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# Sociodemographic predictors and concurrent validity of the Mini Mental State Examination and the Mattis Dementia Rating Scale

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**Abstract** The Mini Mental State Examination (MMSE) and the Mattis Dementia Rating Scale (MDRS) are among the most commonly used screening tests for dementia. The goals of our study were, firstly, to identify sociodemographic factors which may explain the variance of test results in a community sample and, secondly, to investigate the interrelationship of these two dementia screening tests in order to evaluate the concurrent validity. A total of 1947 subjects were investigated in the setting of the Austrian Stroke Prevention Study (ASPS). Our study confirms most previous results demonstrating a relationship of higher dementia test scores with both younger age and higher educational level. Interestingly, the results we obtained suggest only a weak relationship and poor concurrent validity of the two tests. The total scores of the two tests show poor joint variance. This could lead to the conclusion that these tests evaluate different cognitive domains.

**Key words** Dementia screening · Predictors · Concurrent validity

## Introduction

The Mini Mental State Examination (MMSE) and the Mattis Dementia Rating Scale (MDRS) are among the most commonly used screening tests for dementia in clinical practice and research. Both the MMSE score and the MDRS score correlate with age and education. Several authors have therefore recommended to use age- and education-specific cutoff scores in order to avoid overdiagnosis of dementia in low-educated individuals [3, 5, 6, 9, 10, 12].

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One goal of our study was to identify sociodemographic factors which may explain the variance of test results in a community sample. This warrants a study among mentally healthy subjects as the inclusion of patients suffering from dementia or memory impairment would bias our analysis. The second purpose of this study was to investigate the interrelationship of these two dementia screening tests in order to evaluate the concurrent validity.

## Subjects and methods

Between September 1991 and July 1995, a sample of 7169 individuals aged 50–80 years was randomly selected from the official register of residents of Graz, Austria, using a two-step procedure stratified upon age and gender. All individuals received a letter of invitation to participate in the Austrian Stroke Prevention Study (ASPS), a study on the prevalence and effects of risk factors in our community [11]. A total of 1998 subjects agreed to participate in the study.

Inclusion criteria were: (a) no history of neuropsychiatric disease, such as epilepsia, Parkinson's syndrome, Huntington's chorea, multiple sclerosis, syphilis, history of head trauma, severe depression or schizophrenia; (b) no complaints of forgetfulness; (c) no evidence of alcohol- or drug-dependence disorders; (d) no abnormalities on the neurological examination; and (e) no clinically significant laboratory abnormalities. According to DSM criteria [1], none of the participants was diagnosed as demented.

A total of 1957 subjects fulfilled the inclusion criteria and underwent a structured clinical interview, a physical and neurological examination, three blood pressure readings, ECG and laboratory testing including blood cell count and a complete blood chemistry panel. Ten subjects did not complete the mental state examination test procedure; therefore, a total of 1947 subjects have been included in the final data analysis. All participants were German native speakers. A random sample of 200 non-responders was interviewed by phone and did not significantly differ from responders for mean age, and proportions of gender and educational level. Due to the low response rate observed for the ASPS, some selection bias could not be excluded with certainty, although all study participants were randomly selected from the official community register. However, this should have had no major impact on the quality of results, because the study focused on predictors and intercorrelations of the MMSE and the MDRS score, but not reference values for these tests.

The MMSE and the MDRS were administered to all individuals by two trained physicians under constant laboratory conditions. The MMSE is among the most commonly used screening tests for evaluating the cognitive status in clinical practice, research and in

health surveys. The MMSE score falls in a range from lowest possible (0) to highest (30). A value of 24 is usually recommended as the cutoff point [4]. The MDRS provides an estimate of general cognitive functioning and includes subtests of attention, initiation and perseveration, construction, conceptualization, and verbal and non-verbal short-term memory. The MDRS items are hierarchically arranged so that adequate performance on the initial item allows discontinuation of testing within this section assuming that credit can be given to the proband for optimal performance on the subsequent tasks. The MDRS score falls in a range from lowest possible (0) to highest (144) [7]. In a previous paper we reported the age- and education-specific distribution of the MDRS score obtained from 1001 study participants. The lowest quintile percentile value which has been considered abnormal ranged from 140 in subjects aged 50–59 years with at least college experience to 130 in subjects aged 70–80 years with a maximum of 9 years of schooling. The lowest quintile value of the whole study group was 135 [10]. The clinical diagnosis of dementia usually includes one of these cognitive tests as a component.

Age was categorized 50–55 ($n$ = 392, 20%), 56–60 ($n$ = 407, 21%), 61–65 ($n$ = 525, 27%), 66–70 ($n$ = 455, 23%) and 71–80 years ($n$ = 168, 9%). Education was categorized by years of schooling completed, and each participant was assigned to the category corresponding to the highest grade achieved: ≤ 8 ($n$ = 646, 33%), 9–10 ($n$ = 771, 40%), 11–13 ($n$ = 405, 21%) and 14–18 ($n$ = 125, 6%). Distribution of gender was 58% ($n$ = 1129) female and 42% ($n$ = 818) male.

The MMSE and the MDRS scores were dichotomized into high and low, and the median was used as the cutoff point (MMSE score 27, range 19–30; low: $n$ = 991, 50.9%; high: $n$ = 956, 49.1%; MDRS score 141, range 106–144; low: $n$ = 796, 40.9%; high: $n$ = 1151, 59.1%).

Statistical analysis was performed with the personal computer version of the Statistical Package for Social Sciences (SPSS) [8]. Intercorrelations of the continuous scaled variables were assessed by Pearson correlation procedure. Multiple logistic regression analysis was used to assess the relative contribution of predictor variables on both test scores. Kappa coefficient was calculated as a measure of the degree of agreement.

