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Development of the subjective cognitive function decline scale for middle-aged Koreans

YongJoon So^a, Jinsun Hahm^b, Sei-Young Lee^c, Jung-Ha Kim^{d*} and Kwangsu Moon^{a*}

^aDepartment of Psychology, Chung-Ang University, Seoul, Republic of Korea; ^bBrain-Cognitive Health Center, Dr Shin's Neurology Clinic, Wonju, Republic of Korea; ^cDepartment of Otorhinolaryngology-Head and Neck Surgery, Chung-Ang University College of Medicine, Seoul, Republic of Korea; ^dDepartment of Family Medicine, Chung-Ang University College of Medicine, Seoul, Republic of Korea

ABSTRACT

Objectives: This study developed the Subjective Cognitive Function Decline Scale for Middle-aged South Koreans (SCFD-K), addressing the need for early detection of potential mild cognitive impairment. This study fills a gap in the existing research, which mainly targeted older demographics or generalized cultural differences.

Method: We conducted focus group interviews (FGIs) among 36 participants and with nine experts to answer basic questions related to cognitive decline, after which we developed a draft scale using the Delphi with another 15 experts. To examine the reliability and validity of the scale, an online survey of 2,000 people was conducted.

Results: An exploratory factor analysis identified four distinct factors, which are language, visuospatial function, personality/emotion, and memory, with a total of 20 items (Cumulative variance ratio = 57.76), and a confirmatory factor analysis validated the four-factor structure with a good model fit (CFI = 0.932, TLI = 0.921, RMSEA = 0.057, and SRMR = 0.042) and acceptable internal consistency (Cronbach's α = 0.735–0.907).

Conclusion: This analysis established the SCFD-K as a reliable and valid tool for assessing cognitive decline among middle-aged South Koreans. The findings have key cultural implications and inform proactive interventions and shaping future healthcare strategies in South Korea.

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Cognition; subjective cognitive decline; middle-aged; dementia; questionnaire

Introduction

Subjective cognitive decline (SCD) is defined as a self-perceived decline in cognitive capacity compared to a previous state involving the cognitive domains of processing speed, executive function, memory, and visuospatial abilities (Jessen et al., 2014, 2020). Approximately 10–20% of adults aged 45–65 years report cognitive problems, and the prevalence of SCD increases with age (Centers for Disease Control and Prevention, 2019; Taylor et al., 2018; van Harten et al., 2018). Clinicians are faced with an increasing number of individuals who seek medical help with a subjective decline in cognitive function.

SCD reflects a state of cognitive decline from the perspective of the individual, the observation of such a decline by others is not required. According to trajectories of SCD and objective cognitive function over time, SCD is a broad condition that develops differently over time because of the variety of potential underlying causes (Jessen et al., 2020). In the case of reversible SCD, SCD occurs but remits fully, and objective cognitive functions remain stable. Conditions underlying SCD include depression, side-effects from medication, or intermittent sleep disturbances. In the non-reversible stage of SCD, SCD occurs and continues without remitting; however, objective cognitive functions remain largely stable. The normal aging process can be an underlying cause of this type of SCD. Regarding SCD with subsequent progressive cognitive decline to impairment, SCD occurs and objective cognitive functions subsequently

deteriorate to dementia. This deterioration can be caused by neurodegenerative disease, including, but not limited to, Alzheimer's disease. The proportion of individuals in each of the three SCD trajectories is yet to be fully delineated. However, most individuals with SCD do not decline to dementia. Even though SCD is not related to progressive cognitive deterioration in most individuals, SCD could be an early indicator of future cognitive decline for some individuals (Slot et al., 2019).

A large cohort study found that memory complaints occurred approximately 16 years before dementia diagnosis (Verlinden et al., 2016). Compared with those without SCD, older adults with SCD are 2.3 times as likely to develop dementia and mild cognitive impairment (MCI; Mitchell, 2008).

SCD has also been linked to mental health issues including depression and anxiety (Ahn et al., 2021; Wang et al., 2021). SCD has been associated with several negative consequences, such as to anxiety, anger, increased stress, worrying and fear of dementia (Jenkins et al., 2021; Metternich et al., 2010; Wang et al., 2021). Among individuals younger than 60 years of age, the likelihood of a medical condition causing future cognitive decline and dementia is low, which suggests that the likelihood of SCD among them being related to other or potentially reversible causes (e.g. depression) is higher than aged 60 years or older (Jessen et al., 2014).

The World Health Organization (WHO) estimates that the number of people aged 60 years or older worldwide will increase to 1.4 billion by 2030 and 2.1 billion by 2050 (WHO, 2023). The

CONTACT Jung-Ha Kim  girpower219@cau.ac.kr  Department of Family Medicine, Chung-Ang University Medical Center, Chung-Ang University College of Medicine, 102 Heuksukro, Dongjak-gu, Seoul 06973, Republic of Korea; Kwangsu Moon  ksmoon@cau.ac.kr  Department of Psychology, Chung-Ang University, 84 Heuksukro, Dongjak-gu, Seoul 06974, Republic of Korea

*These authors contributed equally to this work.

