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Validity of the telephone interview for cognitive status (TICS) and modified TICS (TICSm) for mild cognitive imparment (MCI) and dementia screening

Eun Hyun Seo [a], Dong Young Lee [a,b,*], Shin Gyeom Kim [c], Ki Woong Kim [d], Do Hoon Kim [e], Bong jo Kim [f], Moon-Doo Kim [g], Seong Yoon Kim [h], Young Hoon Kim [i], Jeong-Lan Kim [j], Jee Wook Kim [b], Seok Woo Moon [k], Joon Hyuck Park [g], Seung-Ho Ryu [l], Jong Choul Yoon [m], Nam Jin Lee [n], Chang Uk Lee [o], Jin Hyeong Jhoo [p], Il Han Choo [b], Jong Inn Woo [a,b]

[a] *Interdisciplinary Program for Cognitive Science, Seoul National University, 599 Kwanak-ro, Kwanak-gu, Seoul 151-742, Republic of Korea*
[b] *Department of Neuropsychiatry, Seoul National University Hospital, 28 Yongon-dong, Chongno-gu, Seoul 110-744, Republic of Korea*
[c] *Department of Neuropsychiatry, Soonchunhyang University Bucheon Hospital, 1174 Jung-dong, Wonmi-gu, Bucheon, Incheon 420-767, Republic of Korea*
[d] *Department of Neuropsychiatry, Seoul National University Bundang Hospital, 166 Gumi-ro, Bundang-gu, Seongnam, Gyeonggi-do 463-707, Republic of Korea*
[e] *Department of Psychiatry, Hallym Univerisity Chuncheon Sacred Heart Hospital, 153 Gyo-dong, Chuncheon, Kangwon-do 200-704, Republic of Korea*
[f] *Department of Psychiatry, Gyeongsang National University Hospital, 90 Chilam-dong, Jinju, Gyeongsang-do 660-702, Republic of Korea*
[g] *Department of Psychiatry, Jeju National University Hospital, 1753-3 Ara 1-dong, Jeju 690-702, Republic of Korea*
[h] *Department of Psychiatry, University of Ulsan Asan Medical Center, 86 Asan Medical Center-ro, Songpa-gu, Seoul 138-736, Republic of Korea*
[i] *Department of Psychiatry, Inje University Busan Baik Hospital, 633-165 Gaegum-dong, Jin-gu, Busan 614-735, Republic of Korea*
[j] *Department of Psychiatry, Chungnam National University Hospital, 33 Munhwa-ro, Jung-gu, Daejeon 301-721, Republic of Korea*
[k] *Department of Psychiatry, Konkuk University Chungju Hospital, 620-5 Gyohun 2-dong, Chungju, Chungcheong-do 380-704, Republic of Korea*
[l] *Department of Psychiatry, Konkuk University Hospital, 4-12 Hwayang-dong, Kwangjin-gu, Seoul 143-729, Republic of Korea*
[m] *Department of Neuropsychiatry, Gyeonggi Provincial Hospital for the Elderly, 17 Sangha-dong, Gihung-gu, Yongin, Gyeonggi-do 446-512, Republic of Korea*
[n] *Department of Psychiatry, Chonju Welfare Hospital for The Elderly, 321-51 3 Ga, Samcheon-dong, Wansan-gu, Chonju, Chonra-do 560-293, Republic of Korea*
[o] *Department of Psychiatry, Seoul Saint Mary's Hospital, 505 Banpo-dong, Seocho-gu, Seoul 137-701, Republic of Korea*
[p] *Department of Psychiatry, Kangwon National University Hospital, 26 Kangwondeahak-ro, Chunchon, Kangwon-do 200-947, Republic of Korea*

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ABSTRACT

This study aimed to validate the TICS and modified TICS (TICSm) in Korean elderly population and to compare MCI and dementia screening ability between TICS and TICSm. TICS and TICSm were administered to 70 cognitively normal (CN), 75 MCI, and 85 dementia subjects, with mini-mental state examination (MMSE) and other cognitive and functional measures. TICS and TICSm scores were highly correlated with other global cognitive and functional scores. The CN vs. dementia discrimination ability of both instruments was as excellent as that of MMSE (sensitivity/specificity at optimal cutoff: 87.1/90.1 for TICS; 88.2/90.0 for TICSm). Although their CN vs. MCI discrimination performances were comparable to that of MMSE, they were far from perfect (sensitivity/specificity: 69.3/68.6 for TICS; 73.3/67.1 for TICSm). There was no significant difference in dementia or MCI screening accuracy between TICS and TICSm. Both of them also showed high test–retest reliability. Our findings indicate that TICS and TICSm are reliable and as valid as MMSE in regard of screening cognitively impaired elderly. In terms of the comparison between TICSm and TICS, however, TICSm has little advantage over TICS for screening dementia and even MCI, in spite of longer administration time and more efforts required.

