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A Comparison of the Mini-Mental State Examination (MMSE) with the Five-Minute Cognitive Test (FCT) for Community Dwelling Older Adults: A Cross-Sectional Study

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Abstract

Objective: To assess the prevalence of cognitive disorder in a community setting among older adults with two cognitive scales.

Materials and Methods: A cross-sectional study involving 450 elderly adults from five urban and regional health facilities in Gorgan was conducted. The instruments were the demographic checklist, mini-mental state examination (MMSE), five-minute cognitive test (FCT). Statistical analysis was performed using SPSS software version 18, with a significance level set at $p < 0.05$.

Results: The participants' mean age was 68.44 ± 7.62. Of them, 42 percent are men and 58 percent are women. According to the MMSE, 46.70% of older adults have normal cognition, whereas 50% of them have a healthy cognitive status based on the FCT evaluation. According to the logistic regression analysis for both scales, age and gender were significant influencing factors. Furthermore, the receiver operating characteristic analysis displays the FCT's noteworthy area under the curve (0.91, $p < 0.000$). The diagnostic accuracy, sensitivity, and specificity of the FCT test were found to be 90.00%, 87.50%, and 92.86%, respectively.

Conclusion: An alternative instrument to the MMSE that could be considered is the FCT, which is a valid, rapid, and reliable cognitive screening tool.

Keywords: Cognitive impairment, MMSE, FCT, cross-sectional study, older adults

Introduction

Cognitive impairment (CI) affects about 50 million people globally, and as the population ages, it is predicted that that this number will grow to 75 million by 2030 (1). Dementia has a substantial negative influence on society. It leads to a loss of economic productivity as well as an increased workload for families and caregivers (2).

A substantial number of comorbidities with accompanying functional impairment are common among older adults, and memory problems exacerbate these conditions for some of them (3). Early detection of CI is a crucial step towards enhancing early identification and treatment, lessening the likelihood of dementia and Alzheimer's occurrence, monitoring the prevalence, and lowering the cost of the healthcare system (4,5).

The primary care setting is the first-line centre in which patients with CI can receive medical consultation (6). The American Academy of Neurology a significant provider of healthcare, acknowledged that "early diagnosis can help identify some forms of mild CI (MCI) that may be reversible, including those caused by sleep problems, depression, or medications This early diagnosis leads to treatments that can improve a person's quality of life, such as correcting hearing loss and avoiding social isolation" (7).

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There are numerous screening exams available to check for CI. Doctors give patients a battery of tasks designed to evaluate one or more domains of cognition as part of screening tests. Further neuropsychological testing should be conducted in response to a positive screening test result to clarify the dementia subtype (8).

The mini-mental state examination (MMSE) is the most prevalent screening tool in different studies. Additional screening tools consist of the clock drawing test, abbreviated mental test, Montreal Cognitive Assessment (MoCA), telephone instrument for cognitive status, informant questionnaire on cognitive decline in the elderly, and the five-minute cognitive test (FCT). Each of these instruments has a unique indication and set of benefits (9-11).

Globally, the MMSE is the most widely used as a validated cognitive instrument in clinical settings and research (12). Research has revealed that, despite being a widely accepted and validated tool for dementia screening, the MMSE is biased toward patients who are educated and illiterate, and it has a low sensitivity for identifying MCI (13,14).

Early identification of CI and prompt preventive intervention are ensured by a valid cognitive screening test that is quick and easy to administer (15,16). For non-native English speakers or those without formal education, current screening techniques are frequently irrelevant (17). The FCT is another innovative tool for cognitive screening. It has the advantage of being quick and accurate in identifying CI at an early stage (18). Given the growing number of older adults and the significance of early detection of cognitive decline, we need to use cognitive evaluations other than in-person neuropsychological testing (19).

Even though it is widely acknowledged that identifying CI in older adults is crucial, primary care frequently overlooks CI in older adults (20). Therefore, early detection using the appropriate quick test is essential. This study aims to assess the differences between two cognitive assessment scales (FCT, MMSE) among older adults living in the community.