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Republic of Korea became an aged society in 2018, with an older population ratio (the percentage of the total population aged ≥ 65 years) of 14.3%. This is a fast transition from an aging society (in 2000) to an aged society (in 2018). If the trend continues, the proportion is expected to exceed 20% by 2025, making South Korea a super-aged society (Statistics Korea, 2020). Neurodegenerative diseases are characterized by a progressive deterioration of brain function, with a significantly consequent decrease in the quality of life of patients and their families (Batista & Pereira, 2016).

In South Korea, the number of people living with MCI was 290,313 (aged ≥ 65 years) and 52,880 (aged < 65 years). In 2022, the estimated prevalence of dementia and MCI among older South Korean adults was 10.33% and 22.73%, respectively. The estimated number of people aged 65 years and older with dementia is growing at a rate of 50,000 per year from 2019 to 2021 (Ministry of Health and Welfare, 2022). Recently, the incidence of the disease has also been increasing among middle-aged people under 50 years. Therefore, the increasing prevalence of SCD among middle-aged adults is becoming an important public health concern in South Korea.

SCD among middle-aged people under 60 years of age occurs for different reasons than among older people. Therefore, early detection and appropriate intervention can help them live an active later life. Additionally, it has the preventative effect of minimizing productivity loss among middle-aged and older adults and reducing future dementia care costs.

The WHO has recently redefined the concept of 'active aging' as the process of optimizing opportunities for health, participation, and security to enhance the quality of life as people age (WHO, 2002), emphasizing that the promotion of healthy lifestyles must be started at an early age. Moreover, according to the lifespan perspective, life in old age is the culmination of life in youth. The best way to ensure that we live a healthy life in later years is to continue our efforts to slow down and prevent age-related decline as much as possible before we reach old age. It has been suggested that it is important to explore successful aging, particularly in relation to cognitive function (Whitbourne & Whitbourne 2020).

SCD is determined using a personal and introspective measure (Moret-Tatay et al. 2023). Many of the existing SCD measures have been developed focusing on elderly populations and the detection of MCI or Dementia (Farias et al., 2021; Gifford et al., 2015; Rami et al., 2014; van Harten et al., 2018). Specifically, the Everyday Cognition (ECog) for assessing symptoms that may point at progression to MCI or dementia (Farias et al., 2021); the Informant-Report Scale on Cognitive-Linguistic Abilities of the Elderly (ISCOLE) for the evaluation of changes in cognitive and language abilities with aging among older adults from the informant's perspective (Lee, 2016); the Everyday Memory Questionnaire (EMQ) for measuring how often difficulties arise in performing everyday memory tasks (Royle & Lincoln, 2008); Cognitive Failure Questionnaire (CFQ) for assessing the frequency of cognitive errors in daily life for adults (Broadbent et al., 1982); and the Cognitive Function at Work Questionnaire (CFWQ) for assessing SCD across a range of cognitive domains among middle-aged and older adults at work (Heikkinen et al., 2023).

However, there are limitations in generalizing the existing scales to the Korean middle-aged population. First, despite SCD with aging manifesting in a variety of cognitive domains, existing scales focus on memory or differentiate MCI and AD among

older populations. Second, most previous scales are not specifically fitted for SCD among middle-aged adults. Cognitive demands of daily life are typically different for elderly than for younger people who are active in workplace or outside. Hence, to capture the early symptoms, a questionnaire should tap into everyday situations that are cognitively demanding and relevant for the middle-aged people being assessed. Finally, culture can influence how dementia is perceived. Thus, these perceptions are often influential in terms of responses to symptoms such as SCD (Cox, 2007). The conceptualization of the cognitive, behavioural, and emotional dimensions of dementia differs in each culture (Calia et al., 2019). Therefore, a better understanding of the social construction of dementia, as well as MCI and SCD, can improve public health approaches to rehabilitation and care (Bosco et al., 2019).

SCD is a broad condition that develops differently over time as a result of the variety of potential underlying causes. However, if it worsens, it can progress to MCI and then dementia, making it impossible to live independently. Thus, it is crucial to maintain cognitive function through active interventions during the reversible stage (Lina & Chan, 2020). Early and accurate detection of SCD among middle-aged adults and the identification of underlying conditions or causes affecting SCD are critical to planning treatment and appropriate intervention.

Therefore, we aim to develop a new reliable and cost-effective scale for screening adults with SCD in the middle-aged South Korean population (aged 45–64 years) who are pre-entering old age.

Materials and methods

Research design

The research design was organized in the following order: literature review, FGI, Delphi, and survey to develop the Subjective Cognitive Function Decline Scale for Middle-aged South Koreans (SCFD-K). The Institutional Review Board of Chung-Ang University Hospital, South Korea (no. 1041078-20230930-HR-274) approved the FGIs, Delphi, and surveys.