1. Introduction

Many cognitive screening instruments have been developed for the detection of dementia. Most of them including the mini-mental state examination (MMSE) (Folstein et al., 1975) requires face-to-face administration, which is not always feasible and cost a lot especially to screen geographically dispersed populations. These disadvantages of face-to-face administration instruments limit large-scale population-based cognitive screenings for clinical trials, epidemiological studies, or community-based dementia early detection program (Welsh et al., 1993). To overcome this limitation, several telephone interview-based cognitive screening instruments have been developed (Brandt et al., 1988; Roccaforte et al., 1992; Lanska et al., 1993; Gatz et al., 1995; Kawas et al., 1995; Go et al., 1997).

The telephone interview for cognitive status (TICS), developed by Brandt et al. (1988), is one of the most popular telephone

* Corresponding author at: Department of Neuropsychiatry, Seoul National University Hospital, 28 Yongon-dong, Chongno-gu, Seoul 110-744, Republic of Korea. Tel.: +82 2 2072 2205; fax: +82 2 744 7241.
E-mail address: selfpsy@snu.ac.kr (D.Y. Lee).

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interview-based screening instruments. The TICS consists of 11 items including word list memory, orientation, attention, repetition, conceptual knowledge, and nonverbal praxis. It has been used for epidemiological studies and clinical trials of dementia and known to have high reliability and validity (Brandt et al., 1988; Welsh et al., 1993). Although the TICS was modeled after the MMSE, it has less ceiling effects than the MMSE, and can be reliably used even for persons with visual or physical deficits (Welsh et al., 1993; Desmond et al., 1994).

A modified version of the TICS (TICSm) was also developed (Welsh et al., 1993). Compared with the TICS, a delayed verbal recall item, known as the most sensitive cognitive measure for mild cognitive impairment (MCI) and early Alzheimer's disease (AD) detection, is added in the TICSm, while most other TICS items are still maintained. A series of studies indicated that the TICSm is as valid as the TICS as a screening instrument for dementia (Welsh et al., 1993; Gallo and Breitner, 1995; Beeri et al., 2003). Some studies also reported that the TICSm was valid even for screening MCI (Graff-Radford et al., 2006; Cook et al., 2009; Duff et al., 2009). Any previous studies, however, have not directly compared the screening ability for MCI between the TICS and TICSm, although it is expected that the TICSm have better performance than the TICS in MCI screening given delayed verbal recall item.

Both the TICS (Ferrucci et al., 1998; Jarvenpaa et al., 2002; Dal Forno et al., 2006; Konagaya et al., 2007) and TICSm (Beeri et al., 2003) have been validated in several non-English language using populations, such as Spanish, Italian, Finnish, Hebrew, and Japanese ones. Both instruments or any other telephone interview-based cognitive screening instruments, however, were not validated for Korean population, although Korea is one of the most rapidly aging countries in the world (UN, 2008; Korea National Statistical Office, 2005) and dementia have already become a major health problem (Lee, 2007).

In this study, we first aimed to validate both the TICS and TICSm in Korean elderly population. We also directly compared MCI and dementia screening ability between the TICS and TICSm.