Materials and Methods

A community-based, cross-sectional study was carried out in collaboration with Golestan University of Medical Sciences. The Golestan Research Ethics Committee (approval ID: IR.GOUMS.REC.140, date: 28.11.2023) gave its approval for the study. Every participant or informal caregiver provided written informed consent.

Participants

A representative cohort comprising 450 elderly individuals from the community was assembled from five urban and regional health facilities located in Gorgan, Iran. Based on the relevant study and Morgan's statistical table, the sample size was ascertained to be 379 individuals. In order to enhance the precision of the findings and to facilitate the computation of the sample size, a total of 450 individuals were ultimately surveyed (21). The inclusion criteria were age of 60 years or older, no severe visual or auditory impairments, no documented history of depression or traumatic experiences, the ability to read and write, and providing informed consent to participate in the study. The criteria for exclusion encompassed the incomplete submission of the questionnaire, defined as failing to answer at least two questions, as well as any indication of reluctance to continue participation.

Procedure

This descriptive-analytical cross-sectional study used random sampling to select elderly individuals aged 60 years and above from five health centers in Gorgan city 2023. Providing informed consent, the trained research assistants performed data collection through face-to-face interviews. Data were systematically gathered at the local community health centres.

Participants were recruited for the study according to the inclusion criteria. A demographic checklist was used, including age, gender, marital status, residence, and level of education. The MMSE and the FCT were also used. We performed data collection through face-to-face interviews. The researcher read each question loudly, and the elders filled out the questionnaires.

Initially, the participants underwent a rigorous screening process based on predefined entry and exit criteria, followed by the systematic documentation of their demographic characteristics, which encompassed age, gender, marital status, residential location, and educational attainment, as captured in the researcher's questionnaire. Subsequently, two distinct assessment instruments, namely the MMSE, and the FCT, were employed to ascertain the cognitive functioning of the participants.

Measurements

Mini-Mental State Examination

Generally, the MMSE is frequently employed in a comparative context to evaluate the metric properties and diagnostic efficacy of novel assessment instruments (22). The MMSE encompasses a variety of distinct cognitive domains, which assess orientation to time, orientation to place, free recall, attention and calculation, delayed recall, and linguistic abilities, respectively. The MMSE has a score range of 0 to 30, where a higher score indicates better cognitive functioning (23). The valid and psychometric version of the MMSE for the Iranian older adult population was used for this study (24). This assessment's total scores fall into one of four categories: severe CI is represented by scores 0-10, moderate CI by scores 11-20, mild CI by scores 21-26, and normal cognitive status by scores 27-30 (24,25).

Five-Minute Cognitive Test

The FCT was conceived through a comprehensive multiphase research initiative, culminating in a final iteration designed to assess five distinct cognitive domains, namely episodic memory, linguistic fluency, temporal orientation, visuospatial abilities, and executive functioning (18). A total of eight culturally unbiased images were extracted from the International Picture Naming Project to serve as stimuli for the assessment of episodic memory. The FCT creates scores that range from 0 to 20, where lower scores indicate lower cognitive functioning. A person who scores higher than 16 points is said to have a normal cognitive range, while those who score between 16 and 14 points indicate mild CI, and those who score lower than 14 points indicates CI (26).

Statistics

Statistical analysis was performed using SPSS software version 18, with variables reported as frequencies and percentages. The Shapiro-Wilk test was utilized to assess the distribution of variables. Chi-square and ANOVA tests were conducted to analyse demographic variables and cognitive status. Regression models were used to examine the role of each of these variables. Receiver operating characteristic (ROC) analysis was also used to determine scale thresholds.

Results

Study Cohort Characteristics

The participants' mean age was 68.44 ± 7.62. Fifty-eight percent of them were women and 42% men. The majority of participants in the study had completed primary education (32%). Out of the total, 42% were homemakers and 26% were retirees collecting pensions. Thirty percent of the individuals reported that one of their children resides close to where they live.