As most existing scales are targeted at the elderly or focus on specific cognitive functions, it was necessary to compare the items derived from the literature review with the FGI responses. The diverse FGI groups were used to elicit experiences or phenomena of cognitive decline based on different perspectives (Krueger, & Casey, 2014). The FGI participants comprised a normal group, a group with cognitive complaints, and health centre professionals who frequently counsel and treat middle-aged people. Draft scales derived from the literature review and FGIs were re-selected using the Delphi survey method. It is a useful technique for determining measurement items and systematically collecting and synthesizing the opinions of experts in a field to build consensus (Jorm, 2015). After Delphi, reliability and validity were verified through a nationwide survey of 2,000 participants.

Developing the preliminary questionnaire for the SCFD-K

Focus group interviews

Two rounds of FGIs were conducted. The first included 36 non-patients (12 each in their 40s, 50s, and 60s) who had never been diagnosed with a cognitive function-related illness. Each

age group was divided into a normal group (six participants) and a cognitive function complaint group (six participants) according to the pre-test results of the Prescreening Korean Dementia Screening Questionnaires (KDSQ-P; cut-off score = 3; Jeon et al., 2010). The FGI participants were recruited online by GLOBAL RESEARCH GROUP (<https://www.globalri.co.kr/main/index.php>), a firm that specialises in survey research and the FGIs were conducted by an expert in facilitation. Participants were asked about their various experiences with cognitive decline (i.e. the phenomenon). The main questions were divided into six domains: memory, language, attention/calculation, space–time, understanding, and others. Example question was ‘What experiences lead to the perception of memory loss?’

The second round was conducted with nine nurses and exercise therapists from public health centres who frequently interacted with middle-aged people. They were asked about the various types of cognitive decline observed among middle-aged people visiting health centres. Examples question was ‘Which areas of cognitive decline (memory, calculation, visuospatial function, language, etc.) are of most concern to those who visit the health centre and what are the specific symptoms?’ Other questions were the same as those used with the general population.

Preliminary questions were developed by analysing and categorizing cognitive decline identified through the FGIs. After that, all five authors independently assigned each sentence to the most appropriate domain (memory, language, attention/calculation, visuospatial, comprehension, and others), sentences with three or more agreements (60%) were selected for the questionnaire, and questions with similar content across the selected questions were consolidated. The items were divided into five domains (50 items): memory (12 items), language (9 items), attention/calculation (10 items), visuospatial function (10 items), and personality/emotional change (9 items).

Delphi method

A Delphi method was used with 15 relevant experts, including professors, doctors, clinical psychologists, and health psychologists working in medical institutions, universities, and related counselling and treatment centres. The Delphi was conducted in two rounds, with the same experts asked to rate and respond *via* email. In the first round, 50 preliminary items were rated on a five (1–5)-point scale in terms of appropriateness and importance. We also asked additional questions and sought clarifying comments.

For each item in the second Delphi survey, we provided the results of the first Delphi analysis (mean, standard deviation, median, range, additional comments, and content validity ratio [CVR]) so that they could compare their responses with those of the entire panel. We asked participants to rate the appropriateness and importance of each item on a five-point Likert scale after reviewing the initial Delphi results. Preliminary questions were selected based on the results of the second Delphi method. The selection criteria utilized the CVR of appropriateness and importance, with items that met the CVR criteria for both appropriateness and importance being selected first and items that met the CVR criteria for either importance or appropriateness being selected second. The CVR is considered content valid if it is above the minimum value, depending on the number of panels (Ayre & Scally, 2014). In this study, the CVR threshold was 0.49 when 15 experts participated. Finally, 30 items were selected and evenly distributed: six items for each of the five domains.

Developing the final SCFD-K

Participants

A nationally representative survey firm conducted an online survey of 2,000 adult men and women aged 45–64 years through a specialised online research company (MACROMILL EMBRAIN, <https://www.embrain.com/>). Consent was obtained for voluntary participation, and compensation was provided by the company to participants. All cities and provinces in the country were included, and the gender ratio of participants was equal at 50%, with 500 participants (25%) aged 45–49 years, 1,000 (50%) aged 50–59 years, and 500 (25%) aged 60–64 years. The reason for this sampling was that 49.8% of South Koreans are male, 15.46% are in their 40s, 16.62% are in their 50s, and 14.57% are in their 60s, which is similar by gender and generation (Korea Statistical Information Service, 2023).

An additional 30 participants aged 45–64 years were recruited to examine the reliability of the test-retest. However, six participants did not respond to the second questionnaire, and thus, the final 24 participants’ data were analysed.