2. Subjects and methods

2.1. Study population

Study subjects were recruited from the pool of elderly individuals registered in a nation-wide program for the early detection and management of dementia in Seoul and six provinces (Gyeonggi-do, Kangwon-do, Chungcheong-do, Gyeongsang-do, Chonra-do, and Jeju-do) of Korea from June 2007 to May 2008. Dementia, MCI, and cognitively normal (CN) individuals aged 60–90 were included. All subjects were examined by psychiatrists with advanced training in neuropsychiatry and dementia research according to the Consortium to Establish a Registry of Alzheimer's Disease protocol (Morris et al., 1989; Lee et al., 2002). The CERAD clinical assessment battery included clinical dementia rating scale (CDR) (Morris, 1993), blessed dementia scale-activities of daily living (BDS-ADL) (Morris et al., 1989; Lee et al., 2002), the short blessed test (SBT) (Lee et al., 1999), general medical examination, neurological examination, laboratory tests, and brain magnetic resonance imaging (MRI) or computerized tomography (CT). Standard administration of the CERAD battery was previously described in detail (Morris et al., 1989; Lee et al., 2002). Reliable informants were necessarily interviewed to acquire the accurate information regarding the cognitive, emotional and functional changes as well as the medical history of the subjects. A diagnosis of dementia was made according to the criteria of the fourth edition of the DSM-IV (APA, 1994). MCI was diagnosed according to current consensus criteria: (a) cognitive complaint corroborated by an informant, (b) objective cognitive impairment for age, education and gender, (c) essentially preserved general cognitive function, (d) largely intact functional activities, and (e) not demented (Winblad et al., 2004). Objective cognitive impairment was defined when a performance score for at least one test among seven cognitive tests included in the CERAD neuropsychological assessment battery (CERAD-NP) (Morris et al., 1989; Lee et al., 2004), i.e., word list memory (WLM), word list recall (WLR), word list recognition (WLRc), constructional recall (CR), verbal fluency (VF), 15-item Boston naming test (BNT), and constructional praxis (CP), was $1.5 \times$ S.D. below the respective age-, education- and gender-specific normative means (Lee et al., 2004). All MCI individuals had an overall CDR of 0.5. All CN subjects received a CDR score of 0. The exclusion criteria for all subjects were any present serious medical, psychiatric, and neurological disorders that could affect the mental function; evidence of focal brain lesions on MRI; the presence of severe behavioral or communication problems that would make a clinical examination difficult; an absence of a reliable informant. Individuals with minor physical abnormalities (e.g., diabetes with no serious complications, essential hypertension, mild hearing loss, or others) were included. A panel consisting of four neuropsychiatrists with expertise in dementia research made the clinical decisions including diagnosis and CDR after reviewing all the available raw data. The Institutional Review Board of the each sites approved the research protocol and all study procedures, and subjects or their legal representatives gave written informed consent.

2.2. Translations of the TICS and TICSm into Korean

Three neuropsychiatrists who were familiar with both English and Korean translated the English versions of the TICS and TICSm into Korean ones. After initial translation, one professional English–Korean translator performed back-translation. The back-translated draft was reviewed and confirmed by the authors of the original version. The overall structures of the original versions were essentially maintained in the Korean versions. Minor modifications, however, were made for some items to make them more suitable for Korean culture with the permission of the authors of the original version. For example, English words in verbal memory tests (item 5 of both the TICS and TICSm) and repetition task (item 8 of both the TICS and TICSm) were not translated into semantically equivalent Korean ones. Instead, new Korean words were selected considering the relative frequency and imagery in Korean language. The question for 'Vice President's name' (item 9 of both the TICS and the TICSm) was also replaced to one for 'Prime Minister's name, since there is no Vice President in Korea.

As all items in the English version of the TICSm except item 12 (additional word list recall item) and item 3 (question for an address instead of question for age and phone number of TICS) are identical to the corresponding TICS items, so the items in the Korean version of the TICSm were maintained to be same with those corresponding items in the Korean version of the TICS. The maximum scores of each instrument are 41 and 50 respectively.

2.3. Administration of the MMSE, TICS, and TICSm

Experienced clinical psychologists or research nurses first administered the MMSE to all the subjects who met both inclusion and exclusion criteria. Both the TICS and TICSm were applied by research nurses within 4 weeks after MMSE administration. The common items included in both the TICS and TICSm were administered only once. In order to assess test–retest reliability, both the TICS and TICSm were applied twice with a 4-week interval to 29 individuals (CN 10, MCI 11, dementia 8).

2.4. Statistical analysis

Internal consistency was measured with Cronbach's alpha, and test–retest reliability was determined by using Intraclass correlation coefficient. Concurrent validity was assessed by examining partial correlations with other cognitive and functional measures controlling age, education, and gender. In regard of discrimination validity, the means of test scores were compared among CN, MCI, and AD groups by analysis of covariance (ANCOVA) controlling age and education levels with post hoc contrasts with Tukey's honestly significant difference (HSD) method. Receiver operating characteristic (ROC) curve analysis was also performed to investigate discrimination validity of the TICS and TICSm. Areas under the curve (AUC) of ROC curves were compared among the TICS, TICSm and MMSE according to the method suggested by Hanley and McNeil (1983).

