

INFLUENCE OF AGE AND SCHOOLING ON THE PERFORMANCE IN A MODIFIED MINI-MENTAL STATE EXAMINATION VERSION

A study in Brazil Northeast

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ABSTRACT - Performance in cognitive tests can be influenced by age and education level. In developing countries, formal education is limited for most people. Application of the Mini-Mental State Examination (MMSE) test, in its original version could have an adverse effect on the evaluation of low educated and elderly individuals. *Objective:* To assess the cognitive performance of low and middle educated old people in a modified version of the adapted to portuguese language MMSE. *Method:* A study was carried out enrolling 253 individuals, aged 60 to 90 years included in different schooling levels. Four educational groups were studied: illiterate; 1-4 schooling years; 5-8 schooling years and over 8 schooling years. Besides, the sample was also studied according to six classes: 60-65, 66-70, 71-75, 76-80, 81-85 and 86-90 years. The modified version (mo-MMSE) included modifications in copy and calculation items from the adapted MMSE (ad-MMSE) to Portuguese language. The maximum possible score was the same in the two versions: total, 30; copy, 1 and calculation, 5. *Results:* mo-MMSE scores were significantly higher than ad-MMSE for every age classes. A negative correlation was observed between age and scores in individuals of 1-4 and in individuals over eight schooling years, both in ad-MMSE and mo-MMSE. However, there was not a significant correlation between age and scores in illiterate group and in individuals of 5-8 schooling years. *Conclusion:* The modification of copy and calculation items of ad-MMSE, are responsible by the best performance in mo-MMSE. Cultural background could have influenced this result. Individuals with more than eight years of formal instruction are protected against a reduction of their capacity to solve cognitive tests. However, low instructed individuals have not this capacity and so they present signals of intellectual aging before they become elderly people.

KEY WORDS: Mini-mental State Examination, cognition, education, cognitive assessment, age.

Influência da idade e escolaridade sobre a performance da versão modificada do Mini-Exame do Estado Mental: estudo no nordeste do Brasil

RESUMO - A realização de testes cognitivos pode ser influenciada por fatores como idade e educação. Nos países em desenvolvimento, a educação formal está limitada para a maioria da população. A aplicação do teste Mini-Exame do Estado Mental (MEEM), na sua versão original, pode ter efeito adverso em pessoas com baixo nível de educação e idosos. *Objetivo:* Avaliar a performance cognitiva da população de baixo e médio nível de educação e idosa em uma versão modificada do MEEM adaptado para língua portuguesa. *Método:* Foram estudados 253 indivíduos idosos com idades entre 60 e 90 anos incluídos em diferentes níveis de escolaridade. O estudo foi constituído por quatro grupos de escolaridade: analfabeto; 1-4 anos; 5-8 anos e mais de 8 anos. A amostra também foi estudada de acordo com seis classes: 60-65, 66-70, 71-75, 76-80, 81-85 e 86-90 anos. A versão modificada (MEEM-mo) incluiu modificações nos itens de cópia e cálculo da versão adaptada (MEEM-ad) para a língua portuguesa. O escore máximo foi o mesmo para ambas as versões: total, 30; cópia, 1 e cálculo, 5. *Resultados:* O escore do MEEM-mo foi mais significativo do que o do MEEM-ad para cada classe de idade. Uma correlação negativa foi observada entre a idade e o escore em indivíduos de 1-4 anos e em indivíduos com mais de oito anos de escolaridade, ambas no MEEM-ad e MEEM-mo. Não existia correlação significativa entre idade e escore no grupo de analfabetos e nos indivíduos de 5-8 anos de escolaridade. *Conclusão:* As modificações realizadas nos itens cópia e cálculo do MEEM-ad são responsáveis pela melhor performance encontrada no MEEM-mo. Os fatores culturais podem ter influenciado este resultado. Indivíduos com mais de oito anos de instrução formal são protegidos contra uma redução de suas capacidades para solucionar testes cognitivos. Entretanto, indivíduos com baixo nível de instrução não têm esta capacidade e, dessa forma, apresentam sinais de envelhecimento antes de se tornarem pessoas idosas.