Measurement

To measure SCD, 30 preliminary items were used, and the frequency of experiencing each item was measured on a four-point Likert scale (0: less than once a month, 1: 1–2 times a month, 2: 1–2 times a week, 3: 3–4 times a week). Two of the most popular tests for the initial screening for dementia in Korea, with established reliability and validity, were used to validate the SCFD-K score. The KDSQ-P (Jeon et al., 2010) comprises five items measured by three-point Likert scale (never–sometimes–often). The KDSQ-P is a cognitive function screening questionnaire included in the National Health Insurance Service general check-up for people aged 66 years and older. The ISCOLE (Lee, 2016) uses 16 items measured by four-point Likert scale (*not at all* to *very much*). The ISCOLE measures cognitive decline that occurs with aging and comprises several difficulties that can arise in everyday life. The scale comprises nine different cognitive and language domains. Four domains (attention, memory, language, and problem solving) were selected for validation and each item modified as a self-reported questionnaire to make it more suitable for use among middle-aged people.

Mental health-related variables were measured, including depression, with two items from the Patient Health Questionnaire-2 (Kroenke et al., 2003; four-point scale, *never* to *almost every day*); anxiety, with three items from the Hamilton Anxiety Scale (Hamilton, 1959; four-point scale, *almost never* to *very often*); stress, with three items from the Perceived Stress Scale (Reis et al., 2010; five-point scale, *never* to *very often*); and psychological well-being, with three items from the WHO-Quality of Life-Brief (WHOQOL Group, 1998; five-point scale, *not at all* to *very often*). Demographic variables such as gender, age, occupation, and education were also measured.

Data analyses

Statistical analyses were conducted using SPSS 26.0 and AMOS 26.0 (IBM, Armonk, NY, USA): frequency analyses to identify demographic characteristics; exploratory factor analyses (EFA) to analyse the factor structure; confirmatory factor analyses (CFA) to determine the model fit of the derived factor structure; correlation analyses between the SCFD-K, KDSQ-P, and ISCOLE to verify criterion validity; another correlation analysis between the SCFD-K,

depression, anxiety, stress, and psychological well-being to examine convergent validity; and *t*-tests and analyses of variance (ANOVAs) to determine whether there were statistical differences in SCFD-K scores based on demographic characteristics.

Results

Demographic characteristics

Of the 2,000 total respondents, the number of women and men was equal at 1,000 each, and the average age was 53.97 ± 5.6 years (men: 53.95 ± 5.6 , women: 53.99 ± 5.6). Educational levels ranged from less than a middle school graduate (0.9%) to a high school graduate (21.2%), college degree (66.3%), and graduate degree or higher (11.8%). Additionally, 1,561 (78.1%) of the participants were married and 1,400 (70%) were employed.

Normality test

To check the normality of the data collected from the survey items, skewness, and kurtosis were calculated. Normality was determined to be satisfied when the skewness of each scale did not exceed two, and kurtosis did not exceed seven (West et al., 1995). Of the 30 preliminary items, the items 'Sometimes I do not get enough money or change for things' (skewness 2.875, kurtosis 9.634) and 'Sometimes I cannot get to my destination by myself using transportation' (skewness 3.257, kurtosis 13.102) did not meet the criteria and were excluded before EFA. The inter-item and item-total score correlations of the 28 items were analysed, and all correlation coefficients were above 0.30, so they were not removed.

Exploratory factor analysis

Of the 2,000 respondents, 1,000 were randomly selected for EFA, and the remaining 1,000 were used for CFA. Normally, the data would have to be collected at different times for EFA and CFA; however, because collecting such a large amount of data across the country from the same survey company might include the same people, we collected it all at once and analysed half of it randomly. The Kaiser–Meyer–Olkin (KMO) test showed that the KMO index was 0.952, which met the criteria set forth by Kaiser (1974). The Bartlett test of sphericity, which verifies the significance of the correlation matrix, was significant ($\chi^2(378) = 11737.222, p < 0.001$).

EFA was performed using principal axis factor extraction and equimax rotation. A screening test was conducted on the extracted factors. Four factors met the Kaiser criterion (eigenvalues > 1.0). Items were selected if they had a factor loading value of 0.4 or higher for one factor and a cross-factor loading value of 0.3 or higher for the other, which hindered factor discrimination (Tabachnick & Fidell, 2001). Consequently, eight of the 28 preliminary items were eliminated, and the final 20 items were extracted (Appendix A).

Factors 1, 2, 3 and 4 are named Visuospatial, Language, Personality/emotion, and Memory, respectively (Table 1). The internal consistency of the identified factors was sufficient: language (Cronbach's $\alpha = 0.846$), visuospatial ($\alpha = 0.834$), personality/emotion ($\alpha = 0.802$), and memory ($\alpha = 0.735$). Additionally, Cronbach's α of the 20 items altogether was 0.909.

Confirmatory factor analysis

A CFA using the Maximum Likelihood method was conducted with 20 questions, and the model fits of two structural models

Table 1. Exploratory factor analysis of SCFD-K preliminary questions ($n = 1,000$).

