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Development of the Subjective Memory Complaints Questionnaire

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Key Words
Subjective memory complaints · Subjective memory complaints questionnaire · Reliability · Validity · Dementia

Abstract
Aim: We aimed to evaluate the psychometric properties of the Subjective Memory Complaints Questionnaire (SMCQ). ***Methods:*** The reliability of the SMCQ was evaluated by testing its internal consistency and test-retest reliability. Pearson correlation analyses were performed to assess the concurrent validity. Confirmatory factor analysis was used to evaluate the construct validity. Diagnostic ability for dementia was tested with receiver operator characteristic curve analyses. ***Results:*** Cronbach's α coefficient and intraclass correlation coefficients of the SMCQ were 0.864 and 0.828 ($p < 0.001$), respectively. The SMCQ scores were significantly correlated with the scores on Camdex Memory Complaint Questionnaire, Seoul Informant Report Questionnaire for Dementia and cognitive tests from the CERAD (Consortium to Establish a Registry for Alzheimer's Disease) neuropsychological test battery ($p < 0.01$). The results of confirmatory factor analyses confirmed that the SMCQ consisted of subjective memory complaints (SMC) for general memory and for everyday memory. The SMCQ score discriminated well between nondemented elderly without dementia and those with dementia ($p < 0.01$). The area under the curve value of the SMCQ was 0.84, indicating that it had high diagnostic ability. ***Conclusion:*** The SMCQ was found to be a brief, reliable and valid questionnaire for evaluating SMC. It might be useful for evaluating the cognition of elderly subjects when reliable informants are not available.

Introduction

Subjective memory complaints (SMC) [1, 2], also referred to as subjective memory loss or subjective memory impairment [3, 4], are very common in the elderly [5]. SMC has not been recommended as a screening test for dementia because dementia patients were reported to have poor insight into their cognitive impairment, even in the early stages [6, 7]. In addition, association of SMC with objective cognitive impairment has not been consistently replicated, especially in cross-sectional studies [2, 3, 8–12]. Moreover, many studies reported that SMC were more strongly associated with noncognitive variables, in-

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cluding depression, than with cognitive function. In spite of these, there are increasing evidences that it might be associated with the risk of dementia [13, 14] and subjects with SMC showed a smaller hippocampal volume and more extensive white matter hyperintensities than those without SMC [15–17]. This suggests that SMC may reflect cognitive decline due to structural brain changes.

In this situation, development of validated questionnaires for SMC is essential to activate SMC research. There are several measures of SMC with various levels of validation [18]. SMC has been assessed by a single question [19, 20] or by questionnaires [10, 11, 21–23]. There are suggestions that using more than 1 question to measure SMC is appropriate because elderly subjects do not view memory as a single entity [18]. Psychometric properties of many self-rated questionnaires for SMC – including the Camdex Memory Complaint Questionnaire (CMCQ) [11] and cognitive questions in the Geriatric Mental State Schedule [4], which were used in the previous studies – were not formally tested [18]. In addition, some of the metamemory scales, for which reliability and validity were established, were too long for general use [22, 23].

For this study, we developed the Subjective Memory Complaints Questionnaire (SMCQ), a brief self-rated questionnaire for SMC, and validated its psychometric properties, including reliability and validity, and its diagnostic ability in detecting dementia.

Subjects and Methods

Construction of the SMCQ

The SMCQ consists of 14 items reflecting various aspects of SMC, including metacognition of general and specific memories. A similar approach was used in the previous studies [24, 25]. An expert consensus panel that consisted of 5 neuropsychiatrists selected the items of the SMCQ from among 59 items used for assessing SMC in the previous studies [4, 10, 15, 21, 26]. Four items of the SMCQ (Do you think that you have a memory problem? Do you think that your memory is worse than 10 years ago? Do you think that your memory is poorer than that of other people of a similar age? Do you feel that your everyday life is difficult due to memory decline?) were designed to assess global memory function, and the other 10 items (Do you have difficulty in remembering a recent event? Do you have difficulty in remembering a conversation from a few days ago? Do you have difficulty in remembering an appointment made a few days ago? Do you have difficulty in recognizing familiar people? Do you have difficulty in remembering where you placed objects? Do you lose objects more often than you did previously? Have you become lost near your home? Do you have difficulty in remembering 2 or 3 items to buy when shopping? Do you have difficulty in remembering to turn off the gas or lights? Do you have difficulty in remembering the phone numbers of your own children?) were designed to assess everyday memory function.

