work status in adults in Saudi Arabia: a cross-sectional study

Mohammed Alarabi, Abdullah Al-Turki, Mohammed Mahasin, Abdulrahman Al-Sehly, Faisal Al-Dawood, Saleh Al-Kurini, Shahid Bashir*

Department of Physiology, Faculty of Medicine, King Saud University, PO Box 2925, Riyadh 11461, Saudi Arabia

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***Correspondence:**
Dr. Shahid Bashir,
E-mail: sbashir10@gmail.com

ABSTRACT

Background: Cognitive decline is not inevitable with age; studies have shown that it can be affected by a number of education and work related factors. We explored this association by carrying out a cross-sectional study in King Khalid University Hospital and King Abdulaziz University Hospital in Riyadh, Saudi Arabia.
Methods: We enrolled 202 adults, whose ages ranged between 40 and 85 years. Data was collected using a validated Arabic translation of a standardized test assessing cognitive function, known as the Mini Mental State Examination (MMSE). Subjects were also inquired about their level of education and work status.
Results: The results showed that in our subjects of adults above the age of 40, the mean MMSE score was 23.45 (SD=4.203). Females (n=94) had lower scores than their male counterparts (n=108) (mean difference: 3.11, 95% CI 2 to 4.22; $p<0.001$). There was a strong negative correlation between Age and MMSE scores ($r=-0.308$; $p<0.001$). Higher levels of education were associated with higher MMSE scores ($p<0.001$). Having no education was associated with a major decline in scores compared to a college education (mean difference: 8.16, 95% CI 6.76 to 9.56; $p<0.001$). Being employed was associated with higher scores ($p<0.001$). This was irrespective of gender, although females were more likely to have had no education or work ($p<0.001$).
Conclusions: Higher levels of education and employment both seem to be associated with higher cognitive function scores in the studied demographic. Further research is required for population generalization and to establish a causal relationship.

Keywords: Cognitive function, Mini mental state examination, Education

INTRODUCTION

Cognitive health is the individual's unaffected ability to learn, think, and remember. It enables one to reason, concentrate, judge, plan, and organize.[1] Although aging commonly affects some cognitive function, such as processing speed, there is substantial inter-individual variability.[2] This makes it clear that cognitive impairment is not an inevitable consequence of aging.[3] As a matter of fact, research has found lifestyle practices such as education, work, and intellectual engagement to be associated with successful preservation of cognitive function. Education seems to be more closely associated than other factors; research indicates that education exerts protective effects on cognitive function.[4]

This is reflected in cognitive function scores of individuals with varying levels of education.[5,6] Cognitive function can be scored in various ways; one of the most widely used methods is known as the Mini Mental State Examination (MMSE). It was introduced in 1975 to thoroughly but routinely investigate the cognitive realm.[7] The test "assesses many cognitive domains, including orientation, memory, language, calculation, and visual construction.[6] International studies have shown that cognitive changes with age can be reduced, proving that cognitive impairment is not an inevitable result of aging.[7-9] Studies suggest that continuous learning and mental exercise may be crucial interventional factors in preserving cognitive health throughout aging.[10] The Successful Aging studies by MacArthur established "the psychological and physiological benefits of education on cognition in aging individuals."[4] Another study conducted on an Arab population concluded that education influences performance on the Arabic translation of the MMSE in cognitively normal elderly.[5]

The use of the MMSE in cognitive health research is prevalent; some studies have been carried out with an Arabic version of the test. Among them is a study done in northern Israel, which showed that "the mean MMSE score of males (26.3, SD=4.1) was higher than that of females (23.6, DF=4.2)."[5]

Another study conducted with an Arabic MMSE was the one carried out in KKUH in 1999. The study showed The mean score of educated subjects falls within the conventional cut-off score of >24 in Western countries. However, this cut-off value has a low specificity of 51.5%, with sensitivity of 100% for the diagnosis of dementia according to Al-Rajeh Both of these studies showed that the mean MMSE of males was higher than that of their female counterparts.[6] This may be due to cultural and societal influences on the previous generations regarding female education and employment.