## Results

Table 1 gives the results of logistic regression analyses predicting the likelihood of scoring high or low on the MMSE and the MDRS. The final model included educational level and age as significant predictors for both test scores. Higher age was associated with poorer cognitive performance, whereas better education exerted a positive effect on the participants' test results. All possible interaction terms were included in different models without reaching significant influence and were thus omitted.

Concurrent validity was calculated with Pearson correlation between the total scores of the MMSE and the

**Table 1** Results of logistic regression analyses

| Variable | B | S.E. | *df* | *P* | Odds ratio | CI (95%) |
|---|---|---|---|---|---|---|
| *MMSE* | | | | | | |
| Age (years) | | | 4 | 0.0000 | | |
| 50–55 | | | | | Reference | |
| 56–60 | –0.4685 | 0.1471 | 1 | 0.0014 | 0.6259 | 0.47–0.83 |
| 61–65 | –0.5709 | 0.1392 | 1 | 0.0000 | 0.5650 | 0.43–0.74 |
| 66-70 | –0.8210 | 0.1450 | 1 | 0.0000 | 0.4400 | 0.33–0.58 |
| 71-80 | –0.8774 | 0.1946 | 1 | 0.0000 | 0.4159 | 0.28–0.61 |
| Education (years) | | | 3 | | | |
| ≤ 8 | | | | | Reference | |
| 9–10 | 0.1790 | 0.1129 | 1 | 0.1128 | 1.1960 | 0.96–1.49 |
| 11-13 | 0.9692 | 0.1346 | 1 | 0.0000 | 2.6359 | 2.02–3.43 |
| 14–18 | 1.3927 | 0.2261 | 1 | 0.0000 | 4.0256 | 2.59–6.27 |
| Gender (male) | | | | | Reference | |
| Gender (female) | 0.1334 | 0.0993 | 1 | 0.1792 | 1.1427 | 0.94–1.39 |
| *MDRS* | | | | | | |
| Age (years) | | | 4 | 0.0000 | | |
| 50–55 | | | | | Reference | |
| 56–60 | –0.4437 | 0.1594 | 1 | 0.0054 | 0.6417 | 0.47–0.88 |
| 61–65 | –0.6237 | 0.1506 | 1 | 0.0000 | 0.5360 | 0.40–0.72 |
| 66–70 | –1.2429 | 0.1551 | 1 | 0.0000 | 0.2885 | 0.21–0.39 |
| 71–80 | –1.3051 | 0.2025 | 1 | 0.0000 | 0.2711 | 0.18–0.40 |
| Education (years) | | | 3 | | | |
| ≤ 8 | | | | | Reference | |
| 9–10 | 0.6719 | 0.1148 | 1 | 0.0000 | 1.9579 | 1.56–2.45 |
| 11–13 | 1.4333 | 0.1457 | 1 | 0.0000 | 4.1924 | 3.15–5.58 |
| 14–18 | 1.8006 | 0.2516 | 1 | 0.0000 | 6.0534 | 3.70–9.91 |
| Gender (male) | | | | | Reference | |
| Gender (female) | –0.371 | 0.1040 | 1 | 0.7211 | 0.9635 | 0.79–1.18 |

MDRS ($r = 0.29$, $P = 0.000$). The total scores of the two mental state examinations had only 8.4% joint variance. Furthermore, the total score of the MMSE was correlated to each of the subtest scores of the MDRS, i.e. the total score of the MMSE correlated with the MDRS subtest "attention" $r = 0.18$ ($P = 0.000$), with the MDRS subtest "initiation and perseveration" $r = 0.04$ ($P = 0.099$), with the MDRS subtest "construction" $r = 0.10$, ($P = 0.000$), with the MDRS subtest "conceptualization" $r = 0.17$ ($P = 0.000$), and with MDRS subtest "verbal and non-verbal short-term memory" $r = 0.27$ ($P = 0.000$).

Using the previously recommended cutoff score of 135 for the MDRS, 4.2% of study participants were classified as cognitively impaired; the recommended cutoff score of 24 of the MMSE classified only 1.6% of the sample as cognitively impaired. Evaluating the data dichotomized by the cutoff scores in a fourfold table resulted in a kappa value of 0.05. Thus, agreement of the two tests was low.

## Discussion

Our study confirmed most previous results demonstrating a relationship of higher dementia test scores with younger age and higher educational level. The posed question of the agreement of the two tests, which are intended for the same purpose, namely dementia screening, led to the following answer: The results we obtained suggest only a weak relationship and poor concurrent validity of the two tests in a community sample. The total scores of the two tests showed poor joint variance. This was also true for any correlation between the MDRS subtests and the MMSE total score. This could lead to the conclusion that these tests evaluate different cognitive domains.

Another research group compared the MMSE score and the MDRS score of a small sample, which resulted in a moderately high association. Specific analyses of single items and subtests revealed unexpected relationships. It was concluded that the two tests evaluate some overlapping mental abilities, but validity is not well supported [2].

The result of a dementia screening procedure seems to depend largely on the test employed. A clinical dementia diagnosis will generally be supported by a range of diagnostic procedures conferring stability. A larger importance of the aforementioned low degree of concurrent validity is given in health surveys and routine screenings in normal populations where the status of cognitive performance can obviously be evaluated quite differently depending on which test is used. There is firstly a certain risk of estimating low valid prevalence rates and, secondly, of misjudging the necessity or non-necessity of further diagnostic procedures.

Due to the relatively low agreement of the two dementia screening tests we recommend the use of at least two different scales for mental status assessment in symptomatic patients in order to obtain comparability of test results. Given the varying classification of mental status tests measuring cognitive impairment, in population health surveys with expectedly low prevalence rates of dementia, higher cutoff scores may be suggested for indication of further diagnostic evaluation.

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