A Preliminary Study of the Mini-Mental State Examination in a Spanish Child Population

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The Mini-Mental State Examination is one of the most widely used screening tests for the adult population in daily neurologic practice. The aim of this study was to describe and to analyze the results of the Mini-Mental State Examination administered to Spanish children and to assess the relationship between Mini-Mental State Examination scores and the child’s mental age/intelligence quotient. The study population included 181 children whose ages ranged between 4 and 12 years. The neuropsychologic battery consisted of the Mini-Mental State Examination and Kaufman Brief Intelligence Test. Percentiles were obtained for the Mini-Mental State Examination total score according to age ranges. Performance gradually increased from 4 to 10 years of age when a plateau in the total Mini-Mental State Examination score was reached. At the age of 6 years, results exceeded 24 on average. Pairwise mean comparisons showed statistically significant differences between the age groups \( P < .05 \). Data distribution could be classified in 4 independent groups for the following chronologic ages: 4, 5, and 6 years and from 7 to 12 years of age. The total Mini-Mental State Examination score correlated significantly with the child’s chronologic \( r = 0.80, P < .001 \) and mental \( r = 0.76, P < .001 \) ages. This is a preliminary study of the application of the Mini-Mental State Examination in a Spanish child population as well as a first step for the assessment of the usefulness of this instrument as a cognitive screening tool for children’s development.

Keywords: MMSE; cognition; test standardization; neuropsychologic tests

Since the original publication in 1975, the Mini-Mental State Examination has been extensively used in epidemiologic and clinical research for the assessment of higher mental functions in adults and the detection of cognitive impairment. Scores lower than the cutoff of 24 points are generally indicative of cognitive disorder. The cutoff range helps to grade impairment severity. Results of the Mini-Mental State Examination are affected by age and education level, so that cutoff value should be adjusted by these 2 variables. Population-based studies have shown adequate sensitivity and specificity of the Mini-Mental State Examination, with 87% sensitivity and 82% specificity for cutoff values of 23 or 24 points. This score is normally used for the detection of cognitive impairment, suggesting dementia or delirium.

Several screening instruments focused on the detection of developmental disturbances are available for neuropsychologic examination in childhood. These tests, however, cover a narrow range of children’s ages and cognitive domains. Although there are numerous testing batteries for the assessment of cognitive disorders, they usually require long administration times and considerable training of the examiner. Therefore, simple screening tests are needed to allow the assessment of a wider range...
of cognitive functions in children in a short period of time, which would assist in early detection of higher cognitive deficits.

Three previous studies have reported the use of the Mini-Mental State Examination in child and youth populations. Two of these were conducted in populations from Australia and Japan. Authors of both studies emphasized the need to obtain population-based normative data, suggesting the suitability of the Mini-Mental State Examination in the pediatric clinical setting. The third study provides normative data based on the performance of normal Nigerian young students on the Mini-Mental State Examination. Given that 11.4% of subjects achieved lower scores suggesting mild or moderate cognitive impairment, a modification of the Mini-Mental State Examination is recommended for suitable use of the instrument in clinical practice. For this reason, description of norm-based scoring of the Mini-Mental State Examination in a Spanish child population will contribute to obtaining accurate normative data and to replicating the results reported in previous studies.

This preliminary study was conducted to describe and analyze the performance of the Mini-Mental State Examination in a pilot sample of Spanish children aged between 4 and 12 years. The relationships between the Mini-Mental State Examination total score and mental age and intelligence quotient were also examined.

Patients and Methods

Participants
A total of 181 children ranging in age from 4 to 12 years participated in the study. All children were recruited in a subsidized private school in Barcelona of medium socioeconomic status. In collaboration with the school committees, parents gave their written consent prior to the participation of all children in this investigation. This study protocol was approved by the Ethics Committee of Hospital Universitari del Mar (CEIC-IMAS) of Barcelona. The inclusion criteria were regular school attendance and absence of learning disabilities. Children with previous medical history of central nervous system impairment, psychiatric disorder, developmental disturbance, or any sensory deficit that could interfere with the test execution or influence the cognitive function were excluded.