To enhance the feasibility and reliability of each item in the elderly, the subject's responses to each question were restricted to either yes or no. The highest possible total score on the SMCQ is 14 points (SMCQ-T): 4 points for the judgment of global memory (SMCQ-G) and 10 points for everyday memory (SMCQ-E). Higher SMCQ scores are indicative of severer SMC.

Subjects

All of the subjects were community-dwelling Korean elderly aged 65 years and older. They were recruited from either the participants of the Korean Longitudinal Study for Health and Aging (KLoSHA) [27] or the volunteers for the Dementia Screening and Registry Program in Seongnam and Seoul. The KLoSHA is a population-based longitudinal study on health, aging and common geriatric diseases in Korean elderly aged 65 years and older, and it was conducted between September 2005 and September 2006 in Seongnam, the biggest satellite city of Seoul, Korea [27]. The subjects of the KLoSHA consist of 714 subjects who were randomly sampled and 272 subjects who volunteered. Among the 714 randomly sampled subjects, 692 subjects completed the SMCQ. The Dementia Screening and Registry Program subjects comprised 687 volunteers. In total, the study sample consisted of 692 randomly sampled subjects and 959 volunteers.

All of the subjects who participated in this study were fully informed regarding study participation, and informed consent was obtained from each subject or their legal guardians. The study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital.

Clinical and Neuropsychological Assessment

All of the subjects were subjected to a standardized clinical interview and physical/neurological examinations, which were administered by a neuropsychiatrist with advanced training in dementia research in accordance with the protocol of the Korean version of the CERAD (Consortium to Establish a Registry for Alzheimer's Disease) clinical assessment battery [28].

To examine the validity of the SMCQ, the CMCQ [10, 11], Seoul Informant Report Questionnaire for Dementia (SIRQD) [28], and standardized Korean version of the CERAD Neuropsychological Assessment Battery (CERAD-K-N) [29] were coadministered with the SMCQ. The CMCQ consists of 1 question for assessing global memory and 3 questions for assessing everyday memory. The SIRQD is an informant-reported questionnaire that consists of 15 questions assessing remote and recent memory, language, and activities of daily living functioning of the subject [28]. The CERAD-K-N includes a word list memory test, a word list recall test and a word list recognition test for verbal episodic memory, construction recall for visual memory, the verbal fluency test and the 15-item modified Boston Naming Test for semantic memory and language, the Mini-Mental State Examination (MMSE) for global cognition, and a constructional praxis test for constructional functions.

The Korean version of the Geriatric Depression Scale [30] was also administered for the evaluation of concomitant depressive symptoms.

The diagnoses of dementia and major psychiatric disorders and Clinical Dementia Rating (CDR) [31] were made by a panel of 4 neuropsychiatrists with expertise in dementia research. Two of

the neuropsychiatrists (K.W.K., D.Y.L.) were certified as CDR raters by the Memory and Aging Project of Alzheimer's Disease Research Center, Washington University School of Medicine. Diagnoses of dementia and major psychiatric disorders, including major depressive disorder, were made according to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria [32]. The subjects who were diagnosed as having major psychiatric disorders, including schizophrenia and major depressive disorder, were excluded.

Reliability

In order to evaluate the test-retest reliability of the SMCQ, the SMCQ was readministered to 20 subjects (78.1 ± 9.0 years old, men 13, women 7) 4 weeks after the initial assessment by the same rater, and the intraclass correlation coefficient between the SMCQ scores of the 2 assessments was calculated. The internal consistency of the SMCQ was examined by Cronbach's α and item total correlations.