3. Results

Seventy CN normal elderly, 75 with MCI and 85 individuals with dementia were included in the present study. Among the patients with dementia, 64 (75.3%) had probable or possible AD, and the other 21 (24.7%) patients had non-AD dementia. Among the participants with MCI, 65 (81.3%) individuals had amnestic MCI (aMCI). The demographic and clinical characteristics of subjects are summarized in Table 1. Internal consistency measured by Cronbach's alpha was 0.87 for both Korean versions of the TICS and TICSm. Intraclass correlation coefficient between test and retest score was 0.95 ($p < 0.001$) for both TICS and TICSm.

Table 2 shows the results of partial correlation analyses between the TICS and TICSm, and the MMSE, SBT, clinical dementia rating sum of box score (CDR-SOB) and BDS-ADL. Both the TICS and TICSm were significantly correlated with other cognitive or functional measures. The mean scores of the TICS and TICSm were significantly different among CN, MCI, and dementia group (Table 1). Post hoc comparison showed that there was a significant mean score difference between any two diagnostic groups.

Table 3 shows the results from ROC curve analyses for the assessment of discrimination validity of the TICS, TICSm and MMSE. Both the TICS and TICSm were highly accurate in discriminating dementia from CN. Their CN vs. dementia discrimination ability were comparable to that of MMSE. The TICS had 87.1% sensitivity and 90.0% specificity at the optimal cutoff score of 24/25, and the TICSm showed 88.2% sensitivity and 90.0% specificity at the optimal cutoff score of 23/24. There was no significant difference of dementia discrimination accuracy between the TICS and TICSm.

Table 2
Partial correlations* of TICS and TICSm with MMSE, SBT, CDR-SOB, and BDS-ADL.

Tests	TICS-K	TICSm-K	MMSE	SBT	CDR-SOB	BDS-ADL
TICS-K	1					
TICSm-K	0.97	1				
MMSE	0.79	0.75	1			
SBT	−0.73	−0.71	−0.76	1		
CDR-SOB	−0.65	−0.62	−0.62	0.66	1	
BDS-ADL	−0.49	−0.46	−0.40	0.51	0.68	1

* $p < 0.001$ for all correlation coefficients by partial correlation controlling age, education, and gender.

Table 3
AUCs and cutoff scores of TICS, TICSm, and MMSE in CN, MCI, and dementia groups.

		CN vs. D	CN vs. MCI	MCI vs. D
TICS-K	AUC	0.948	0.755	0.846
	SE	0.016	0.040	0.031
	95%CI	0.916–0.981	0.676–0.833	0.785–0.906
	Cutoff	24/25	28/29	21/22
	Sen/Spe	871/90.0	69.3/68.6	75.3/81.3
TICSm-K	AUC	0.952	0.758	0.850
	SE	0.016	0.040	0.030
	95%CI	0.921–0.984	0.680–0.836	0.791–0.909
	Cutoff	23/24	28/29	20/21
	Sen/Spe	88.2/90.0	73.3/67.1	75.3/78.7
MMSE	AUC	0.941	0.784	0.827
	SE	0.017	0.038	0.033
	95%CI	0.907–0.974	0.709–0.858	0.762–0.891
	Cutoff	20/21	22/23	18/19
	Sen/Spe	85.9/91.4	64.0/72.9	70.6/81.3

Note: All cutoff scores were optimal cutoff scores.

In terms of CN vs. MCI discrimination, the discrimination accuracy of the TICS and TICSm was not statistically different from that of the MMSE (Table 3). There was also no difference between the TICS and TICSm. When choosing optimal cutoff score of 28/29, the sensitivity and specificity of the TICS were 69.3% and 68.6%, respectively. The sensitivity and specificity of the TICSm at the optimal cutoff score 28/29 were 73.3% and 67.7%, respectively. Even when we focused on aMCI discrimination from CN, the discrimination accuracy was not different between any two of the TICS, TICSm, and MMSE (AUC = 0.767, 95%CI = 0.686–0.847 for the TICS; AUC = 0.774, 95%CI = 0.695–0.853 for the TICSm; AUC = 0.807, 95%CI = 0.735–0.880 for the MMSE).

