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ORIGINAL ARTICLE

Itel MMSE: a short phone screening test for cognitive decline. Italian Validation study by the SINdem Neuropsychology Working Group

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Abstract

Introduction The Italian telephone-based Mini-Mental State Examination (Itel-MMSE) is considered a very easy tool for screening individuals with dementia, gained importance during COVID-19, but lacks validation and faces a ceiling effect.

Aim In the present study, we conducted a study standardizing and validating it, establishing cut-off values for two versions.

Methods Across 24 Italian sites, 707 healthy individuals (50–89 years, men: 268, women: 439) with diverse educational levels (3–24 years) were recruited. Subjects met criteria for normal conditions investigated through a semi-structured interview covering neurological, psychiatric, general medical, and psychopharmacological history. Two test versions were created to assess test–retest reliability at 45-day intervals. We also enrolled 187 subjects with Mild Cognitive Impairment (MCI) and 181 with Alzheimer's Disease (AD) for validation. The raw scores obtained on both versions of Itel-MMSE were set as dependent variables in linear regression models that included age, education, and gender as independent variables.

Results Mean raw Itel-MMSE1 score was 20.82 (range: 13–22). Multiple linear regression demonstrated significant effects of sociodemographic variables for age and education, establishing a new cut-off ≥ 18.49. Mean raw Itel-MMSE2 score was 20.97 (range: 10–22), with a new cut-off ≥ 18.45. Validation showed high informative values, with areas under the curve (AUCs) for MCI and AD conditions and both versions (Itel-MMSE1: MCI AUC = 0.801, AD AUC = 0.907; Itel-MMSE2: MCI AUC = 0.827, AD AUC = 0.977).

Conclusion The Itel-MMSE proves valuable as a screening method for detecting and monitoring dementia in remote phone screenings, with different cut-offs aiding MCI patient identification in clinical settings.

Keywords Cognitive screening · ItelMMSE · Alzheimer's disease · Dementia · MCI · Neurospychology

Introduction

During the SARS-Cov2 pandemic, the availability of tools and procedures to assess patients who were not able to reach clinical centers due to social distancing has become a critical issue. This problem involved frail patients, such as persons affected by cognitive impairment. Several studies reported that individuals with dementia worsened from both the cognitive and behavioral points of view during quarantine [1, 2], making the availability of valid tools to perform remote assessment relevant. In a more general framework, the availability of tools for remote cognitive assessment could enhance the access to healthcare for persons with reduced mobility due to clinical conditions and/or social and geographical factors. Years before the recent pandemic all these reasons led researchers to develop several tools to assess cognition remotely [3–6]. These assessments are often conducted using standardized cognitive tests or questionnaires adapted for administration over the phone. Among the most widely used there are the Telephone Interview for Cognitive Status (TICS) [7, 8], the Brief Alzheimer's Screen (BAS) [9], the Memory Impairment Screen (MIS) [10] and the Tele-GEMS [11].Most of these tools however are based on self-report of symptoms, and for this reason they may be not as accurate as tests that are directly administered to individuals.

The Mini-Mental State Examination (MMSE; [12]) is probably the most diffuse tool for the assessment of

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cognition in persons with cognitive impairment. Given its wide diffusion, the MMSE has been one of the first cognitive tests to be adapted for remote administration via phone [13].

The Italian version of the Telephone Mini-Mental State Examination (Itel-MMSE) was proposed by Metitieri et al. [14]. In their original paper, the authors reported a fair level of concordance between Itel-MMSE and MMSE in patients with dementia at different stages, with the only exception of subjects with severe dementia. They also reported good test–retest and inter-rater reliability and provided a conversion model to transform Itel-MMSE score into the corresponding scores of MMSE.

Vanacore and colleagues [15] administered the Itel-MMSE to 107 healthy individuals and confirmed its good internal consistency and correlation with traditional MMSE. They also reported that the cut-off of 21 showed the highest level of sensitivity in detecting subtle cognitive impairment (in terms of performance on neuropsychological tests). However, in this study individuals scoring below 21 were older and less educated than individual scoring 22 or more. Since the authors did not provide normative data and correction grids for age and education, it is conceivable that the cut-off may be different when demographic variables are taken into account. To the best of our knowledge, standardized scores and normative data adjusted for age and education level are not currently available for the Itel-MMSE.