Validity

To evaluate the concurrent validity of the SMCQ, Pearson correlation coefficients for the scores of the SMCQ and the scores of the CMCQ, the SIRQD, and the 8 neuropsychological tests from the CERAD-K-N were calculated. Partial correlation analyses were also performed to eliminate the influence of age, sex, education and depressive symptoms.

To evaluate the discriminant validity of the SMCQ, the mean SMCQ score of the cognitively normal elderly subjects without dementia was compared with that of dementia patients using ANOVA.

Confirmatory factor analysis was performed to determine whether the SMCQ consisted of global judgment factor and specific judgment factor as intended. Because the data violate the multivariate normality assumption (critical ratio = 28.78), Bollen-Stine bootstrapping was performed to calculate the χ^2 index (n = 2,000). Because the χ^2 index is very sensitive to small deviations from the null hypothesis, especially in large samples, overall model fitting was evaluated not only by the Bollen-Stine probability value, but also by the goodness-of-fit index (GFI), comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). Among these indices, values close to 1 for GFI, CFI and TLI, and below 0.5 for RMSEA are considered indicative of a good model.

To measure the diagnostic accuracy of the SMCQ for dementia, the area under the receiver operator characteristic (ROC) curves (AUC), the standard errors (SE) and the 95% confidence interval (95% CI) were calculated. The optimal cutoff scores satisfying both sensitivity and specificity for dementia were also determined. In addition, we compared the diagnostic accuracies of the SMCQ, SIRQD and MMSE for dementia by comparing their AUC. AUC were compared by calculating a critical ratio z proposed by Hanley and McNeil [13] in 1983. The z was defined as

$$z = \frac{A_1 - A_2}{\sqrt{SE_1^2 + SE_2^2 - 2rSE_1SE_2}}$$

where A_1 and SE_1 refer to the observed AUC and estimated standard error of the AUC associated with test 1, A_2 and SE_2 refer to the observed AUC and estimated standard error of the AUC associated with test 2, and r refers to the estimated correlation coefficient between A_1 and A_2. Note that z follows the standard normal distribution. The same analyses were separately performed for voluntary and random samples.

All statistical analyses were carried out using SPSS 15.0 and AMOS 4.0.

Table 1. Demographic and clinical characteristics of the subjects

	Whole sample	Random sample	Volunteer sample
Subjects	1,651	692 (41.9)	959 (58.1)
Age, years	74.3 ± 8.2	71.7 ± 5.3	76.3 ± 9.3*
Women	945 (57.3)	397 (57.4)	486 (50.7)**
Education, years	6.3 ± 5.4	7.8 ± 5.7	6.2 ± 5.1*
Cognitive function tests, scores			
Geriatric depression scale	12.3 ± 7.5	11.6 ± 7.4	12.9 ± 7.5*
SMCQ			
Global	2.1 ± 1.3	1.9 ± 1.2	2.2 ± 1.3*
Everyday	2.9 ± 2.8	2.5 ± 2.6	3.2 ± 2.8*
Total	5.0 ± 3.7	4.4 ± 3.6	5.4 ± 3.8*
CMCQ	1.2 ± 1.1	1.1 ± 1.0	1.3 ± 1.1*
SIRQD (n = 962)	10.7 ± 8.6	8.5 ± 7.4	14.4 ± 9.0*
Word list memory test	14.1 ± 5.5	15.5 ± 4.5	13.5 ± 5.9*
Word list recall test	4.6 ± 2.4	5.2 ± 2.2	4.2 ± 2.5*
Word list recognition test	8.1 ± 2.5	8.5 ± 1.9	7.7 ± 2.8*
Verbal fluency test	12.7 ± 4.5	13.8 ± 4.2	11.9 ± 4.5*
mBNT	9.4 ± 3.3	10.2 ± 3.1	8.7 ± 3.3*
MMSE	22.9 ± 5.1	23.9 ± 4.3	22.1 ± 5.1*
Praxis	9.0 ± 2.1	9.4 ± 2.0	8.5 ± 2.3*
Praxis recall	5.1 ± 3.4	5.9 ± 3.3	4.5 ± 3.4*
Dementia	187 (11.3)	34 (4.9)	153 (16.0)**