PALAVRAS-CHAVE: Mini-Exame do Estado Mental, cognição, educação, avaliação cognitiva e idade.

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Detailed assessment of cognitive function is essential for accurate diagnosis and management in general neurological practice. This requires a high degree of training by a neurologist or a psychologist, besides to be time-consuming¹. Among the cognitive tests there is the Mini-Mental State Examination (MMSE) proposed to differentiate patients with non-specified organic brain syndrome and depression from normal individuals, being useful both in quantitatively estimating the severity of cognitive impairment and in documenting serially cognitive changes². Assessing MMSE in research protocols is particularly important to establish the incidence or prevalence of cognitive impairment and to examine correlates of mental status³.

The fact that in underdeveloped and developing countries a high formal education is not supplied for large population groups could bring negative consequences for cognitive abilities of many people.

A reduced performance has been observed particularly in tests evaluating cognition of elderly and low educated individuals^{4,5}. Besides, cultural background can influence performance in tests such as MMSE because some particular items in this test could represent different meanings for different cultures^{6,7}. According to Fratiglioni et al.⁸, the performance on the MMSE is variable among countries. This might be due to different educational levels of the population, or to different *curricula* structures of the same schooling level in different countries. Thus, "norms" or "adjustment techniques" derived from one country cannot be considered universally applicable. In order to prevent the possibility of education to mask the performance in this test and, as a consequence, to represent a potential risk factor for cognitive assessment, it is opportune to reassess the validity of the MMSE whenever it is going to be used in a new population. Although adaptation of MMSE to Brazilian cultural context has been made by Bertolucci et al.⁴ this did not solve specific problems found in the execution of the test in regions as Brazil Northeast. Such is the use of nouns for evaluation of immediate memory, which have not the same meaning in different regions of Brazil (e.g the words *tapete* and *caneca*). Items measuring recall of three words, pentagon copy, and orientation in time seem to be most sensitive to both normal aging and dementing illnesses⁹. Yet it is well known that for low instructed individuals is not easy to solve

calculation problems. Considering these aspects it is important to minimize false positive results in testing low educated people living in those cultural contexts. In the present study, MMSE⁴ copy and calculation items were changed according to the cultural background of Brazil Northeast, in order to investigate the issue.

METHOD

A randomized cross-sectional study using both a modified and the adapted to Portuguese language MMSE version⁴ (thereafter called respectively, mo-MMSE and ad-MMSE) enrolling 253 individuals (187 women and 66 men), aged between 60 and 90 years ($69,4 \pm 6,8$ years), with low and middle formal instruction, residents in Olinda city, Pernambuco, Brazil, was performed. Individuals belonged to low and middle socio-economic classes of the county. Previously to the application of the test people were inquired about their normal daily routine. Individuals able to conduct themselves as well as to recognize primary and secondary colors, time in a clock, cash money, and to use a tin opener, were admitted to the study. A clinical interview was made in order to investigate neurological and psychiatric diseases. People with low visual or auditory acuity, motor or rheumatic disturbance, chronic alcoholism, cardiovascular disease, recent head trauma (last 12 months) or not motivated, were excluded. During interview all individuals revealed interest to participate in the study.

According to the schooling level, four groups were constituted as follows: group illiterate (n=28) - individuals without any formal schooling instruction; group 1-4 degree (n=119) - individuals with 1 to 4 years of formal instruction; group 5-8 degree (n=85) - individuals with 5 to 8 years of formal instruction; and group over 8 degree (n=21) - individuals with 8 or more years of formal instruction. Besides, the sample was studied according to six age classes regardless on score schooling levels: 60-65, 66-70, 71-75, 76-80, 81-85 and 86-90 years.

Both tests were applied to individuals in their homes. The determination of scores in ad-MMSE and mo-MMSE was made as indicated in Brito-Marques and Cabral-Filho¹⁰. For the different schooling levels a correlation between the achieved score and age was determined. According to the age classes, comparisons of scores between the tests were performed as well.

Statistical analyses were made by Pearson correlation and two-tailed paired "t" test. The null hypothesis was rejected when $p \leq 0.05$. The statistics software Minitab 3.0 was used for calculations.