Based on the cognitive status evaluation of the MMSE form, 46.70% of the elderly have normal cognition, while based on the FCT evaluation, 50% were healthy in terms of cognitive status (Table 1).

When assessing demographic factors, age and sex have been crucial in assessing cognitive abilities. Female gender and older age are associated with more severe and inappropriate cognitive status (Table 2).

The results of the Pearson correlation test indicated a statistically significant positive relationship between the average MMSE and FCT scores ($r=0.748$, $p < 0.001$). According to the multivariate logistic regression model, only age and sex were found to be statistically significant in the final model. Even though education has been linked to the MMSE this association was not significant for the multivariate model's prediction ($p > 0.05$) (Table 3).

The ROC curve was used to determine sensitivity and specificity. The area under the curve (AUC) for FCT was 0.91 and $p < 0.000$ (Figure 1).

Table 4 reports the diagnostic capabilities of the MMSE in comparison to the FCT for assessing cognitive disorders. The sensitivity and specificity of the FCT test were 87.50% and 92.86%, respectively. The diagnostic accuracy of the FCT test was 90.00% (Table 4).

Discussion

The MMSE and the FCT were compared in this study to see if the new scales could screen for cognitive disorders as accurately as the MMSE. The findings showed that the MMSE and FCT scales discriminate between people with CI and healthy individuals almost identically. Age and sex were identified as influencing factors for cognitive disorders based on the logistic regression for both scales. Furthermore, the ROC analysis shows significant remarkable AUC for FCT.

It is crucial to acknowledge that, in a community setting, the MMSE is the most thoroughly studied scale for detecting dementia in Iran's senior population (27). Individuals with

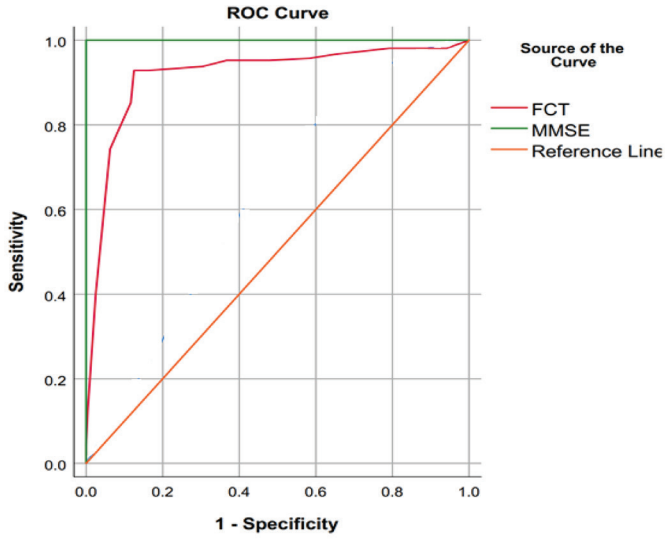

Figure 1. The receiver operating characteristic curves of MMSE, and FCT

FCT: Five-minute cognitive test, MMSE: Mini-mental state examination, ROC: Receiver operating characteristic

Table 1. Mean and frequency of cognitive status based on MMSE, and FCT scale

Cognitive scales		Frequency (%)	Mean ± SD
MMSE	Normal	210 (46.70)	29.33 ± 0.95
	MCI	88 (19.60)	24.90 ± 1.24
	Moderate	143 (31.80)	17.88 ± 2.01
	Severe	9 (2.00)	8.88 ± 1.26
FCT	Normal	225 (50.00)	16.19 ± 3.51
	Moderate	45 (10.00)	9.00 ± 0.00
	Severe	180 (40.0)	6.91 ± 1.50

FCT: Five-minute cognitive test, MCI: Mild cognitive impairment, MMSE: Mini-mental state examination, SD: Standard deviation