Only a few studies assessed the clinical validity of telephonic versions of the MMSE. Camozzato and colleagues [16] administered the Brazilian version of the test (maximum possible score: 22) to 133 individuals (66 affected by AD and 67 normal subjects) and reported high levels of specificity (1) and sensitivity (0.9). Different results were obtained on a sample (31 healthy individuals, 34 patients affected by AD) who underwent the Cantonese version (maximum possible score: 26) of a telephone version of the MMSE (sensitivity = 1; specificity = 0.67) [17]. Finally, a further version of telephonic MMSE was developed in German [17] and validated on a sample composed by 34 patients (18 affected by MCI and 16 affected by mild dementia) and 14 healthy individuals, reporting both sensitivity and specificity values of 1. However, despite the promising results, these studies were underpowered from the statistical point of view, and it is not possible to draw any conclusion about the diagnostic accuracy of the test. Furthermore, only the study by Camozzato et al. [16] was conducted using a telephonic version of the MMSE analogous to the one originally derived from MMSE and previously applied to the Italian population.

The lack of normative values considering age, education, and sex, and the lack of reliable validation studies represent serious limitations that hinder the routine application of Itel-MMSE in clinical practice. The aims of the present study were: 1) to provide a standardization of the Itel-MMSE in two different versions; 2) to assess the clinical validity of the test on a sample of subjects affected by Mild Cognitive Impairment (MCI) and Dementia due to probable (AD).

Materials and method

Study design, centers and participants

This is a nation-wide multicenter study. Twenty-four Centers for Cognitive Disorders and Dementia (CDCD) distributed among Northern (11), Center (5), and Southern-Insular Italy (8) were involved. The invitation to participate to the study was made through two Italian scientific groups involved in the Italian Neurological Society for Dementia (SINDem): the Neuropsychology working group led by PC and CM, and the COVID and dementia working group on CDCD, led by AB. Twenty-seven centers accepted to participate, three of them were not able to conclude the enrolment phase; 24 centers finally participated to the study (Figs. 1 and 2).

Several meetings were organized to develop two parallel versions of the Itel-MMSE (i.e., selection of the items matched in terms of word frequency and meanings between the two versions) and define in a rigorous way the materials and the procedures for test administration and scoring (see Appendix 1 and 2). In December 2020 representatives of the

Fig. 1 Distribution of sites among different regions

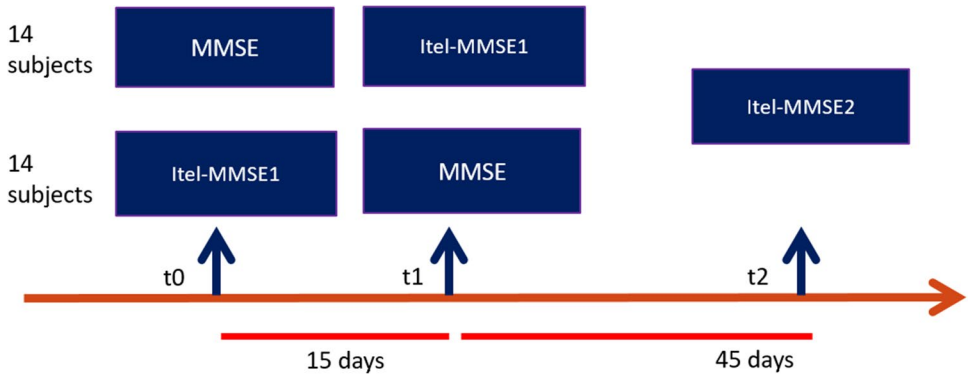

Fig. 2 Order administration for each site. Each site had to enroll a minimum of 28 subjects (14 first in face-to-face condition and 14 first in phone condition)

Table 1 Distribution of demographic data stratified by sex, age, and education, in the sample of healthy individuals