The protocol of this paper was approved by the Ethical Committee for Research of the University of Pernambuco and it is according to the Resolution 196/96 of National Committee of Ethics in Research.

RESULTS

As we can see (Table 1) the scores in mo-MMSE were higher than in ad-MMSE for every age class. Differences between means ranged from 1.59 to 3.57 points ($p < 0.001$, for all comparisons).

Considering the whole sample a positive high correlation ($r = 0.878$, $p < 0.001$) between scores achieved in mo-MMSE and ad-MMSE (Figure), was observed.

In Table 2, as we can verify, there was not a significant relationship between age and scores in illiterate and in 5 to 8 years schooling groups, not only in ad-MMSE but in mo-MMSE as well. However, a negative correlation exists (Table 2) between age and scores for the individuals of 1-4 ($r = -0.298$, $p < 0.01$ and $r = -0.212$, $p < 0.05$), for ad-MMSE and mo-MMSE, respectively) and over 8 years of schooling both in ad-MMSE ($r = -0.473$, $p = 0.030$) and in mo-MMSE ($r = -0.469$, $p = 0.032$).

DISCUSSION

From the best performance observed in all age classes of the modified MMSE version when compared to the adapted MMSE⁴ we can conclude that the introduced copy and calculation item changes, facilitated the solution of the tasks. Since this improvement was observed in every age class, it is likely that the best mo-MMSE copy and calculation

item achievement to be associated with basic knowledge of culture features in which that people have lived for a long time¹⁰. In Brazil Northeast some of these features, such as recognizing a triangle, is easier than recognizing a pentagon. In fact, triangle is a geometric figure simpler than pentagon; moreover in their daily activity, people routinely deal with triangle shapes (popular musical instruments, objects for playing), but not with pentagon shapes². The recognition might be even more difficult when the overlapping drawing of

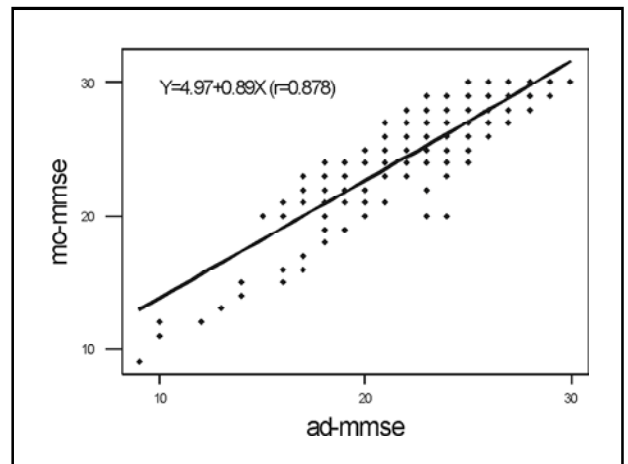


Figure Pearson correlation between ad-MMSE and mo-MMSE scores of individuals from 60 to 90 years old.

Table 1. Mean scores (+ SD) in the ad-MMSE and mo-MMSE of individuals from 60 to 90 years old.

Age(y)	ad-MMSE	mo-MMSE	Mean difference	T	p
60-65	24.30 (±2.79)	26.64 (±2.55)	2.34	10.47	<0.001
66-70	23.34 (±3.52)	25.79 (±3.29)	2.45	12.43	<0.001
71-75	23.29 (±3.47)	25.40 (±3.31)	2.11	9.34	<0.001
76-80	21.90 (±5.18)	23.49 (±5.59)	1.59	4.65	<0.001
81-85	22.58 (±4.39)	24.74 (±4.49)	2.16	4.50	<0.001
86-90	22.00 (±5.03)	25.57 (±3.69)	3.57	5.84	<0.001

Table 2. Pearson correlation between age and score in ad-MMSE and mo-MMSE according to schooling degree.