Of the 181 participants, 83 were boys (45.9%) and 98 girls (54.1%). The primary language of 127 (70.2%) was Catalan and of 54 (29.8%) Spanish; 90.6% were right-handed (n = 164) and 9.4% left-handed (n = 17). The study sample was divided into 9 different groups with the purpose to include 20 subjects within each category of age range. Exceptions were only made for the following groups: 5 years (n = 21), 10 years (n = 21), and 12 years (n = 19).

Procedure

The neuropsychological battery consisted of the Mini-Mental State Examination NORMACODEM version and the Kaufman Brief Intelligence Test. The aim of the NORMACODEM project is to validate within a Spanish population several cognitive and functional instruments for the study of dementia. The Mini-Mental State Examination was included in this project and was adapted following the original version. The test was administered to 450 subjects (253 control volunteers, 86 subjects with mild cognitive impairment, and 111 patients with Alzheimer’s disease). Age and formal education were clearly related to the performance obtained by controls; therefore, all scores were adjusted according to these 2 variables. The cutoff score for detecting dementia in the Spanish adult population is 24 points.

The Kaufman Brief Intelligence Test was chosen because it is quick and easy to administer, and score interpretation is simple and objective. The Kaufman Brief Intelligence Test has a high internal consistency and excellent test-retest reliability; in addition, the Kaufman Brief Intelligence Test correlates significantly with the Wechsler Intelligence Scale for Children—Third Edition. On the other hand, the Kaufman Brief Intelligence Test meets the need of evaluating the intellectual status of children and adults covering a wide range of ages, from 4 to 90 years. This study is involved in a more extended investigation on retrogenesis, the process by which degenerative mechanisms reverse the order of acquisition of cognitive capacities in normal development. Due to this fact, other instruments were also included during the evaluation, but the results are not shown. For the purpose of the present study, children participated in a single assessment session. Total time for the administration of the test took around 20 to 40 minutes.

Intelligence quotient (IQ) was assessed to ensure all participants included in the study were within the standard norms and to assess the relationship between IQ and Mini-Mental State Examination scores. The Kaufman Brief Intelligence Test consists of 2 subtests: Expressive Vocabulary (word definition and vocabulary knowledge) and Matrices, providing 3 overall scores: total, verbal, and manipulative. Mental age was estimated by multiplying the chronologic age by IQ and dividing by 100. IQ corresponds to the Kaufman Brief Intelligence Test total score.

Sociodemographic data were required and registered before starting the neuropsychological assessment. With the permission of the school committee, participants completed all tests in a quiet and comfortable room in the school facilities during the regular school schedule. An adequate control of all environmental conditions necessary for the execution of the ensuing protocol was guaranteed.
Data Analysis

The first step consisted of a descriptive analysis of the sample distribution according to chronologic age and school grade. Measures for standard deviation (SD), maximum and minimum values, skewness, and kurtosis were provided. Continuous variables with a normal distribution were analyzed with the Student’s *t* test for independent samples; when distribution of variables departed from normality, the Mann-Whitney *U* test was applied, and statistical significance was set at *P* ≤ .05. Pearson’s correlation coefficient was used to assess the relationship between Mini-Mental State Examination total score and other variables such as chronologic age, mental age, and Kaufman Brief Intelligence Test scores (total, verbal, and manipulative). The Statistical Package for Social Sciences (SPSS) (version 11.5 for Windows) was used for the analysis of data.

Results

Descriptive data concerning Mini-Mental State Examination total scores achieved by the different age groups are provided in Table 1. In Table 2, percentiles are shown that correspond to Mini-Mental State Examination scores achieved in each age range.

Figure 1 shows a box plot with median, interquartile range (IQR), and minimum and maximum values for total Mini-Mental State Examination scores for each age range.

Analysis of variance (ANOVA) revealed statistical differences between and within groups (*F* = 153.24, *P* < .001). Pairwise mean comparisons between each range of age were applied using the *t* test with the Scheffé correction. Table 3 shows the statistical differences of pairwise comparison between the different age ranges. Results were considered significant if *P* < .05.

Significant correlations for the Mini-Mental State Examination total score were found with chronologic age (*r* = 0.80, *P* < .001), mental age (*r* = 0.76, *P* < .001), and Kaufman Brief Intelligence Test scores for verbal (*r* = −0.178, *P* < .016) but...
not manipulative \((r = -0.048, P = .520)\) or total scores \((r = -0.142, P < .056)\).