Based on previous studies, we hypothesized that different levels of education and work circumstances associated with cognitive function in adults over the age of 40 in two tertiary care hospitals in Riyadh, Saudi Arabia.

METHODS

This is a quantitative observational cross-sectional study; to statistically analyze the association between the variables in the target population. It was conducted in the Department of Physiology, College of Medicine and King Khalid University Hospital (KKUH), Riyadh, Saudi Arabia.

The study concluded with the enrollment of 202 subjects. Out of the 202 subjects, 108 were male (53.5%) and 94 were female (46.5%), (Table 1). The Median age was 55, while the Range was 45, with minimum=40, and maximum=85. The research protocol was approved by the Institutional Review Board, College of Medicine and KKUH.

Table 1: Demographic table.

Number of subjects	Number of males	Mean MMSE for males	Number of females	Mean MMSE for females	p-value
202	108 (53.5%)	24.9±3.35	94 (46.5%)	21.79±4.45	<0.0001

Exclusion criteria were blindness, stroke, Alzheimer's disease and any kind of psychiatric disorders.

Patients were asked to undergo the Mini-Mental State Examination (MMSE) during their stay at the hospital or routine ambulatory visits between February 2014 and April 2014. Demographic characteristics such as sex, age, were assessed. A preform, both in English and Arabic, was designed and also included as was a validated standardized Mini-mental State Examination (MMSE).[5]

Cognitive function

Cognitive function was evaluated using the Mini Mental State Examination (MMSE), which is one of the most widely used tools for quantitative evaluation of cognitive function. As for Arabic speakers, a translated version of the MMSE was used; as was proposed in 1999 by a group of Saudi researchers.[5,6]

Questionnaire on lifestyle factors

The goal of the newly implemented questionnaire was to get a scientific assessment of the actual status on physical and mental capabilities of people in advanced stages of adulthood (age 40+ years). The assessment also explored level of education and work status for each subject. The contents of the questionnaire will be part of the supplement to this paper and can be inspected there.

Data analysis

After data collection was complete, the data was entered and processed using Statistical Package for the Social Sciences (SPSS). (IBM, 2012).[8] Descriptive and frequency statistics were obtained for the MMSE scores and each variable, and some data were managed to allow for further data analysis.

To check for statistically significant differences in MMSE scores between groups of categorical variables, a t-test was conducted for variables with only two groups, as was a One-Way ANOVA with Tukey post-hoc tests for variables with three groups or more. Cases were isolated depending on gender or other possibly confounding variables in certain circumstances to avoid any bias. As for qualitative variables, Pearson's correlation test was done to test for significant correlations. The most significant variables were used in a regression model to test for their predictability of MMSE scores in the studied sample.

RESULTS

The study concluded with the enrollment of 202 subjects. Data collection started in February 2014 and ended in March 2014. Out of the 202 subjects, 108 were male (53.5%) and 94 were female (46.5%). The MMSE scores (n=202) mean was 23.45±4.20 SD), with 95% Confidence Interval from 22.87 to 24.03. The Median was 24 points, while the Range was 16, with highest score = 30, and lowest score = 14 points. There was a significant difference between the two gender groups, *t* (171.808)=5.529, p<0.0001, and 95% Confidence Interval from 2.000 to 4.221 points, with males scoring significantly higher on the MMSE than females. The mean age of our sample of adults above 40 was 56.75 (SD=10.747). The Median age was 55, while the Range was 45, with minimum = 40, and maximum=85. A Pearson Correlation test was done, and revealed there was a strong, negative correlation between Age and Cognitive Function Score (MMSE), which was significant (r = -0.308, n = 202, p<0.0001, Figure 1).