Table 2. Cognitive score of the elderly based on demographic variables

Variables		MMSE				FCT		
		Normal	MCI	Moderate	Severe	Normal	Moderate	Severe
Age		66.54 ± 6.32	69.22 ± 8.84	70.02 ± 7.69	80.22 ± 2.94	67.65 ± 7.30	67.42 ± 8.06	69.68 ± 7.76
p-value ANOVA		0.000				0.018		
Sex	Male	111 (52.90)	26 (29.50)	45 (31.50)	3 (33.30)	115 (51.10)	9 (20.00)	61 (33.90)
	Female	99 (47.10)	62 (70.50)	98 (68.50)	6 (66.70)	110 (48.90)	36 (80.00)	119 (66.10)
p-value Pearson chi-square		0.000				0.000		
Marital status	Married	180 (85.70)	65 (73.90)	115 (80.40)	3 (33.30)	187 (83.10)	34 (75.60)	142 (78.90)
	Single/widow/divorce	30 (34.50)	23 (26.40)	28 (32.20)	6 (6.9)	38 (43.70)	11 (12.60)	38 (43.70)
p-value Pearson chi-square		0.000				0.371		
Living arrangement	City	191 (91.00)	71 (80.70)	118 (82.5)	7 (77.80)	198 (88.00)	40 (88.9)	149 (82.8)
	Rural	19 (9.00)	17 (19.30)	25 (17.5)	2 (22.20)	27 (12.00)	5 (11.10)	31 (17.20)
p-value Pearson chi-square		0.040				0.271		
Education	Elementary	70 (33.30)	32 (36.40)	43 (30.10)	2 (22.20)	78 (34.70)	11 (24.40)	58 (32.20)
	Middle	52 (24.80)	26 (29.50)	36 (25.20)	6 (66.70)	56 (24.90)	13 (28.90)	51 (28.30)
	High school	13 (6.20)	9 (10.20)	28 (19.60)	0 (0.00)	16 (7.10)	9 (20.00)	25 (13.90)
	Diploma	57 (27.10)	17 (19.30)	29 (20.30)	1 (11.10)	58 (25.80)	11 (24.40)	35 (19.40)
	Bachlor	18 (8.60)	4 (4.50)	7 (4.90)	0 (0.00)	17 (7.50)	1 (2.20)	11 (6.10)
p-value Pearson chi-square		0.018				0.189		
Child number		3.54 ± 1.93	3.61 ± 2.10	3.58 ± 1.69	3.55 ± 2.12	3.60 ± 1.91	3.80 ± 2.24	3.46 ± 1.78
p-value ANOVA		0.994				0.526		
Drug number		2.98 ± 3.08	2.59 ± 2.80	2.90 ± 2.23	4.66 ± 6.00	2.96 ± 3.19	2.71 ± 2.18	2.90 ± 2.59
p-value ANOVA		0.205				0.862		

FCT: Five-minute cognitive test, MCI: Mild cognitive impairment, MMSE: Mini-mental state examination, ANOVA: Analysis of variance

Table 3. Multivariate logistic regression

Model	Variable	Parameter estimate	Standard error	p-value	Odds ratio (95% CI)
MMSE	Age	0.08	0.01	0.000	1.08 (1.05-1.12)
	Sex	1.11	0.21	0.000	3.04 (2.00-4.61)
	Education	0.13	0.08	0.115	1.13 (0.96-1.33)
FCT	Age	0.03	0.01	0.007	1.03 (1.01-1.06)
	Sex	0.92	0.20	0.000	2.52 (1.69-3.75)
	Education	0.10	0.08	0.203	1.10 (0.94-1.29)

FCT: Five-minute cognitive test, MMSE: Mini-mental state examination, CI: Confidence interval

higher levels of education might gain an unequal advantage from the educational bias in these tests. Regarding the other cognitive tests assessed in this study—MoCA, Addenbrooke's Cognitive Examination III (ACE-III), Assessment of Cognition and Executive function (PEACE), Rey Auditory Verbal Learning Test (AVLT) The lengthy administration times make them unsuitable for regular use in primary care and community care settings (28). In individuals with mild CI, impaired episodic memory has been identified as the initial symptom and has been found to predict the development of Alzheimer's disease (AD) (18). The FCT was

Table 4. Diagnostic properties of the MMSE test compared to the FCT in diagnosing cognitive disorders.