## Discussion

The Mini-Mental State Examination total scores of this child population seem to follow a normal distribution within all different groups of age. Mini-Mental State Examination performance shows a positive trend due to the fact that scores gradually increase from the age of 4 years (with 14 points on average) until the age of 10 years, when total performance seems to reach a plateau (mean score of 29 points). At the age of 6 years, results surpass 24 points on average, which is considered the cutoff to distinguish normal adults from those cognitively impaired. The percentiles correspond to the Mini-Mental State Examination total score and allow assessment of the subjects’ overall cognitive function for their age.

Concerning the statistically significant differences observed between the groups, several age ranges can be considered depending on the similarity of the Mini-Mental State Examination scores achieved. Therefore, data distribution could be classified into 5 independent groups for the following cronologic ages: 4, 5, and 6 years, as well as for ages ranging between 7 and 9 years and between 10 and 12 years old. This distribution suggests 2 different developmental stages according to the gradual increase observed in the Mini-Mental State Examination performance. The first stage would include the age range from 4 to 6 years old, a period in which an important development of the overall cognitive function is observed, mainly focused on orientation, language, and attention-concentration \((P < .001)\). The second stage would comprise ages 7 to 12 years \((P < .001)\), a period in which constructional ability is the main process acquired, in addition to a continuous improvement of attention and concentration abilities. However, improvement in the latter abilities is particularly noticed at the age of 7 to 9 years old. Scores reach a plateau at 10 to 12 years old.

If we compare our results with those obtained by Shoji et al., we observe higher mean \((\pm SD)\) scores within Spanish children 4 and 6 years old \((14.25 \pm 2.75 and 24.20 \pm 2.23, respectively\) as compared with the results achieved by a Japanese population from the same age with mean values of 10.4 \pm 3.9 and 22 \pm 2.6, respectively. However, we must be cautious when considering our results, due to the significant difference observed between sample sizes in both studies: there were 1046 subjects in the Japanese sample and 181 participants in the present study.

With regard to the present findings, it is apparent that Mini-Mental State Examination scores reach a plateau at about 10 years of age. Therefore, our results would be in agreement with those reported by Ouvrier et al. in an Australian population but would slightly differ from those obtained by Shoji et al., where scores reach a plateau at the chronologic age of 11 years old. The findings related to mean scores between Spanish, Japanese, and Australian children cannot be explained in terms of significant differences related to the age of entry in noncompulsory and compulsory education (preschool and primary school), because in Japan and Spain, children reach these stages at a same age, whereas in Australia, most children commence 1 year before. However, differences between educational systems and other differences in these samples may explain part of the minimal differences observed.

Pearson’s correlation coefficients revealed statistically significant associations between Mini-Mental State Examination total score and chronologic age, mental age, and Kaufman Brief Intelligence Test verbal score. Highly positive correlations were found for the Mini-Mental State Examination total score with chronologic age \((r = 0.80, P < .001)\) and mental age \((r = 0.76, P < .001)\). A low but significant correlation with the Mini-Mental State Examination score was also found for the Kaufman Brief Intelligence Test verbal score \((r = -0.17, P = .016)\). No significant association was observed for Kaufman Brief Intelligence Test verbal with manipulative scores.

In the study by Ouvrier et al., statistically significant correlations between Mini-Mental State Examination total score and chronologic age \((r = 0.57, P < .001)\) and mental age \((r = 0.83, P < .001)\) were observed. Correlation values for mental age are very similar in this study, but lower values were reported by Ouvrier et al.

This is the first pilot study of the Mini-Mental State Examination test conducted in a Spanish child population. With this study, we open a new line of research to assess the applicability of the Mini-Mental State Examination in children. The first step consisted of providing preliminary normative data for a Spanish population. A larger sample is needed to obtain more reliable population-based norms. The next step would be the validation of the test, comparing our results with those provided by other samples of children with different neurological disorders, to determine the cut-off scores for the different chronologic ages. This would

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**Table 3. Statistical Differences Observed in Pairwise Comparisons Between the Different Age Ranges Concerning the Mini-Mental State Examination Total Performance**

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Significance level: \(P < .05\).
allow us to investigate the quality of the Mini-Mental State Examination as a suitable instrument for screening higher mental functions in children and as a first approach for studying the retrogenetic model in Alzheimer's disease.

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References