Figures in parentheses are percentages. mBNT = 15-Item modified Boston Naming Test. * $p < 0.01$ vs. random sample (independent t test); ** $p < 0.01$ vs. random sample (χ^2 test).

Results

Subjects

A total of 1,651 subjects completed the present study: 692 (41.9%) were from the random sample, and the other 959 (58.1%) were from the volunteer sample. Among them, 187 (11.3%) subjects were diagnosed with dementia (Alzheimer's disease, 134; vascular dementia, 39; other dementia, 14). Among the patients with dementia, 73 were very mild (CDR = 0.5), 79 were mild (CDR = 1), 30 were moderate (CDR = 2) and 4 were severe (CDR = 3). The demographic and clinical characteristics of the subjects are summarized in table 1.

Reliability

The internal consistency of the SMCQ was very high. Cronbach's α coefficient for the SMCQ was 0.864, and those for the SMCQ-G and SMCQ-E were 0.694 and

Table 2. Concurrent validity of the SMCQ

	SMCQ-T	SMCQ-G	SMCQ-E
CMCQ	0.827	0.706	0.799
SIRQD	0.535	0.454	0.540
Geriatric Depression Scale	0.494	0.473	0.427
Cognitive function tests			
Word list memory test	–0.289	–0.178	–0.303
Word list delayed recall test	–0.296	–0.184	–0.317
Word list recognition test	–0.256	–0.147	–0.275
Verbal fluency test	–0.273	–0.177	–0.283
15-Item Boston Naming Test	–0.251	–0.158	–0.263
MMSE	–0.315	–0.176	–0.340
Praxis	–0.245	–0.139	–0.265
Praxis recall	–0.256	–0.154	–0.273

All correlation coefficients were statistically significant (Pearson correlation analysis, $p < 0.01$).

Table 3. Comparison of the SMCQ scores between dementia patients and nondemented normal elderly subjects

	Nondemented	Demented
Subjects	1,464	187
Age, years	73.7 ± 7.9	78.3 ± 9.1[a]
Women	820 (56)	125 (67.7)[b]
Education, years	7.0 ± 5.4	5.8 ± 5.5[a]
Geriatric Depression Scale	12.0 ± 7.4	14.9 ± 7.4[a]
SMCQ[c]		
Global	1.9 ± 1.2	2.9 ± 1.2
Everyday	2.6 ± 2.6	5.4 ± 2.9
Total	4.6 ± 3.5	8.2 ± 3.8

Figures in parentheses are percentages.
[a] $p < 0.01$ (independent t test); [b] $p < 0.01$ (χ^2 test); [c] $p < 0.01$ (ANCOVA, using age, sex, education and depression scale score as covariates).

0.827, respectively. The item total correlations ranged from 0.375 to 0.708, and all correlations were statistically significant ($p < 0.01$). The test-retest reliability of the SMCQ, SMCQ-G, and SMCQ-E were 0.828 ($p < 0.001$), 0.471 ($p = 0.03$) and 0.836 ($p < 0.001$), respectively.

Validity

The SMCQ scores were significantly correlated with the scores of the CMCQ, the SIRQD and the 8 neuropsychological tests ($p < 0.01$), indicating that the SMCQ had a high concurrent validity (table 2). The correlations between the SMCQ and these measures remained statistically significant when the random sample and the voluntary sample were analyzed separately ($p < 0.01$). All correlation coefficients, except for praxis function, were significant after adjusting for the effects of age, sex, education and depressive symptoms ($p < 0.05$). The SMCQ-T, SMCQ-G and SMCQ-E scores were all significantly higher in the dementia patients than in the elderly subjects without dementia after adjustment for the influence of age, sex, education and depressive symptoms ($F = 55.4$, d.f. = 1,645, $p < 0.001$), indicating that the SMCQ had discriminant properties for dementia (table 3).