SCFD-K	Visuospatial	Language	Personality/emotion	Memory
Visuospatial 2	0.690	0.128	0.162	0.233
Visuospatial 5	0.675	0.184	0.185	0.151
Visuospatial 6	0.632	0.254	0.178	0.148
Visuospatial 3	0.615	0.114	0.146	0.198
Visuospatial 1	0.605	0.221	0.203	0.171
Language 2	0.194	0.671	0.194	0.287
Language 6	0.217	0.656	0.255	0.178
Language 3	0.220	0.609	0.158	0.316
Language 5	0.190	0.584	0.228	0.193
Language 4	0.144	0.562	0.261	0.250
Personality/emotion 4	0.138	0.243	0.692	0.122
Personality/emotion 5	0.157	0.189	0.636	0.094
Personality/emotion 1	0.238	0.161	0.599	0.259
Personality/emotion 6	0.142	0.128	0.583	0.216
Personality/emotion 2	0.224	0.316	0.443	0.234
Memory 4	0.123	0.224	0.134	0.696
Memory 3	0.163	0.152	0.154	0.614
Memory 6	0.232	0.237	0.160	0.442
Memory 5	0.181	0.296	0.262	0.410
Memory 1	0.155	0.143	0.138	0.380
Eigenvalues	7.420	1.586	1.381	1.164
Variance ratio	37.10	7.93	6.91	5.82
Cumulative variance ratio	37.10	45.03	51.93	57.76

Note: SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans.

(one- and four-factor) were compared with the chi-square value and the comparative fit index (CFI), Tucker–Lewis Index (TLI), root mean square error approximation (RMSEA), and standardized root mean residual (SRMR). In general, chi-square is sensitive to sample size and tends to overestimate, so other additional metrics were considered. CFI and TLI values are considered good if they are above 0.90 and RMSEA and SRMR are below 0.05 (Bentler, 1990).

The four-factor model showed better indices ($\chi^2(174) = 700.400, p < 0.001$, CMIN/DF = 4.271, CFI = 0.932, TLI = 0.921, RMSEA = 0.057, and SRMR = 0.042) than the one-factor model (Appendix B). The factor loading of all paths for each question ranged from 0.50 to 0.79, and the correlation coefficients among 4 factors ranged from 0.58 (between visuospatial and personality/emotion) to 0.74 (between language and memory).

In addition, a secondary factor analysis was conducted to confirm the appropriateness of using the total score as a criterion. A one plus four factor model was tested to determine whether a secondary factorial structure was supported. The result also shows acceptable indices ($\chi^2(166) = 702.533, p < 0.001$, GFI = 0.929, CFI = 0.932, TLI = 0.922, RMSEA = 0.057 and SRMR = 0.017), and thus, in addition to the four factors, we used a total score to determine the cut-off criteria score.

Reliability

To check the reliability of the final selected items using CFA, the internal consistency (Cronbach's α) was the same. In addition, the test–retest reliability was stable at 0.93 ($p < 0.001$), with an additional 24 recruited middle-aged adults administered 2–3 week apart. Test–retest reliability values were 0.81 for language, 0.87 for visuospatial, 0.90 for personality/emotion, and 0.86 for memory.

Validity

To verify the construct validity of the SCFD-K, correlational analyses were conducted to examine the relationships between the sub-factors. Significant positive correlations existed between the sub-factors ($r_s = 0.492 \sim 0.589, p < 0.001$). Correlational analyses were also conducted using the KDSQ-P and ISCOLE to determine the criteria validity. The relationships between the KDSQ-P, ISCOLE, and SCFD-K sub-factors were all positive and significant ($r_s = 0.340 \sim 0.720, p < 0.001$). In addition, all SCFD-K sub-factors were significantly correlated with depression, anxiety, stress ($r_s = 0.225 \sim 0.499, p < 0.001$), and psychological well-being ($r_s = -0.237$ to $-0.476, p < 0.001$; Table 2).

Higher and lower scores on the KDSQ-P and ISCOLE were separated to determine whether there was a difference in the cognitive decline assessment scale scores. On the KDSQ-P, a cut-off score of 3 for further screening was used to separate the high- and low-scoring groups. The KDSQ-P was used to distinguish between the normal and symptomatic SCD groups. The SCFD-K is a 20-item scale with scores ranging from 0 to 60, the KDSQ-P is a five-item scale with scores ranging from 0 to 10, and the ISCOLE is a 16-item scale with scores ranging from 0 to 48.

There was a significant difference between the high and low groups in SCFD-K ($t = 24.82, p < 0.001$), KDSQ-P ($t = 72.41, p < 0.001$) and ISCOLE scores ($t = 31.89, p < 0.001$). The 25%, 50%, and 75% scores for the SCFD-K for 2000 participants were 5, 9, and 15, respectively. Therefore, a score of 16 or higher is in the top 25%, indicating that a person may be clinically diagnosed with MCI or has a high likelihood of developing MCI and requires early and active intervention (Table 3).