	Criteria	Value	95% CI
FCT	Sensitivity	87.50%	82.64-91.41
	Specificity	92.86%	88.49-95.95
	LR+	12.25	7.50-20.00
	LR-	0.13	0.10-0.19
	PPV	93.32%	89.55-95.80
	NPV	86.68%	82.29-90.11
	Accuracy	90.00%	86.85-92.61

FCT: Five-minute cognitive test, MMSE: Mini-mental state examination, CI: Confidence interval, LR+: Positive likelihood ratio, LR-: Negative likelihood ratio, PPV: Positive predictive value, NPV: Negative predictive value

created to identify deficiencies in a wide range of cognitive domains, such as executive function, language fluency, time orientation, episodic memory, and visuospatial function. Eight culturally impartial images were selected from the International Picture Naming Project to be used as items for episodic memory. As a result, FCT was created with a stronger focus on evaluating episodic memory (8 points) (26).

Cognitive Status

Based on the MMSE and FCT scales, the current study's findings showed that mild to moderate cognitive disorders affected about half of the population. The mean MMSE score for MCI cases was 24.90 ± 1.24, while the mean score for normal older adults was 29.33 ± 0.95. In moderate cases, the mean FCT score was 9.00 ± 0.00, while in normal older adults, it was 16.19 ± 3.51. The mean score of MMSE, for older adults in China was 27.9 ± 1.28 for normal people and 26.3 ± 1.9 for MCI people. The mean score for mild AD, MCI patients, and normal individuals, according to FCT evolution, was 8 ± 3.2, 14.9 ± 2.8, and 17.8 ± 1.2, respectively (26). Additionally, in a different study of the Chinese population, the mean MMSE scores for mild AD, MCI, and normal older adults were 20.11 ± 2.90, 26.25 ± 1.87, and 27.89 ± 1.38, respectively. According to FCT evaluation, the mean scores for MCI patients and healthy individuals were 26.45 ± 4.72 and 30.40 ± 2.91, respectively (18).

Previous research has shown that image-based memory assessments are successful in predicting the transition from MCI to AD. These assessments also accurately differentiate between healthy controls and AD patients. (29,30). Instead of using word recall, the FCT used picture recall to capture episodic memory deficit. In addition to removing any concerns regarding linguistic and educational bias, this design should facilitate the adoption of the FCT by other older adults who lack literacy.

Cognitive Score Based on Demographic Variables

Additionally, based on the results of the logistic regression, age and sex were considered risk factors for cognitive status, aligning with the findings of Pan et al. (18). The mental status was higher in women and worse in older people. However, Zhang et al. (26) found no significant difference in FCT scores between males and females, but they did find a meaningful correlation between FCT scores age and educational year.

According to Jin et al. (31), most multi-cohort studies indicated that women in the oldest age group had a faster rate of cognitive decline than men. These findings were validated by the outcomes of additional multi-cohort research (32). Compared to human males, females exhibit higher lifetime risk, neuropathology, and CI (33). Jeong et al. (34) reported that the cognitive function scores of men were higher than those of women. Men's age, employment status, and depression were linked to dementia, regardless of their cognition. However, for women, the impact of these factors was more pronounced when cognitive function was low (34).