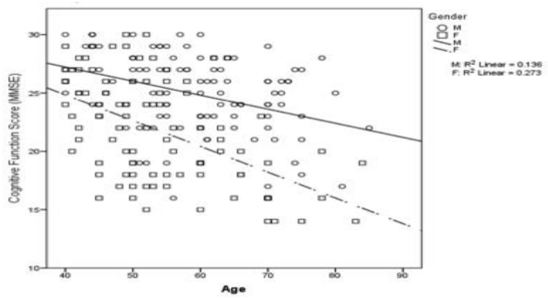

Figure 1: Correlation between age and MMSE scores for male and female subjects.

The study subjects were asked about the highest level of education they reached, and out of 202, 54 subjects (27.1%) said they obtained No Education, 22 subjects (11.1%) said they reached Elementary School, 20 subjects (10.1%) said they reached Middle School, 39 subjects (19.6%) said they reached High School, and 64 subjects (32.2%) said they went to College/University.

Table 2: Comparison of MMSE between groups with different education levels for all subjects.

Multiple Comparisons						
Dependent Variable: Cognitive Function Score (MMSE) Tukey HSD						
(I) Highest education level reached	(J) Highest education level reached	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
No Education	Elementary School	-3.588*	0.694	0.000	-5.50	-1.68
	Middle School	-5.665*	0.718	0.000	-7.64	-3.69
	High School	-6.007*	0.577	0.000	-7.60	-4.42
	University/College	-8.159*	0.507	0.000	-9.56	-6.76
Elementary School	No Education	3.588*	0.694	0.000	1.68	5.50
	Middle School	-2.077	0.848	0.107	-4.41	0.26
	High School	-2.420*	0.732	0.010	-4.43	-0.40
	University/College	-4.571*	0.678	0.000	-6.44	-2.70
Middle School	No Education	5.665*	0.718	0.000	3.69	7.64
	Elementary School	2.077	0.848	0.107	-0.26	4.41
	High School	-0.342	0.755	0.991	-2.42	1.74
	University/College	-2.494*	0.703	0.004	-4.43	-0.56
High School	No Education	6.007*	0.577	0.000	4.42	7.60
	Elementary School	2.420*	0.732	0.010	0.40	4.43
	Middle School	00.342	0.755	0.991	-1.74	2.42
	University/College	-2.151*	0.558	0.001	-3.69	-0.62
University/College	No Education	8.159*	0.507	0.000	6.76	9.56
	Elementary School	4.571*	0.678	0.000	2.70	6.44
	Middle School	2.494*	0.703	0.004	0.56	4.43
	High School	2.151*	0.558	0.001	0.62	3.69

There was a significant difference in Cognitive Function Scores (MMSE) between the aforementioned groups as determined by a One-Way ANOVA test (F (4, 194)=68.702, p <0.0001). A Tukey post-hoc test showed the significant differences in MMSE scores between the groups (Table 2).

There was a significant association between Education Level and Gender in our sample ($X^2(4,199)=24.614$, p<0.0001). Female subjects were more likely to have had no education, and Male subjects were more likely to have reached College/University. To avoid confounding by Gender, we isolated Male subjects and revealed there was still a significant difference in MMSE scores between the groups of Education Level, it was determined with a One-Way ANOVA test (F (4,101)=14.426, p<0.0001). A Tukey post-hoc test showed the significant differences in MMSE scores between the Male groups.

We also isolated Female cases, and showed there was a significant difference in MMSE scores between the Female groups of Education Level using a One-Way ANOVA test (F (4,88) = 57.780, p<0.0001). A Tukey post-hoc test showed the significant differences in MMSE scores between the female groups. Due to significant differences in MMSE scores between the groups for both genders, we re-analyzed the difference in MMSE scores between the two genders for each Level of Education (Figure 2). Subjects who received No Education were isolated (n=54), and there was still a significant difference in Cognitive Function Scores (MMSE) between Male and Female subjects, *t* (52)=3.127, p=0.003, and Confidence Interval from 0.947 to 4.339 points, with Male subjects scoring significantly higher than Females.