As shown in figure 1, the SMCQ consists of 2 parts: 1 for the global assessment of memory function and 1 for the specific assessment of memory function. As expected, the 4 items included in the SMCQ-G comprised the global assessment, and the other 10 items included in the SMCQ-E comprised the specific assessment. Although the Bollen-Stine p value was statistically significant ($\chi^2 = 446.4$, d.f. = 76, $p < 0.001$), the other GFI, TLI, CFI and RMSEA indices for model-fitting were 0.961, 0.929, 0.940 and 0.54 (range 0.049–0.059), respectively, indicating a good model. The results remained unchanged when the analyses were performed separately for the random and volunteer samples.

As shown in table 4, the optimal cutoff scores for dementia on the SMCQ, SIRQD, and MMSE were found to be 5/6, 10/11 and 18/19, respectively, and 77.0%, 88.6% and 89% of the diagnoses were predicted correctly, respectively. The AUC of the SMCQ was smaller than that of the SIRQD ($z = 6.01$, $p < 0.05$) and MMSE ($z = 4.55$, $p < 0.05$), indicating that the overall diagnostic accuracy of the SMCQ for dementia was lower than that of the SIRQD and the MMSE. When analyses were confined to early stages of dementia, the results were essentially the same. When the analyses were performed separately for the voluntary and random samples, the AUC of the SMCQ was comparable to that of the SIRQD and MMSE in the random sample ($z = 0.75$, $p = 0.22$ for MMSE vs. SMCQ; $z = 0.55$, $p = 0.29$ for SIRQD vs. SMCQ). However, the AUC of the SMCQ was smaller than that of the SIRQD and MMSE in the voluntary sample ($z = 4.75$, $p < 0.05$ for MMSE vs. SMCQ; $z = 5.14$, $p < 0.05$ for SIRQD vs. SMCQ).

Discussion

In the present study, the SMCQ was found to be a reliable and valid instrument for evaluating SMC in the elderly. Elderly people are not accustomed to reporting