Education/Age	50–59	60–69	70–79	80–89	Total M/F
≤ 5	3/7	4/12	9/26	14/21	30/66
6–8	20/32	15/21	15/21	2/10	52/84
9–13	28/69	33/54	20/31	10/9	91/163
≥ 14	25/54	35/50	19/18	16/4	95/126
Total M/F	76/162	87/137	63/96	42/44	268/439
Total	238	224	159	86	707

centers participated to the first operative meeting aimed at discussing the study protocol. All comments and feedback were periodically summarized to harmonize the procedures among sites. The final consensus was reached in February 2021: an operative meeting with the neuropsychologists involved was organized where the administration modalities were discussed and shared. The collection of normative data started after the approval of the project by the local ethics committees. The enrollment closed in December 2021.

Healthy individuals The final sample included 707 healthy Italian participants. Participants were enrolled among spouses and care givers of patients referring to the clinical sites. They were excluded if they had other prior/current neurological or major psychiatric disorders; a history of traumatic brain injury, brain tumours, or stroke; a history of alcohol or drug abuse; sensory or motor deficits possibly affecting performance. Medical history was investigated by means of a semi-structured interview exploring the areas of neurological, psychiatric, general medical and psychopharmacological history. Subjects were stratified across four decades (i.e., 50–59, 60–69, 70–79, 80–89 years) and across four levels of education (i.e., ≤ 5, 6–8, 9–13, ≥ 14 years). The distribution according to age and educational level of the population of study is reported in Table 1.

After the collection of normal individuals, the enrolment of MCI and AD patients was performed between December 2021 and June 2022 and 368 patients were recruited (see distribution of patients in Table 2).

MCI subjects 187 subjects affected by amnestic-MCI (a-MCI) were enrolled in this study. Recruitment included patients between 50 and 89-year-old patients. For the inclusion, a-MCI patients had to meet Winblad [18] and Petersen criteria [19] of MCI due to AD at intermediate level of certainty. MCI patients had to show memory disturbances reported by themselves or an informed caregiver, reporting an impairment as compared to previous level of functioning; evidence of memory deficit as measured by Rey Auditory Verbal Learning Test (RAVLT—delayed recall) and delayed recall of the Rey–Osterrieth's Complex Figure; and preserved independence in everyday activities (that must be carried out as usual or with minimal difficulty). Patients were excluded if they reported traumatic head injury, epilepsy, alcoholism, and/or other major neurological or psychiatric diseases. No patients suffered from medical conditions potentially associated with cognitive disturbances (i.e., renal, hepatic failure, thyroid dysfunction, folate, and/or vitamin B12 deficits). All MCI underwent neuroimaging (MRI/TC) investigations excluding other causes of dementia.

AD subjects A sample of 181 AD patients with mild-to-moderate dementia was recruited (DSM-5, NIA-AA criteria). AD patients age ranged between 50 and 89-year-old with MCI and AD patients were enrolled without constraints for years of education across the different age.

Table 2 Distribution of demographic data, stratified by sex and age of MCI and AD patients

Age	50–59	60–69	70–79	80–89	Total M/F	Total
MCI	7/13	18/17	52/36	22/22	99/88	187
AD	12/5	21/17	35/37	22/32	90/91	181

The study was approved by the local ethics committees and complied with the provisions of the Declaration of Helsinki. All subjects gave written informed consent to participate.

The database was completed in September 2022, Thereafter a double check was made among data manager and peripheral sites to solve incongruences and inconsistences. After the revision of the database, subjects in whom inconsistencies remained unsolved were excluded from the study. From the initial group of 731 subjects, 23 in the Control group were excluded. No MCI and AD patients were excluded. 1 One outlier among healthy participants was also excluded post-hoc.

Adaptation and development of tests

The Itel-MMSE was adapted from the Itel-MMSE by Metitieri et al. [14]. It does not include items involving reading, writing, oral comprehension, and constructional praxis; only one naming-to-description item is maintained. As for the in-person format, if at least one error is committed on the serial subtraction task, an alternative serial spelling task is administered. The total score of the test ranges from 0 to 22.