We tested whether there were differences in SCFD-K total and sub-factor scores based on gender, occupational status, age, and education. The results showed no significant differences in the total SCFD-K scores across all variables. However, women scored significantly lower than men in terms of visuospatial functioning. There was also a significant difference in language skills by age group and in personality and emotional changes depending on education (Tables 4 and 5).

Discussion

Consistent with prior research, this study acknowledges the importance of assessing SCD as an early indicator of potential cognitive disorders (Mitchell, 2008; Slot et al., 2019; Verlinden et al., 2016) and highlights the interconnectedness between cognitive and psychological health, which is an emerging trend in SCD research (Ahn et al., 2021; Wang et al., 2021). Overall, our study aligns with the global trend in SCD research, emphasizing the importance of the early detection and monitoring of cognitive decline.

Factor analysis revealed four SCFD-K subdomains: language, visuospatial, personality/emotion, and memory. The most frequently occurring cognitive domains in previous questionnaires were memory (59%), executive-functioning (16%), attention (11%), and language (8%; Rabin et al., 2015). The visuospatial-functioning factors identified in this study are part of executive-functioning. The most unique factor compared to other studies on SCD was personality/emotional changes. Caselli et al. (2018) found that neuroticism increased, and openness decreased significantly among MCI transitioners than non-transitioners. Longitudinal studies have also indicated that initial personality changes often occur earlier than clinical diagnosis.

Table 2. Means, standard deviations, and correlation analysis results among study variables ($N = 2,000$).

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. SCFD-K Total	—														
2. SCFD-K (Language)	.842***	—													
3. SCFD-K (Visuospatial)	.760***	.520***	—												
4. SCFD-K (Personality/emotion)	.814***	.566***	.492***	—											
5. SCFD-K (Memory)	.797***	.589***	.496***	.507***	—										
6. KDSQ-P	.577***	.511***	.388***	.454***	.497***	—									
7. ISCOLE Total	.720***	.633***	.549***	.561***	.569***	.683***	—								
8. ISCOLE (Attention)	.587***	.511***	.448***	.495***	.426***	.589***	.807***	—							
9. ISCOLE (Memory)	.654***	.553***	.481***	.513***	.558***	.665***	.849***	.639***	—						
10. ISCOLE (Language)	.666***	.606***	.506***	.508***	.518***	.595***	.941***	.670***	.670***	—					
11. ISCOLE (Problem solving)	.461***	.392***	.409***	.340***	.350***	.415***	.752***	.548***	.477***	.730***	—				
12. Stress	.234***	.234***	.225***	.405***	.234***	.223***	.269***	.267***	.259***	.224***	.158***	—			
13. Depression	.453***	.314***	.311***	.531***	.278***	.339***	.416***	.407***	.358***	.374***	.261***	.560***	—		
14. Anxiety	.499***	.372***	.322***	.557***	.331***	.367***	.440***	.423***	.404***	.390***	.245***	.613***	.746***	—	
15. Psychological well-being	-.403***	-.290***	-.271***	-.476***	-.237***	-.330***	-.374***	-.365***	-.314***	-.339***	-.244***	-.384***	-.684***	-.620***	—
Mean	.57	.70	.32	.67	.60	.39	.31	.36	.52	.25	.12	2.43	1.60	1.94	3.45
Standard deviation	.38	.51	.41	.52	.44	.39	.34	.51	.45	.33	.33	.69	.68	.70	.78

Note:

*** $p < 0.001$.

SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans; KDSQ-P: Korean Dementia Screening Questionnaire-Prescreening; ISCOLE: Informant-Report Scale on Cognitive-Linguistic Abilities of the Elderly.

Table 3. Validation of the difference between the normal and cognitive complaint based on KDSQ-P.

Evaluation scales	KDSQ-P cut-off score		<i>t</i>	<i>p</i>
	Cognitive complaint 3 or more (<i>N</i> = 672) <i>M</i> (<i>SD</i>)	Normal Less than 3 (<i>N</i> = 1,328) <i>M</i> (<i>SD</i>)		
SCFD-K score	16.65 (7.9)	8.86 (5.8)	24.82	< .001
KDSQ-P score	4.27 (1.3)	0.79 (0.8)	72.41	< .001
ISCLE score	9.37 (6.2)	2.78 (2.9)	31.89	< .001

Note: SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans; KDSQ-P: Korean Dementia Screening Questionnaire-Prescreening; ISCOLE: Informant-Report Scale on Cognitive-Linguistic Abilities of the Elderly.

Table 4. Means and standard deviations of SCFD-K scores by gender and working status and *t*-test results.

