Feasibility and psychometric properties of Integrated Care for Older People Screening Tool for Taiwanese (ICOPES-TW) cognitive screening test

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Short Title: ICOPES-TW cognition

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Keywords: ICOPE; older people; psychometrics; screening; Taiwan

Abstract

Background: Intrinsic capacity, a concept proposed by the World Health Organization, includes multidimensions to better understand older adults' health conditions for successful healthy aging. One of the key dimensions of intrinsic capacity is cognition. The present study aimed to examine if the cognitive test in Integrated Care for Older People Screening Tool for Taiwanese (ICOPES-TW) is a suitable instrument for screening cognition impairment. ***Methods:*** Older adults from community or medical center settings in Tainan were recruited (n=553; mean±SD age=75.80±8.32; 60.8% females). All participants were administered the ICOPES-TW cognitive test, the Mini-Mental State Examination (MMSE), Lawton's Instrumental Activities of Daily Living (IADL), and Barthel Index (BI) in an in-person interview conducted by a well-trained research assistant. ***Results:*** The ICOPES-TW cognitive test was highly correlated with the MMSE total score (r=-0.752) and moderately correlated with IADL (r=-0.426) and BI scores (r=-0.390). When using a cutoff score of 1 for the ICOPES-TW cognitive test, its accuracy to identify cognitive impairment defined by the MMSE was 60% (sensitivity=0.98, specificity=0.41). When using cutoff score of 2, the accuracy was 83% (sensitivity=0.69, specificity=0.90). Moreover, the ICOPES-TW cognitive test had similar properties to the MMSE in terms of known-group validity (distinguishing different age and educational level groups). ***Conclusions:*** Using ICOPES-TW cognitive test with appropriate cutoff point in different healthcare settings could help providers and researchers quickly identify if an older adult has a cognitive impairment. However, the screening ability of ICOPES-TW cognitive test was deemed fair but future studies are recommended to help improve it.

Introduction

Intrinsic capacity is a concept proposed by the World Health Organization (WHO) to supplement the continuum of their focus on healthy aging [1]. More specifically, it concerns maintaining (or even improving) intrinsic capacity, as a key for older adults to be successful in healthy aging. Intrinsic capacity has been defined as "the composite of the physical and mental capacities of an individual" [2], and concerns fundamental abilities for older adults to live in their community or society with dignity and happiness. In this regard, it is important for healthcare authorities and relevant stakeholders to have efficient and feasible measures to assess intrinsic capacity in order to help older adults pursue successful healthy aging.

Indeed, governments and healthcare providers in different countries have noticed the need of having good intrinsic capacity measures. Consequently, there has been a growing interest in developing or evaluating potential measures for intrinsic capacity assessment [2-10]. In Taiwan (where the present study was carried out), the promotion of intrinsic capacity is managed and guided by the Health Promotion Administration (HPA), Ministry of Health and Welfare [11-13]. More specifically, the HPA has developed the Integrated Care for Older People Screening Tool for Taiwanese (ICOPES-TW) and uses the ICOPES-TW across the whole of Taiwan to assess older adults' intrinsic capacity. Currently, there is only one study that has evaluated some of the psychometric properties of the ICOPES-TW, and its focus was on a score algorithm to identify problems in older adults' activities of daily living (ADLs), including basic ADLs and instrumental ADLs [11]. Therefore, it is unclear if one of the embedded subtests in the ICOPES-TW (i.e., the cognitive test) has good convergent validity and divergent validity. More specifically, the cognitive test in the ICOPES-TW was not evaluated to see if it really assesses cognition impairment in the study by Chang et al [11]. Moreover, ADLs do not directly relate to cognitive competence.

In order to evaluate the psychometric properties of the ICOPES-TW in the assessment of intrinsic capacity, additional evidence is needed to support both convergent validity and divergent validity of each specific subtest. Therefore, the present study psychometrically evaluated the ICOPES-TW cognition test because cognition is an important function for older adults to live healthily in the

community. Indeed, older adults have been found to have an increased risk of developing dementia and related diseases in cognition impairment [14-15]. Prior evidence shows that taking care of older adults with cognition impairment, especially dementia, causes a high level of burden to the family, community, and society [16-18]. In this regard, using the ICOPES-TW cognitive test to identify older adults with potential cognition impairment could help them receive early interventions and subsequently reduce these burdens. Therefore, a thorough psychometric testing for the ICOPES-TW cognitive test, especially with the use of a gold standard test in cognition impairment, is needed.