The design of the study included a face-to-face MMSE, and the administrations of two versions of the Itel-MMSE within 45 days, for test–retest reliability assessment. The two versions of the Itel-MMSE differ as for the words to recall that were also different from the three words of the MMSE version. To reduce the interference effect, different words were used in the administration of the memory subtest of MMSE and of the two versions of Itel-MMSE. In the administration of MMSE the words 'casa', 'pane', 'gatto' were used. The choice of words for the remote versions was made considering only concrete bysillabic word, with similar frequency (BAdIP) (BancaDatiDell'ItalianoParlato) [20] of use of the original ones. 'Lira', 'Pianta', 'Libro' were chosen for Itel-MMSE 1 while 'Gente', 'Parco' 'Mano' for Itel-MMSE 2.

The order of administration of face-to-face MMSE and Itel-MMSE was pseudo-randomized so that to an equal number of the individuals first and then were submitted to each condition. Half of the participants were first administered with the face-to-face MMSE and then they were called by phone after 15 days for the Itel-MMSE 1. In the other half, the conditions were administered in the reverse order: participants started first with the Itel-MMSE 1 and after 15 days they were administered with the face-to-face MMSE. After further 45 days from the last administration, both groups were called to undergo the second version of the Itel-MMSE (Itel-MMSE 2).

Statistics

Standardization

The raw scores obtained on both versions of Itel-MMSE were set as dependent variables in linear regression models that included age, education, and gender as independent variables.

Demographic variables were entered individually into the models; age and education were both used in their original value and after several transformations (logarithmic, quadratic, cubic, and square root). For each variable, the best model was determined by comparing Akaike's Information Criterion Corrected (AICc) and selecting the one with the lowest AICc value. A multiple variables model including the best transformation was used to obtain individual corrected scores.

The corrected scores were ordered from the worst to the best performance to obtain non-parametric tolerance limits [21]. The cut-off point was identified as the tolerance limit leaving above at least 95% of the population, with 95% of confidence. The position of the tolerance limits depends upon the sample dimension. For 707 subjects, the outer tolerance limit (corresponding to the cut-off point) is the 26th worst observation, and the inner tolerance limit is the 46th observation. Equivalent Scores (ES) were determined by subdividing the corrected scores into five ordinal categories [22]: 0 (scores lower than the cut-off point); 4 (scores higher than the median score of the sample); 1, 2, and 3, obtained by dividing into three equal parts the interval between outer tolerance limit and median.

The statistical equivalence of the two Itel-MMSE versions was evaluated by means of the TOST for paired samples as suggested by Lakens, setting the significance level at 0.05 for an equivalent limit of 0.5.

Validation

The clinical validation of both the Itel-MMSE versions was performed according to the diagnosis of Mild Cognitive Impairment (MCI), Dementia due to probable Alzheimer's Disease (AD), and both conditions (MCI + AD). To assess the clinical usefulness of the Itel-MMSE, scores were corrected according to the regression models obtained from the standardization were applied. We performed Receiver Operating Curve analyses with the determination of the area under the ROC curve (AUC) as a measure of diagnostic accuracy. Sensitivity (Sens), Specificity (Spec), Positive Predictive Value (PPV), and Negative Predictive Values (NPV) were calculated for the cut-off point identified by the standardization procedure. All of the statistical analyses were carried out using R software for statistics (version 4.2.1).

Results

Sample characteristics

The sample was composed of 707 healthy individuals (439 women). The mean age was 65.49 years (Standard Deviation (SD) = 10.214) and the mean literacy was 11.99 years (SD = 4.514). The mean score obtained on version 1 of the Itel-MMSE (Itel-MMSE1) was 20.82 (SD = 1.428; minimum = 13; maximum = 22); the mean score on version 2 of the Itel-MMSE (Itel-MMSE2) was 20.97 (SD = 1.390; minimum = 10; maximum = 22). As shown in Graph 1, scores obtained on both Itel-MMSE1 and Itel-MMSE2 were negatively skewed (respectively, $\text{skewness}_{\text{ItelMMSE1}} = -1.87$; $\text{skewness}_{\text{ItelMMSE2}} = -2.25$).