Gender	Male (<i>n</i> = 1000)	Female (<i>n</i> = 1000)	<i>t</i>	<i>p</i>
SCFD-K Total	.56 (.39)	.59 (.36)	1.890	.059
SCFD-K Language	.69 (.52)	.71 (.50)	.616	.538
SCFD-K Visuospatial	.29 (.40)	.35 (.42)	3.206	.001
SCFD-K Personality/emotion	.67 (.54)	.67 (.50)	.241	.809
SCFD-K Memory	.58 (.44)	.62 (.44)	2.503	.012
Work	Working (<i>n</i> = 1400)	Non-working (<i>n</i> = 600)	<i>t</i>	<i>p</i>
SCFD-K Total	.57 (.39)	.58 (.36)	.383	.702
SCFD-K Language	.71 (.52)	.69 (.47)	.946	.345
SCFD-K Visuospatial	.32 (.41)	.33 (.42)	.811	.417
SCFD-K Personality/emotion	.67 (.52)	.67 (.51)	.173	.863
SCFD-K Memory	.59 (.44)	.62 (.43)	1.375	.169

Note: SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans.

Table 5. Means and standard deviations of SCFD-K scores by age and education and ANOVA results.

Age (years)	40s (<i>n</i> = 500)	50s (<i>n</i> = 1000)	60s (<i>n</i> = 500)	<i>F</i>	<i>p</i>
SCFD-K Total	.58 (.42)	.59 (.38)	.54 (.34)	2.727	.066
SCFD-K Language	.71 (.55)	.73 (.50) ^a	.64 (.47) ^b	4.516	.011
SCFD-K Visuospatial	.32 (.45)	.33 (.42)	.31 (.36)	.314	.730
SCFD-K Personality/emotion	.71 (.56) ^a	.69 (.52) ^a	.60 (.45) ^b	6.537	.001
SCFD-K Memory	.58 (.44)	.61 (.45)	.60 (.43)	.702	.496
Education	Below high school (<i>n</i> = 440)	College (<i>n</i> = 1325)	Graduate school (<i>n</i> = 235)	<i>F</i>	<i>p</i>
SCFD-K Total	.56 (.36)	.58 (.38)	.53 (.42)	2.119	.120
SCFD-K Language	.70 (.49)	.71 (.51)	.66 (.53)	.73	.482
SCFD-K Visuospatial	.33 (.41)	.32 (.41)	.30 (.45)	.397	.672
SCFD-K Personality/emotion	.64 (.50)	.70 (.52) ^a	.59 (.54) ^b	5.802	.003
SCFD-K Memory	.59 (.43)	.61 (.44)	.57 (.46)	1.035	.356

Note: Post hoc analysis (Scheffé's test): a > b. SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans.

Therefore, personality changes may aid in the early detection of dementia of the Alzheimer's type, which could facilitate early treatment (Balsis et al., 2005), and may also be indicators of SCD.

Overall, the SCFD-K's emphasis on a wide range of cognitive domains aligns with the comprehensive approach observed in research on the implementation of SCD criteria, reinforcing the importance of multifaceted assessment tools. Additionally, its robust construction and focus on culture and demographics fill a gap in the existing SCD literature, particularly compared to broader tools such as the SCD-Q. Unlike the SCD-Q, which consists primarily of memory-related questions, the SCFD-K is

culturally tailored to enhance its effectiveness in the South Korean context. It also complements the insights provided by studies, such as those on the characteristics of SCD, offering a more nuanced understanding of cognitive decline in this specific age group and cultural setting. Specifically, unlike Western individualism, collectivist societies, such as South Korea and China, traditionally value the philosophy of self-sacrifice for parents and filial piety for children (Yu et al., 2015). Therefore, middle-aged parents do not want their children to be psychologically and financially burdened. In Korea, parents are very reluctant to tell their children about their physical and mental health problems or cognitive decline, as they only have 1–2 children. A unique South Korean psychological concept that reflects this is Parents-Adolescent Affective Bonding (Bu-Ja-Yu-Chin-Sung-Cheong), which has been shown to be negatively correlated with problem-related communication with children (Kim & Lee, 2014). Therefore, the results of delayed problem disclosure, which is a cultural feature of South Korea, are different from those of personality and mood change items and other items related to pure cognitive functioning. In particular, the items 'I am more sensitive to small things than before, and I cannot control my emotions' and 'The things I was motivated to do became a chore and I lost interest' are different from other SCD scales.

We found that the SCFD-K can be used as a sensitive early screening tool for SCD, as there is no tool to assess the level of SCD among middle-aged South Korean adults. Additionally, owing to its relatively small number of questions, the SCFD-K can be a useful self-reported screening tool in medical and general health settings for early screening of cognitive decline. It can be used to motivate health promotion, symptom management/intervention, and evaluation of treatment effectiveness regardless of time and financial constraints or access to healthcare. If regular screening of middle-aged people to identify trends using the SCFD-K can help provide rehabilitative interventions before they progress to MCI or dementia, then the relevance and applicability of the SCFD-K to real-world settings will be ensured.