Both the TICS and TICSm showed relatively reasonable discriminating accuracy in regard of MCI vs. dementia discrimination. As shown in Table 3, AUC comparison showed no significant difference between any of two instruments of the TICS, TICSm and MMSE. The TICS had 75.3% sensitivity and 81.3% specificity at the

Table 1
Demographic and clinical characteristics of study participants, mean ± S.D.

Parameter	CN	MCI	Dementia	F	Tukey test
n	70	75	85		
Age, years	70.03 ± 5.17	73.39 ± 5.75	75.00 ± 6.57	13.89***	A < B, C
Education, years	8.09 ± 4.61	6.79 ± 4.33	5.23 ± 4.44	7.91***	A, B > B, C
% Women	58.6	56.0	60.0		
% CDR 0	100.0	0.0	0.0		
% CDR 0.5	0.0	100.0	28.2		
% CDR 1	0.0	0.0	61.2		
% CDR 2	0.0	0.0	10.6		
CDR-SOB	0.00 ± 0.00	1.01 ± 0.76	5.10 ± 2.91	174.21***	A < B < C
BDS-ADL	0.97 ± 1.84	1.28 ± 1.45	3.46 ± 2.23	41.07***	A, B < C
SBT	2.30 ± 3.30	8.50 ± 6.41	17.44 ± 7.07	98.60***	A < B < C
MMSE	25.26 ± 3.74	21.07 ± 3.41	15.42 ± 4.76	91.83***	A > B > C
TICS	30.40 ± 5.31	25.24 ± 6.09	15.47 ± 7.34	88.97***	A > B > C
TICSm	31.41 ± 6.88	24.84 ± 6.80	14.59 ± 7.05	90.82***	A > B > C

Note: A: CN, B: MCI, C: Demenita.
*** $p < 0.001$.

optimal cutoff score of 21/22, and the TICSm showed 75.3% sensitivity and 78.7% specificity at the optimal cutoff score of 20/21.

4. Discussion

The present study was conducted to validate both the TICS and TICSm as cognitive screening instruments in Korean elderly people and to compare their ability for detecting MCI and dementia. Both the instruments showed high correlation not only with other representative cognitive scale (i.e., MMSE and SBT), but also with clinical severity scale (i.e., CDR-SOB) and functional scale (i.e., BDS-ADL). These results are globally in line with those from previous studies (Brandt et al., 1988; Beeri et al., 2003; Dal Forno et al., 2006; Konagaya et al., 2007), and indicate that both the TICS and TICSm have substantial concurrent validity in Korean population.

In terms of discrimination validity, the mean scores of the TICS and TICSm were significantly different between any two groups of CN, MCI, and dementia. The CN vs. dementia discrimination validity of both instruments was further supported by the results from ROC curve analyses. Both the TICS and TICSm showed high accuracy for CN vs. dementia discrimination and their abilities were equivalent to that of MMSE. This finding indicates that both telephone interview-based instruments are as valid as MMSE, a representative face-to-face cognitive instrument, for dementia screening. Then, the optimal cutoffs of the TICS and TICSm for dementia screening in this study were much lower than those reported in previous studies (Brandt et al., 1988; Welsh et al., 1993; Jarvenpaa et al., 2002; Beeri et al., 2003; Dal Forno et al., 2006; Konagaya et al., 2007). Optimal cutoffs in our study were 24/25 for TICS and 23/24 for TICSm, whereas Welsh et al. (1993) reported 32/33 for TICS and 30/31 for TICSm. Cutoff scores can be influenced by the characteristics of study population. Participants in most previous studies had relatively higher educational levels (usually more than 13 years) than those in this study (mean 6.61 ± 4.59). Educational level is well-known to be positively correlated with the performance of cognitive tests in general (Farmer et al., 1987; Ylikoski et al., 1998; Lee et al., 2004).