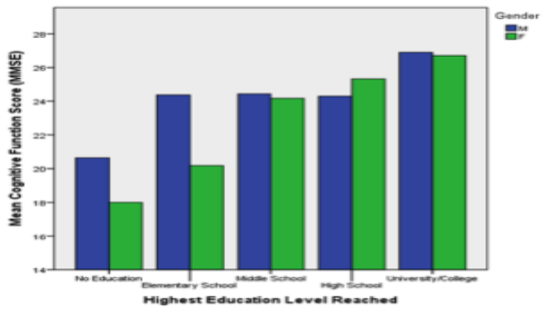

Figure 2: MMSE scores and highest level of education for male and female subjects.

Then Subjects who reached Elementary School were isolated (n=22), and there was still a significant difference in MMSE between Male and Female subjects, *t* (20)=3.704, p=0.001, and a Confidence Interval from 1.827 to 6.531 points, with Male subjects scoring significantly higher than Females. Afterwards, Subjects who reached Middle School were isolated (n=20), and there was NO significant difference between Male and Female subjects, *t* (18)=0.178, p=0.861, and a Confidence Interval from -2.835 to 3.359 points.

Table 3: Comparison of MMSE scores between groups with different work circumstances for all subjects.

Multiple Comparisons						
Dependent Variable: Cognitive Function Score (MMSE), Tukey HSD						
(I) Work Circumstance	(J) Work Circumstance	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Employed	Free Lancer	1.986	1.131	0.298	-0.95	4.92
	Retired	1.831*	0.613	0.017	0.24	3.42
	Unemployed	6.110*	0.570	0.000	4.63	7.59
Free Lancer	Employed	-1.986	1.131	0.298	-4.92	0.95
	Retired	-0.155	1.143	0.999	-3.12	2.81
	Unemployed	4.124*	1.120	0.002	1.22	7.03
Retired	Employed	-1.831*	0.613	0.017	-3.42	-0.24
	Free Lancer	0.155	1.143	0.999	-2.81	3.12
	Unemployed	4.279*	0.592	0.000	2.75	5.81
Unemployed	Employed	-6.110*	0.570	0.000	-7.59	-4.63
	Free Lancer	-4.124*	1.120	0.002	-7.03	-1.22
	Retired	-4.279*	0.592	0.000	-5.81	-2.75

Also, subjects who reached High School were isolated (n=39), and there was NO significant difference between Male and Female subjects, *t* (37)= -1.076, p=0.289, and Confidence Interval from -3.004 to 0.920 points. Finally, subjects who reached College/University were isolated (n=64), and there was NO significant difference between Male and Female subjects, *t* (62)=0.346, p=0.731, and a Confidence Interval from -0.922 to 1.307 points.

Out of the 202 subjects, 63 were employed, 10 were freelancers, 55 were retired, and 74 were unemployed or have never worked. There was a significant difference in MMSE scores between the aforementioned groups as determined by a One-Way ANOVA test ($F(3,198)=41.118$, $p<0.0001$). A Tukey post-hoc test revealed the significant differences in MMSE scores between the groups (Table 3). There was, however, a significant association between Gender and Work Circumstance ($X^2(3, n=202)=95.713$, $p<0.0001$).

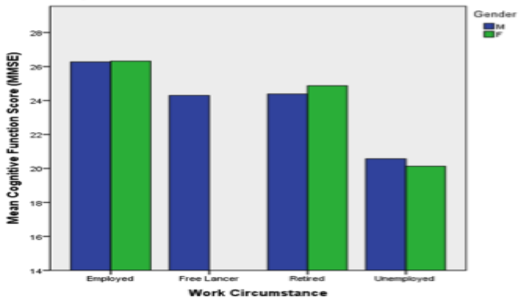

Figure 3: MMSE scores and work circumstance for male and female subjects.