The main limitation of this study is that we could not obtain complete neuropsychological assessments for the cognitive complaint group that participated in the FGIs or the survey participants, and no cognitive screening tests were performed on the informants. Also, the scale's exclusive reliance on subjective reports might have affected responses to the SCFD-K questions, leading to lower scores due to response bias (self-serving bias). Therefore, there is a need to complement neuropsychological assessment with an objective assessment tool for middle-aged adults to subdivide normal (without SCD), normal with SCD (a score above 16), and MCI groups to develop a useful tool not only for the differentiation of various SCD symptoms but also for further diagnosis. In addition, future longitudinal studies using biomarkers are needed to define the predictive capacity of the SCFD-K in this population. Studies with long-term follow-up among middle-aged individuals would be useful to determine how biochemical markers change among those without SCD who are then diagnosed with MCI or dementia, and among those who are diagnosed with SCD, MCI, and dementia sequentially.

Another limitation is, while most scale development studies utilize at least 30 participants for test-retest reliability validation, the number of test-retest participants was insufficient. Initially 30 participants were recruited, but six did not respond to the second round, resulting in 24 participants being used in the final analysis. Future studies should include sufficient participants to examine test-retest across normal, SCD, MCI, and dementia populations.

Finally, a score of 16 on a scale of 0–60 was derived as the cut-off for SCD, considering the existing dementia pre-screening scales and quartiles of survey scores. Consequently, different results could have been obtained if different international scales, sub-factors, and items measuring SCD had been used. Notably, middle-aged people are more resilient than older people, which can change within a few months depending on exercise and learning; thus, even if a client scores 16 or higher, their score could decrease in the future depending on lifestyle, exercise, and learning. Therefore, the cut-off scores need to be revalidated, and the main factors that could influence cognitive decline in midlife need to be systematically explored and examined.

Despite these limitations, the SCFD-K emerged as a vital instrument for the early detection of cognitive issues, enabling proactive intervention and research in cognitive health for the middle-aged South Korean. Its cultural relevance combined with its efficacy in assessing a range of cognitive domains informs stakeholders in neuropsychology, particularly as a culturally and demographically specific assessment tool.

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Data availability statement

https://drive.google.com/drive/folders/1gtDCX6_Kv4Gycqz2LP9gEy6zpGvxijf?usp=sharing.

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Appendix 1. SCFD-K items

Item	Description	Not at all (< 1 time per month)	Sometimes (1–2 times per month)	Often (1–2 times per week)	Very often (3–4 times per week)
Language 1	It is hard to articulate exactly what I need to convey to others				
Language 2	It is hard to get the gist of what the other person is saying or writing				
Language 3	I do not understand something in a conversation, so I ask again				
Language 4	When I read a book or article, I may have to read the same sentence repeatedly to understand it				
Language 5	I cannot think of the right words or expressions to say quickly				
Visuospatial 1	Sometimes I hammer out the path, even in places I have been before				
Visuospatial 2	Orientation/spatial skills are decreased, and actions are slowed by not knowing which way to go				
Visuospatial 3	Even with the providing explanation, it is not easy to find a place near me				
Visuospatial 4	Sometimes I get confused and turn into the wrong street or alley near my house				
Visuospatial 5	Even if I use a map or navigation, sometimes it is hard to determine where to go				
Personality/emotional 1	The things I was motivated to do became a chore and I lost interest				
Personality/emotional 2	I used to be active, but I increasingly do not want to go out and want to stay home				
Personality/Emotional 3	I am more sensitive to small things than before, and I cannot control my emotions				
Personality/Emotional 4	I used to be gentle, but recently I have become aggressive and abusive				
Personality/Emotional 5	I feel less capable of doing things I have been doing for a long time (work, hobbies, chores)				
Memory 1	I forget what I have heard recently and repeat the same questions				
Memory 2	I have been told that I repeat what I have said				
Memory 3	These days, it is hard to remember new information (names, phone numbers, how to use cell phone/smartphone apps, how to operate devices, etc.).				
Memory 4	I cannot remember where I put my belongings (phone, keys, umbrella, wallet, etc.) lately, or I lose them				
Memory 5	I have forgotten that I did something, so I did it again				
10 removed items (2 items due to normality and 8 items due to less than .35 factor loading value)					
1	I suddenly cannot remember the password for something I use frequently.				
2	I cannot think of the right words in conversation, so I use pronouns or get long-winded in my explanations.				
3	I have trouble focusing on one activity (reading, watching a movie, etc.) for long periods of time.				
4	I have difficulty multitasking.				
5	I am less aware of my surroundings when driving or walking.				
6	I have poor math skills and make mistakes with money.				
7	I sometimes do not get paid for things or get change properly.				
8	I have difficulty refocusing and continuing a task after being interrupted by something else.				
9	I sometimes have trouble getting to my destination by myself using transportation.				
10	I find it difficult to learn new and complex things.				

Note: SCFD-K: Subjective Cognitive Function Decline Scale for Middle-aged South Koreans.

Appendix B. Two-model fit index of confirmatory factor analysis ($n = 1,000$)

Model	χ^2	df	CMIN/DF	CFI	TLI	RMSEA	SRMR
One factor	2032.000	170	11.953	.763	.736	.105	.070
Four factor	700.400	164	4.271	.932	.921	.057	.042