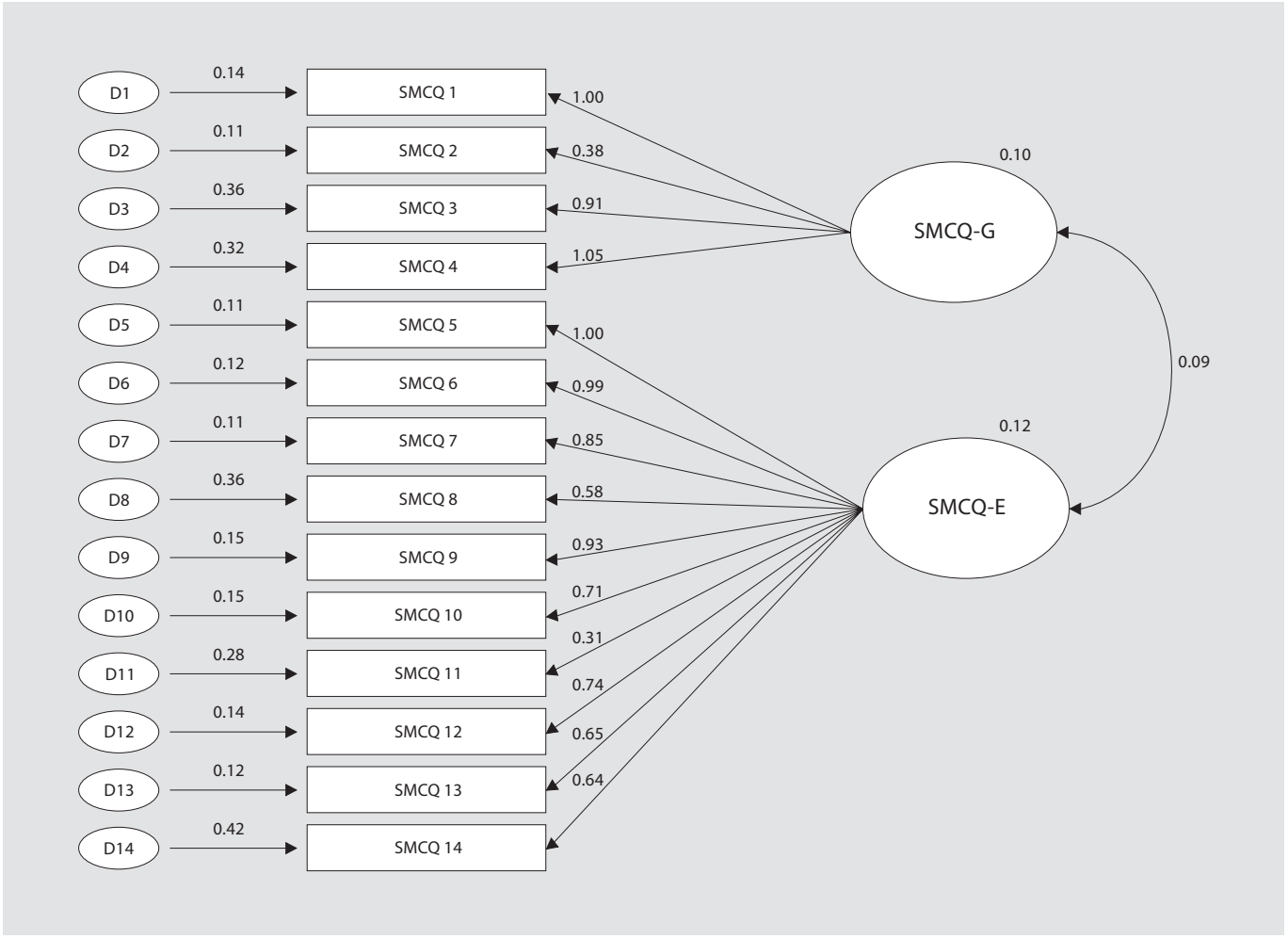

Fig. 1. Confirmatory factor analysis of the SMCQ. D = Dementia.

their memory problems to clinicians, since they usually regard their forgetfulness as a normal part of aging [33]. Thus, methods for eliciting and assessing SMC in the older adults are important. Because the SMCQ consists of various questions that clinicians commonly ask to detect dementia, it is more natural than objective cognitive testing. It is brief enough to use in both clinical and research settings when memory decline is suspected.

In this study, the diagnostic accuracy of the SMCQ for dementia was fairly high and comparable to another study [34], although it was still lower than that of the SIRQD and the MMSE. Since dementia patients were reported to have poor insight into their cognitive impairment even in the early stages [6, 7], self-rating questionnaires have been used far less than informant-based questionnaires in dementia screening [35]. However, several studies suggested that awareness of deficit may vary greatly across individuals [34], and metamemory function is maintained in the early stages of AD [36, 37]. In the previous studies, self-assessment questionnaires for physical and psychological symptoms were administrated to mild to moderate dementia patients [38, 39]. In addition, a recent study reported that self-rated questionnaires could differentiate nondemented from demented individuals, especially when of mild severity [34]. While informant interviews are still more favorable, informants are not always available, especially in community settings, and their judgments may be insensitive to early changes and biased. Thus, the results of this study suggest that the SMCQ can provide useful information on patients' cognitive function when reliable informants are not available. An interesting finding of this study is that