The Itel-MMSE test–retest reliability was evaluated with the intraclass correlation coefficient (ICC_2: single measure, two-way random effect model), which revealed a moderate agreement ($ICC_2 = 0.61$, 95% CI (0.57; 0.65). Itel-MMSE showed a satisfactory concurrent validity with MMSE, which was administered face-to-face, both in version 1 ($b_1 = 0.476$, 95%CI (0.417;0.533); $F_{1,705} = 261.1$, $p < 0.0001$; $AdjR^2 = 0.269$) and in version 2 ($b_1 = 0.468$, 95%CI (0.412;0.524); $_{F1,705} = 269.0$, $p < 0.0001$; $AdjR^2 = 0.275$).

The TOST showed a good level of equivalence between the two versions of the Ite-lMMSE ($t = 8.081$; $p < 0.001$) See methodology in Aiello and Coworkers [23].

Standardization

Version 1 of Itel-MMSE

Gender showed no effect on Itel-MMSE1 scores ($|tl|_{543.3} = 0.25$; $p = 0.805$). Age showed a significant effect after all the transformations. The best model was obtained after quadratic (age + age^2) transformation ($F_{2,704} = 39.20$; $p < 0.0001$; $AIC = 2442.18$; $AdjR^2 = 0.10$). Also, Education showed the best predicting value after quadratic (education + education^2) transformation ($F_{2,704} = 61.33$; $p < 0.0001$; $AIC = 2403.27$; $AdjR^2 = 0.15$).

The final model was:

$$\begin{aligned} ItelMMSE1 = {} & 13.9773071 + 0.174483 \times (age - 66.5) \\ & - 0.0014929x(age^2 - 4392.8) + 0.2709673 \\ & \times (education - 11.99) - 0.0077468 \\ & \times (education^2 - 164.13) \end{aligned}$$

where 66.5 is the mean value of age; 4392.8 is the mean value of age^2;11.99 is the mean value of literacy; and 164.3 is the mean value of education^2.

The outer tolerance limit (corresponding to the cut-off point) was 18.49, and the inner tolerance limit was 18.90. Table 3 displays the Equivalent Scores for Itel-MMSE1and 2and Table 4 displays the correction grid for the most common combinations of age and literacy.

Table 3 Equivalent scores for versions 1 and 2 of Itel-MMSE

Itel-MMSE – version 1	
Equivalent Score 0 (Outer tolerance limit; cut-off point)	≤ 18.49
Inner tolerance limit	≤ 18.90
Equivalent Score 1	≤ 19.61
Equivalent Score 2	≤ 20.59
Equivalent Score 3	≤ 21.36
Equivalent Score 4	> 21.36
Itel-MMSE – version 2	
Equivalent Score 0 (Outer tolerance limit; cut-off point)	≤ 18.45
Inner tolerance limit	≤ 19.04
Equivalent Score 1	≤ 19.70
Equivalent Score 2	≤ 20.75
Equivalent Score 3	≤ 21.69
Equivalent Score 4	> 21.69