Schooling (years)	ad-MMSE			mo-MMSE		
	r	p	Regression equation	r	p	Regression equation
Illiterate	-0.151	0.443	$Y = 27.1 - 0.114x$	-0.070	0.723	$Y = 24.6 - 0.062x$
1-4	-0.298	0.010	$Y = 35.6 - 0.141x$	-0.212	0.050	$Y = 30.2 - 0.101x$
5-8	-0.117	0.285	$Y = 28.7 - 0.069x$	-0.083	0.449	$Y = 30.1 - 0.055x$
>8	-0.473	0.030	$Y = 34.6 - 0.128x$	-0.469	0.032	$Y = 36.6 - 0.140x$

the figures in the test is required. So cultural background acquired out of the school can improve the capacity of individuals to solve the problem, because a familiar figure is included in mo-MMSE but not in ad-MMSE. These findings indicate that informal knowledge about geometric shapes is an important way to face the test challenge. In a similar way, calculation of serial 25-1 instead serial 100-7 could be easier for individuals in Brazil Northeast because in their daily life activities, numerical simple tasks are intensive and much more frequent than the complex ones. It is well known that cultural opportunities play a role in cognitive performance in adult and old individuals¹¹. As showed by Li et al.¹², the solution of calculation problems can suffer influence of schooling, socio-economic status and cultural background. By studying illiterate individuals Tsolaki et al.¹³ modified the serial task 100-7 in MMSE² test to serial week days obtaining better results than in the original task. Further, since anxiety is a basic factor in test situations, the presentation of a simple problem to individuals with a low intellectual basis could elicit less anxiety than the presentation of a more complex task, so facilitating the problem solution, as demonstrated by Brucki¹⁴.

In this study, the lack of a relationship between age and score in two schooling levels lower than eight years and, on the other hand, a decreasing score with the age increasing for individuals over eight schooling years (negative correlation), are noteworthy. First of all, this fact could indicate that, the formal learning in some schooling classes in Brazil Northeast is failing at preparing individuals to manage geometrical and arithmetical problems even of low complexity. We would also suppose that people included in that schooling groups have forgotten most of the cognitive information acquired during their childhood, because their daily usual activities do not encompass intellectual tasks at the same intensity as those of the highest schooling individuals. In addition the highest correlation found in the group over eight years education level suggests that people with the highest instruction are protected against a reduction of its capacity to solve cognitive problems. By the other hand, it should be considered the possibility that other factors besides formal instruction are involved in the resolution of that kind of problems, as showed by Carragher et al.¹⁵. These authors showed that strategies to solve arithmetical and geometric problems differ between people with

and people without formal instruction. In the informal condition the use of computational and drawing rules derives from their daily occupations and working tasks. Regarding this point we can therefore suggest that illiterate or low instructed individuals, when evaluated through cognitive tests based on a more sophisticated mathematical language, could display signs of aging even before they become elderly people. However, individuals of informal conditions, although unable to solve mathematical questions through classical algorithms, can solve the same problems by using the knowledge got from the training in their regular professional activities¹⁵.

In this study the large differences of schooling group sizes could influence the statistical results as a confounding factor so limiting the data interpretation. The significant correlation between age and score for 1-4 schooling years group (119 individuals) but no correlation for the illiterate one (28 individuals) could be due to the well known sample size effect which facilitate to obtain statistical significance in this type of association test^{16,17}. So, this result should be taken cautiously. However, the correlation magnitude in the over eight years group being almost two times that in the 1-4 years schooling group indicate also that higher formal education has a substantial participation in improvement of the cognitive performance.

The inadequate basic instruction supplied by the school can represent a serious public health and social problem (which will not deal with here, but requires a special attention of public authorities in the country). On the other hand, since the scores of the two test versions were positively correlated, the evaluative capacity of the mo-MMSE version in measuring mental performance seems to be so good as that of the ad-MMSE. In cognitive evaluation through a modified test proposed to facilitate the resolution of questions, the possibility exists of false negative results. In the present case, however, the introduced modifications were related rather to cultural meaning than to logic problems *per se*. Thus this possibility is reduced taking account of individuals are facing actual problems similar to that experienced in their day life.

Finally, in order to have a better comprehension of the issue, the accuracy determination of mo-MMSE related to ad-MMSE⁴ to test individuals' cognition handicaps will be further done.

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