Even though older age and female gender have been identified as significant factors in cognitive status in numerous studies, researchers recommend considering regression models and other variables. Age and sex were the only variables in the final model that were statistically significant in the regression analysis. For the multivariate model's prediction, education was not statistically significant. Although many studies have shown that education contributes to the cognitive status of elders, especially when using the MMSE (35), there is still debate and difficulty in interpreting the role of education. As Laks et al. (36) state, education does not significantly influence delayed recall, memory registration, three-step commands, or naming abilities. Despite the level of education, these factors might still be essential, as memory is crucial for identifying dementia. Furthermore, we note that social and cultural norms, along with environmental influences, affect the outcomes of screening tests, according to the results of several studies. Other aspects besides education must be taken into account when assessing tests (37,38). To rule out the possibility of mild CI, Franco-Marina et al. (39) believe that additional testing may be necessary when using an education-adjusted MMSE test to screen for CI. Additionally, some researchers propose modifying MMSE scores according to educational attainment to lessen this bias; However, there is ongoing discussion regarding the suitability and efficacy of these modifications (39-41).

Receiver Operating Characteristic Curve Analysis

The findings demonstrated that the FCT was suitable for diagnosing CI with an AUC of 0.91, a sensitivity of 87.50, a specificity of 92.86, and a diagnostic accuracy of 90.00 percent for identifying people with mild, moderate, and severe cognitive disorders as well as those with healthy cognitive status. According to Pan et al. (18), the FCT could distinguish between normal cognition and AD with an AUC of 1 (0.972-1), sensitivity of 100% (87.2% to 100%), and specificity of 98.13% (93.4% to 99.8%) (18).

The Zhang et al. (26) study found that the AUC of FCT for measuring CI (MCI and mild AD) was 0.885 (95% CI: 0.838 to 0.922). The FCT test had a sensitivity of 80% and a specificity of 84% for diagnosing CI.

Although Hafızoğlu et al. (42) did not present ROC analysis, their findings showed a considerable correlation between FCT scores and MMSE ($r=0.730$, $p < 0.001$) (42).

According to the findings of a few studies, the FCT is a scale that is acceptable in community settings when compared to the MMSE. Since administering the MMSE necessitates staff training and precise experience in calculation and scoring, and because an inexperienced evaluator may misinterpret a person's cognitive state he FCT can be used as a substitute scale in community settings that is easier to administer and interpret.

Study Limitations

Certain Limitations to This Study Should be Mentioned

This research included only five urban and regional health facilities. Future studies should consider sampling from additional locations or the entire city to improve the generalizability of the findings.

One of the study's limitations has been the high proportion of women, which may be a confounding factor in this field given the influence of demographic factors on MMSE and FCT as well as the study's significant age and gender distribution (more women than men). As a result, we recommend that future research employ the stratification method to better control the confounding variable.

The distribution of participants who were categorized as having moderate dementia by the MMSE form moving toward the severe dementia category when evaluated using the FCT, is another possible confounding factor. This factor is among the restrictions brought about by different cut-off points.

Conclusion

In conclusion, the FCT is a quick, valid, and dependable cognitive screening test. FCT has also been shown in this study to be a rapid, user-friendly, and accurate measure of CI in a community context. It takes ten minutes or longer to finish the majority of widely used screening tools. When used in large-scale epidemiological studies or doctors' offices, Cognitive screening tests with shorter administration times would be preferred. The FCT is an instrument rather than the MMSE that may be taken into consideration. These results could help FCT become more widely used in clinical practice and research.

Ethics

Ethics Committee Approval: The Golestan Research Ethics Committee (approval ID: IR.GOUMS.REC.140, date: 28.11.2023) gave its approval for the study.

Informed Consent: Every participant or informal caregiver provided written informed consent.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.C., P.K., M.T.B.S., Concept: M.C., P.K., F.M., M.T.B.S., Design: M.C., P.K., F.M., M.T.B.S., Data Collection or Processing: M.C., P.K., M.T.B.S., Analysis or Interpretation: F.M., Literature Search: M.C., P.K., M.T.B.S., Writing: M.C., P.K., F.M., M.T.B.S.

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