Table 4. ROC analyses of the MMSE, SIRQD and SMCQ for dementia

	Cutoff[1]	Sensitivity	Specificity	AUC		
				AUC	SE	95% CI
Whole sample (normal elderly = 1,464, dementia patients = 187)						
MMSE	18/19	0.879	0.721	0.890	0.012	0.867–0.914
SIRQD	11/12	0.883	0.695	0.886	0.020	0.863–0.910
SMCQ	5/6	0.749	0.686	0.770*	0.020	0.732–0.807
CDR <2 (normal elderly = 1,464, dementia patients = 152)						
MMSE	19/20	0.859	0.721	0.873	0.014	0.847–0.900
SIRQD	11/12	0.855	0.696	0.868	0.014	0.841–0.894
SMCQ	5/6	0.719	0.686	0.755*	0.020	0.714–0.796
Random sample (normal elderly = 586, dementia patients = 33)						
MMSE	18/19	0.923	0.637	0.891	0.024	0.840–0.943
SIRQD	9/10	0.909	0.654	0.872	0.028	0.816–0.927
SMCQ	5/6	0.909	0.696	0.857	0.030	0.797–0.917
Voluntary sample (normal elderly = 226, dementia patients = 146)						
MMSE	17/18	0.788	0.692	0.824	0.021	0.783–0.866
SIRQD	11/12	0.870	0.668	0.850	0.020	0.812–0.888
SMCQ	5/6	0.712	0.659	0.730*	0.036	0.679–0.782

* $p < 0.05$, compared to the AUC of MMSE and SIRQD.
[1] Optimal cutoff scores for dementia by ROC analyses.

diagnostic accuracy of the SMCQ for dementia was comparable to that of the SIRQD and the MMSE in the randomly selected community-dwelling elderly subjects. Although the exact causes were unclear, the results of this study indicate that the association between SMC and objective cognitive impairment might be demonstrated differently according to the source of the sample. Clinical characteristics of the random sample included less depressive symptoms, less cognitive complaints and higher cognitive function than the volunteer sample, and this could have affected the results. Because of small sample of dementia subjects, this result awaits replication.

In the present study, the SMCQ scores showed significant correlations with the objective cognitive tests from the CERAD-K-N, indicating that SMC may reflect objective cognitive impairment. However, the association between SMC and objective cognitive impairment has not been consistently replicated in previous studies [2, 3, 8–12]. Although many methodological factors could affect these conflicting results, the method for ascertaining the presence of SMC should be discussed in relation to our results. In many earlier studies that were unable to demonstrate an association between SMC and objective cognitive impairment, SMC was assessed by a single question [9, 10, 19, 20]. Because elderly subjects do not view memory as a single entity, the use of more than 1 question to measure SMC has been proposed [18]. Moreover, recent studies suggested that the association between SMC and objective cognitive impairment varies according to the questions used for ascertaining SMC [25, 40]. Questions reflecting general beliefs about memory function showed lower correlations with objective cognitive testing than questions reflecting specific events [41]. In this study, the objective cognitive function was more strongly correlated with the SMCQ-E than the SMCQ-G. Dissociation of global judgment of memory function and specific judgment of memories of particular events were frequently observed in neurological disorders [36], which may be attributable to the differential demands on various aspects of metamemory constructs. Therefore, we recommended that questions for assessing specific judgment of memory function should be included when investigating the relationship between SMC and cognitive function.

Several noncognitive variables, such as depression and personality, may confound the association between SMC and objective cognitive impairment. SMC was more strongly associated with depressive symptoms than with cognitive impairment in most previous studies [18]. In this study, the association of the SMCQ scores with the scores of cognitive tests was weak, although it remained significant after adjusting for Geriatric Depression Scale scores. In spite of our effort to exclude major depressive

disorders, subsyndromal depression (including minor depressive disorder, which is the most prevalent type of depression in the elderly) might affect the results [42].

In conclusion, the SMCQ is a reliable and valid instrument for evaluating SMC, and may be also useful for screening dementia in community-dwelling elderly when reliable informants are not available.

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