To avoid confounding by Gender, we isolated cases based on gender and checked again for significant differences in MMSE scores between groups of Work circumstance (Figure 3). First we isolated Female cases, and there was a significant difference in MMSE scores between the Work Circumstance groups as determined by a One-Way ANOVA test ($F(2,91) = 24.673$, $p<0.0001$). A Tukey post-hoc test revealed the significant differences in MMSE scores between the groups for female cases only. Then, we isolated Male cases, and there was a significant difference in MMSE scores between the Work Circumstance groups as determined by a One-Way ANOVA test ($F(3,104)=8.081$, $p<0.0001$). A Tukey post-hoc test revealed the significant differences in MMSE scores between the groups for male cases only.

DISCUSSION

The sample was taken from King Khalid University Hospital (KKUH) and King Abdulaziz University Hospital (KAUH) in Riyadh, Saudi Arabia. The 202 subjects were either admitted patients in the wards, or non-admitted individuals found in the premises. This is why our study results are centered on the community of these hospitals, and can only be generalized to cover adults over the age of 40 who may be found there.

The mean Cognitive Function Score (MMSE) in our sample was 23.45 (SD=4.203), with a Median of 24 points. This is close to the results of the study done in 1999, by Al-Rajeh et al. in which he assessed 33 non-demented adults in KKUH, and which showed a mean MMSE score of 22.3 (SD = 6.3).[6] Present sample mean is also close to the mean obtained in a study done in 2007 published by Inzelberg et al. in Israel assessing 266 Arab adults using the MMSE. Their mean was 24.95 (SD=4.15) and showed, just like our study, a tendency for Male or educated individuals to score higher than their Female or illiterate counterparts.[5]

The mean MMSE score in our sample falls under the common cutoff point of cognitive impairment which is <24, or exactly at it if we consider the median (M=24).[3] Whether this indicates that subjects in our sample suffer from cognitive impairment is arguable, since a similar mean (lower than the cut-off point) was obtained in Al-Rajeh's study in 1999 on normal subjects of a similar demographic.

This, however, should not play a major part in the conclusions drawn from the results of our study, as our aim is NOT to determine the prevalence of cognitive impairment in our target population, but rather to compare cognitive function scores using the MMSE between groups based on variable lifestyle factors. If the groups differ significantly, that would imply an association between the education or work variables and the MMSE score regardless of whether or not the individual is cognitively impaired.

Our study showed that males in our sample scored significantly higher on the MMSE than females. This is in agreement with other published studies in Saudi Arabia and the Arab world.[5,6] On average, males of our sample scored 3 points higher than females. The difference between the two genders in MMSE scores was previously attributed to sociocultural factors regarding female education and employment. Our results show that some of the difference between males and females in MMSE scores may indeed be accounted for by the discrepancy in education level or work circumstance.

The ages of our subjects varied from 40 to 85 years, and the study showed the commonly observed, and documented, decline of cognitive function as scored by the MMSE with increasing age.[1] However, significantly differing results were observed in our sample regardless of age, which supports our hypothesis and literature reports that different lifestyle factors, such as education, and intervention may greatly impact cognitive decline with age.[4]

As predicted, and reported by numerous other researches, education has the largest effect on cognitive function as scored by the MMSE.[2-6] Subjects who obtained no education scored several points less than those who did. And there was a gradual increase in the mean score of subjects belonging to progressively higher levels of education, with those who went to college/university scoring, on average, 8 points more than uneducated subjects. The difference in cognitive function scores between the two genders disappeared as they reached higher education levels (Figure 2), showing that, the sociocultural-dependent educational factors play a major role in the difference between male and female scores on the MMSE.

The work circumstance had a clear effect on cognitive function scores, as those who never worked scored significantly lower than those who did. The difference was more prominent with females, as females who never worked scored, on average, 6 points less than female who were employed.

CONCLUSION

We conclude that for adults, over the age of 40 found in KKUH or KAUH, cognitive function as scored by the MMSE is not only affected by age, but is strongly associated with other variables. The most prominent of these factors appears to be education, as higher levels of learning and being employed seem to be associated with higher scores. We have also shown that the difference between males and females in MMSE scores can be often attributed to other factors such as education or work.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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