In regard of CN vs. MCI discrimination, both the TICS and TICSm showed comparable accuracy with the MMSE. The accuracy, however, was far from perfect (sensitivity/specificity: 69.3/68.6 for the TICS; 73.3/67.1 for the TICSm; and 64.0/72.9 for the MMSE). Even when considering only aMCI vs. CN discrimination, the accuracy of the TICS and TICSm was not improved. Researches on MCI screening abilities of the TICS or TICSm are limited. Cook et al. (2009) recently reported excellent discrimination of aMCI by the TICSm (AUC = 0.933; 82.4% sensitivity and 87.0% specificity). This much better MCI discrimination ability compared with our result is probably related to sample characteristics, educational level in particular. In the present study, educational levels of subjects showed very wide range (from 0 to 18 years) with relatively low mean (6.61 ± 4.59 years). In contrast, participants in the previous study (Cook et al., 2009) were all highly educated (mean = 16.14 ± 2.7 years). This difference in subjects' educational background probably explains in part the discrepancy of MCI discrimination accuracy between studies. When we additionally analyzed for a subgroup of elderly with higher educational level (i.e., more than 12 years of education), AUCs between CN and aMCI were much increased (AUC = 0.878, 95%CI = 0.751–1.000 for the TICS; AUC = 0.868, 95%CI = 0.738–0.997 for the TICSm). The homogeneity of MCI individuals could also be another contributing factor for the discrepancy. Cook et al. (2009) strictly excluded individuals with impairments in cognitive domains other than memory and as a result they included only single amnestic domain MCI, whereas our aMCI subgroup included not only single amnestic domain MCI, but also multiple domain amnestic MCI.

The TICSm did not show better MCI or dementia screening ability than the TICS, although a delayed verbal recall task is additionally included in it. As for dementia screening, this finding is in line with that of Welsh et al. (1993). As they pointed out, the TICS may already be sensitive enough to detect dementia without the delayed recall procedure (Welsh et al., 1993). In terms of MCI screening accuracy, however, this is the first report that directly compares the TICS and TICSm. No difference in MCI vs. CN, or even in aMCI vs. CN, discrimination ability between the TICS and TICSm is contrast with usual expectation, because delayed verbal recall tasks are known to be the most sensitive measures for the detection of MCI (Rabin et al., 2009) and early AD (Knopman and Ryberg, 1989; Chen et al., 2000). This unexpected result may partly be explained by a so-called floor effect of the delayed recall task item. For example, 122 participants, 53.0% of all the study subjects, i.e., CN 18 (25.7%), MCI 36 (48.0%), and dementia 68 (80.0%), had zero score for the item. In contrast, the delayed recall test (i.e., WLR) in the CERAD-NP did not show such effect: only 11.8% of participants had zero score for the WLR, and most of them were from dementia group, i.e., CN 0 (0.0%), MCI 3 (4.0%), and dementia 24 (28.6%). The 10-word list is presented only once in learning task of item 5 in the TICSm, which would make delayed recall procedure of item 13 more difficult, while similar 10-word list is presented three times in WLM of CERAD-NP. These differences probably result in prominent floor effect of the item 13 of the TICSm. In addition, it is more difficult to control examinee's attitude or attention and environment for the test in telephone interview-based cognitive test than in face-to-face test. This may also contribute to poor scores for the delayed verbal recall task in the TICSm.

We also investigated that MCI vs. dementia discrimination by the TICS and TICSm. Both instrument showed modest levels of discrimination accuracy (AUC = 0.846, 95%CI = 0.785–0.906 for the TICS; AUC = 0.850, 95%CI = 0.791–0.909 for the TICSm), which were comparable to that of the MMSE. In spite of the limitation of cross-sectional approach, these findings indirectly support the possibility that the TICS and TICSm can be used as a progression measure from MCI to dementia.

Although some previous studies (Brandt et al., 1988; Beeri et al., 2003; Dal Forno et al., 2006; Konagaya et al., 2007) reported reliabilities of the TICS and TICSm separately, no studies examined reliabilities of both instruments simultaneously for the same subjects. We observed that both the TICS and TICSm showed the same level of high internal consistency and test–retest reliability.

In conclusion, our findings obtained from Korean elderly people indicate that both the TICS and TICSm are reliable and as valid as the MMSE in regard of screening cognitively impaired elderly, especially dementia patients. In terms of the comparison between the TICSm and TICS, however, the TICSm has probably little advantage over the TICS for screening dementia and even MCI, although longer administration time and more efforts of both examiner and examinee are required.

Conflict of interest statement

None.

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