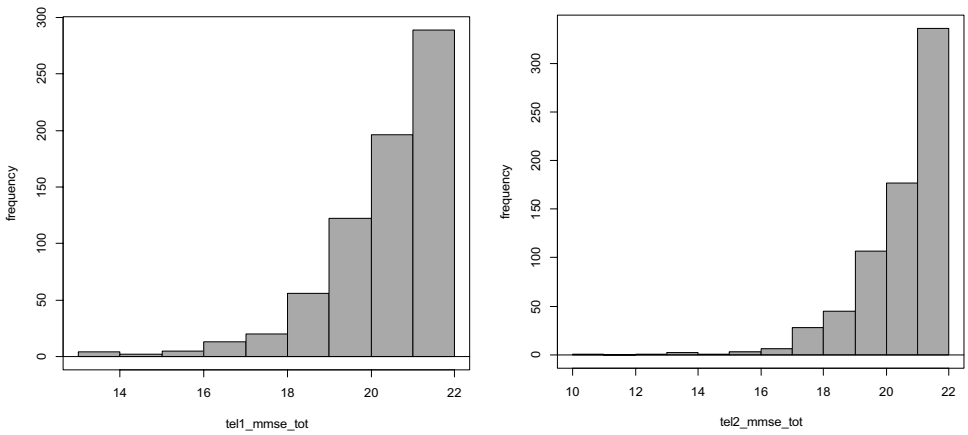

Fig. 3 Frequency distribution of scores obtained on Itel-MMSE1 and Itel-MMSE2

Table 4 Correction grid for versions 1 and 2 of Itel-MMSE

Itel-MMSE version 1									
	Age								
Literacy	50	55	60	65	70	75	80	85	90
5	0,87	0,78	0,77	0,83	0,96	1,17	1,46	1,82	2,25
8	0,36	0,27	0,26	0,32	0,45	0,66	0,95	1,31	1,74
13	−0,18	−0,27	−0,29	−0,22	−0,09	0,12	0,41	0,76	1,20
17	−0,34	−0,43	−0,44	−0,38	−0,24	−0,03	0,25	0,61	1,04
Itel-MMSE version 2									
	Age								
Literacy	50	55	60	65	70	75	80	85	90
5	0.74	0.64	0.62	0.70	0.86	1.11	1.45	1.87	2.38
8	0.26	0.16	0.15	0.22	0.38	0.63	0.97	1.39	1.90
13	−0.18	−0.28	−0.30	−0.22	−0.06	0.19	0.52	0.95	1.46
17	−0.21	−0.32	−0.33	−0.26	−0.09	0.15	0.49	0.91	1.43

Version 2 of Itel-MMSE

The score obtained on Itel-MMSE2 were associated to the same set of predictors as version 1.

In fact, gender showed no effect ($|t|_{537.04} = 0.78$; $p = 0.433$) and both age and education showed the best predicting effect after quadratic transformation (age: $F_{2,704} = 49.62$; $p < 0.0001$; AIC = 2385.94; $AdjR^2 = 0.12$; education: $F_{2,704} = 50.62$; $p < 0.0001$; AIC = 2384.18; $AdjR^2 = 0.12$).

The final model ($F_{4,702} = 40.26$; $p < 0.0001$; $AdjR^2 = 0.19$) was:

$$\begin{aligned} ItelMMSE2 = {} & 13.4447612 + 0.2043803 \times (age - 66.5) \\ & - 0.0017528 \times (age^2 - 4392.8) + 0.2748160 \\ & \times (education - 11.99) - 0.0088756 \\ & \times (education^2 - 164.13) \end{aligned}$$

The outer tolerance limit (corresponding to the cut-off point) was 18.45, and the inner tolerance limit was 19.04. Equivalent Scores and correction grids are displayed respectively in Tables 3 and 4.

Validation

As for version 1 of the Itel-MMSE, the study sample was composed by 368 cognitively impaired individuals, 181 affected by AD, and 187 affected by MCI, who underwent the version 1, and 138 AD and 151 MCI belonging to the same sample, who underwent also Itel-MMSE version2.

The mean scores of both the version of the Itel-MMSE were significantly different among the groups, and between groups comparisons (AD vs healthy individuals, AD vs MCI, and MCI vs Healthy individuals) were all significant after post-hoc comparisons (see Table 5).

The distribution of scores falling below the cut-off point in the control group, and in the group of subjects with cognitively impaired individuals is shown in Table 6, alongside with the corresponding measures of diagnostic accuracy. Supplementary Table 1 displays the distribution of healthy participants, AD, and MCI individuals in respect of equivalent scores; supplementary Graph 1 displays the percentages of individuals belonging to each group obtaining scores corresponding to each equivalent score.

The areas under the curve (AUCs) for each condition and for both the versions of Itel-MMSE are shown in Graph 2.

Discussion

To our knowledge, the present study is the first reporting the standardization of Itel-MMSE in a general healthy population and validation in patients with MCI and Dementia due to probable AD.

Table 5 Results of the ANOVA comparing the corrected score on version 1 and version 2 of the Itel-MMSE in healthy participants, MCI and AD

	Healthy participants		MCI		AD			
	Mean	SD	Mean	SD	Mean	SD	F	p
Itel-MMSE version 1	21.00	1.285	18.86	2.269	14.21	3.956	729.4	< 0.0001
Itel-MMSEI version 2	21.17	1.254	18.38	3.195	13.51	4.201	694.8	< 0.0001

Table 6 Diagnostic accuracy of version 1 and 2 of Itel-MMSE. Sens: sensitivity; Spec: specificity; PPV: positive predictive value; NPV: negative predictive value

Itel-MMSE version 1						
	Score below the cut-off					
	N	%	Sens	Spec	PPV	NPV
Healthy participants	26	3.7				
MCI	70	37.4	0.37	0.96	0.73	0.85
AD	157	86.7	0.87	0.96	0.86	0.97
MCI + AD	227	61.7	0.62	0.96	0.90	0.83
Itel-MMSE version 2						
	Score below the cut-off					
	N	%	Sens	Spec	PPV	NPV
Healthy participants	26	3.7				
MCI	70	46.4	0.46	0.96	0.73	0.89
AD	124	89.9	0.90	0.96	0.83	0.98
MCI + AD	195	67.5	0.67	0.96	0.88	0.88

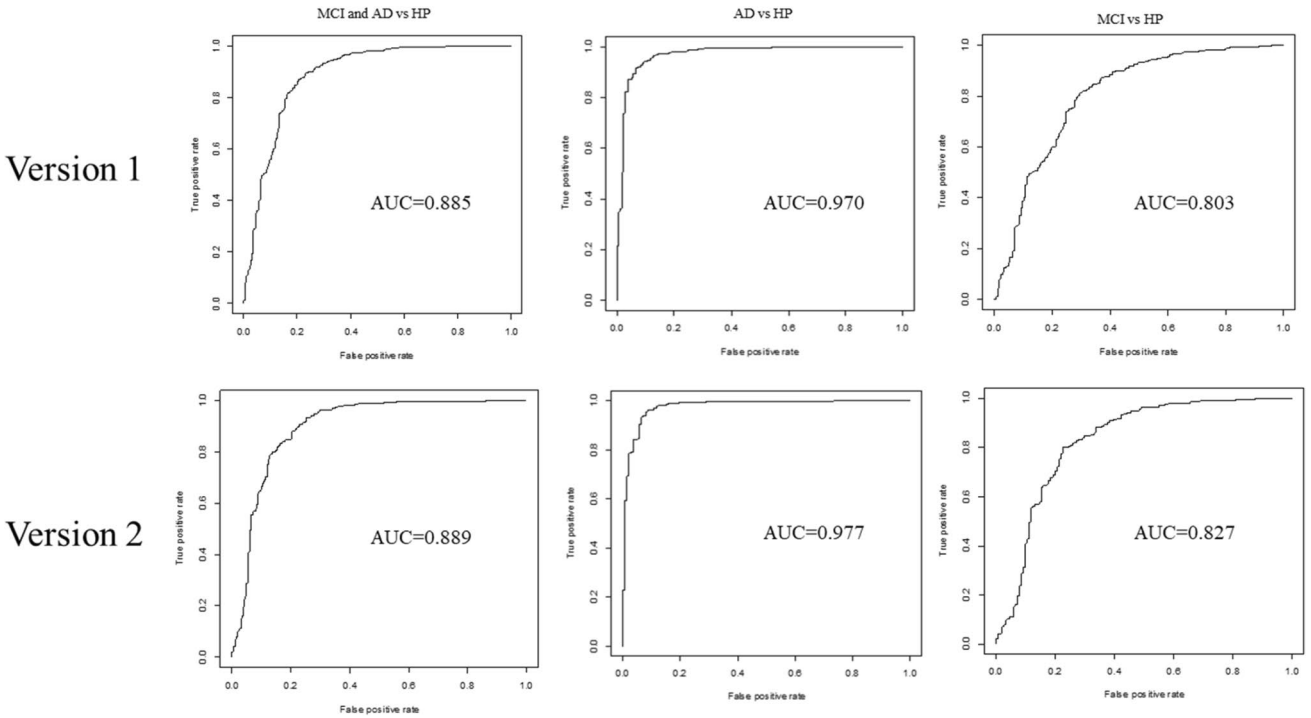

Fig. 4 ROC curves of Itel-MMSE version 1 and 2 for the diagnosis of MCI + AD, AD, and MCI. HP: Healthy Participants

As expected, and in agreement with previous studies on the MMSE in the Italian population [24, 25], age and educational level, but not gender, had a significant effect on the score.

The distribution of scores for both Itel-MMSE versions was overlapping, suggesting a good level of equivalence between the two versions, with a moderate concordance. The values under which the performance was considered pathological (18.49 and 18.45 respectively for version 1 and 2) were quite similar, thus it is conceivable that, as for clinical application, the two versions provide information of similar quality. Moreover, the analyses of equivalence between test showed a good interchangeability. The order of presentation of MMSE, remotely or in presence, did not affect the level of the performances among normal subjects. This provides further confirmation for the interchangeability among the two modalities.

When tested on the clinical sample, both the Itel-MMSE1 and the Itel-MMSE2 displayed a good reliability in differentiating subjects affected by MCI and AD from individuals without cognitive impairment. This applies in particular to the AD sample, in which both sensitivity and specificity

were quite high. It is noteworthy that also negative (NPV) and positive (PPV) predictive values were high, in particular for AD. This result is of some relevance, since the percentages of individuals affected by MCI (187/1075, 17.4%) and AD (181/1075, 16.8%) in our sample is not far from the current estimates of prevalence of these conditions in a real world [26, 27]. Furthermore, the level of accuracy in identifying subjects with cognitive impairment was not significantly different from previous reports on the standard version of the MMSE for the detection of dementia [28] and confirmed the low sensitivity previously reported for the detection of MCI [29].

As correctly pointed out in previous studies by Aiello and colleagues [30] the main risk in the standardization of the ITEL-MMSE lies in the ceiling effect and in its uninformative value when assessing healthy population. Our standardization variances seem more widely distributed in healthy populations, thus permitting a more appropriate standardization. The cut-off derived from the regression analyses seem to discriminate very well between normal subjects and AD showing also a pretty good ability in distinguishing MCI.

Several other studies addressed the usability of neuropsychological test administered by phone but we remain that screening tests represent an unmet need from a clinical and health system organization.

Previous validation studies on the Itel-MMSE [15, 16] lacked normative values and cut-off points, hindering the clinical application of the test. The present study provides adjusted scores and cut-off points validated on a large clinical sample, allowing clinicians to adopt the Itel-MMSE as a tool for the remote assessment of individuals with cognitive impairment. The availability of two versions, with substantially overlapping response profiles, may also facilitate the use of the tool for longitudinal assessment, reducing the risk of practice effect.

A limitation of the study is that the patients population was diagnosed mostly at a clinical level. Thus, we can't speculate on the availability of ITEL-MMSE in detecting MCI due to AD. Since the use of ITEL-MMSE would be mainly devoted to identify demented patients and MCI at a screening level this point appears less relevant.

The wider use of the Itel-MMSE may help to reduce the waiting list to CDCD units in favor of patients in need an urgent access to the neurological, cognitive, and instrumental assessments. On the other hand, the use of phone-based screening assessments for dementia will be more useful in identifying those individuals at risk for dementia or other cognitive impairments/disorders allowing a timely referral to Alzheimer's Units to undergo a quicker diagnostic process and, when available, to new treatment options. Finally, its use could help in monitoring remotely patients in a stable condition avoiding them to refer to hospital and limiting the caregiver burden.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10072-024-07863-4.

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Data Availability Data are stored in the repository of the Memory Clinic, Fondazione Policlinico Gemelli- Rome.

Declarations

The study didn't receive external funding and was carried out among memory clinic in Italy without any potential conflicts of interest with other entities. The authors have no relevant financial or non-financial interests to disclose that are relevant to the content of this article.
This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Fondazione Policlinico A. Gemelli IRCCS (study n° 3488 approved prot 0044005/20 and amendment prot 0035028/21) and then by the ethic committees of the others site.

Consent to participate Informed consent was obtained from all individual participants included in the study.

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