The ICOPES-TW cognitive test contains only three items (scored in dichotomous scale: intact or impaired) and can be administered very quickly (i.e., less than two minutes) to screen potential cognitive impairment among older adults. The current ICOPES-TW procedure to assess the entire intrinsic capacity of the older adults requires them to take a detailed assessment using the Mini-Mental State Examination (MMSE) if they were found to be impaired in one of the three items in the ICOPES-TW cognitive test [19]. Moreover, the ICOPES-TW cognitive test can be conducted by any healthcare professional if they have received proper training. In other words, the ICOPES-TW cognitive test is a feasible screening tool when incorporating other tests in intrinsic capacity assessment.

However, as aforementioned, the psychometric evidence regarding the ICOPES-TW is insufficient given that only one previous study has been published. Consequently, how the ICOPES-TW cognitive test performs in its screening ability is unclear. Therefore, the present study used different psychometric methods to provide additional psychometric evidence for the ICOPES-TW cognitive test to supplement current knowledge of the ICOPES-TW's psychometric properties [11]. More specifically, the MMSE was used as the gold standard for the ICOPES-TW cognitive test for its sensitivity, specificity, and accuracy of cognitive impairment detection. Moreover, known-group validity (between different age groups and between educational levels), convergent validity (with MMSE), divergent validity (with ADL measures), and internal consistency of the ICOPES-TW cognitive test were also examined.

Methods

Study design, participants, and recruitment procedure

With the use of a cross-sectional design, the present study was conducted in Tainan city from September 2023 to March 2024. Data were collected using face-to-face interviews conducted by a well-trained research assistant with a background in occupational therapy. Participants were recruited using convenience sampling from two settings: community (community-dwelling older adults) and a medical center (patients who were older adults in the National Cheng Kung University Hospital [NCKUH]) in Tainan. Participants from the community settings (n = 284; 51.4%) were approached with the assistance of village heads and all the participants were living in an urban area of Tainan. Participants from the medical center (n = 269; 48.6%) were approached with the assistance of physicians and nursing staff. The inclusion criteria of the participants were (i) being aged 60 years or older; and (ii) having the ability to provide written informed consent. The only exclusion criterion of the participants was not being able to communicate with and/or follow the researcher's instructions. After ensuring the eligibility of the participants and providing sufficient information for them to understand the study, those who signed the written informed consents were firstly asked for their sociodemographic information (i.e., age, sex, marital status, education level). Then, they were assessed for cognition (using ICOPES-TW cognitive test and MMSE; see *Measures* section for details). Lastly, their ADLs (including basic ADLs and instrumental ADLs) were assessed (using Barthel Index and the Lawton IADL Scale; see *Measures* section for details).

Measures

Basic activities of daily living

Basic ADLs were evaluated using the Barthel Index of Activities of Daily Living (BI) [20]. The BI includes daily-life activities, such as feeding, transferring (chair/bed), grooming, bathing, dressing, bowel control, bladder-control, toileting, ambulation, and stair climbing. All items are summed and scores range from 0-100. A higher score on the BI indicates better ADL.

Instrumental activities of daily living

Instrumental activities of daily living (IADLs) were evaluated using the Lawton IADL Scale. This scale was developed by Lawton and Brody in 1969 to assess eight necessary instrumental ADLs, including using the telephone, preparing food, shopping, housekeeping, doing laundry, transportation, self-medicating, and managing finances [21]. Each item is summed to score from 0 to 8. A higher score on the Lawton IADL Scale indicates worse IADL.

Cognitive performance

First, the ICOPES-TW cognitive test was used to assess cognition. The ICOPES-TW cognitive test comprises three items, including (i) remembering three words, (ii) orientation time and space, and (iii) recalling three words. If a person cannot answer one of the two questions about orientation or cannot remember three words (i.e., a person wrongly remembers any of the three items), it means cognitive decline is likely and needs advance assessment. The ICOPES-TW is scored based on impairment (score 1) or intact (score 0) for each item, and a higher ICOPES-TW total score indicates poorer cognition.

Second, the MMSE was used to assess cognition more comprehensively than using the ICOPES-TW cognitive test. The original MMSE was developed by Folstein in 1975 [22] and then it was translated into Chinese for Taiwanese residents in 1988 [23]. The MMSE is a 30-item cognitive function instrument that assesses orientation, memory, registration, recall, calculation, language, and ability to draw a complex polygon. This test can be used for initial classification among mild cognitive impairment (MCI) patients to determine their care need in a comprehensive assessment [24]. A higher total score on the MMSE indicates a better level of cognition. In the Chinese MMSE, the educational level of those who have graduated from the third grade of elementary school is defined as 23/24, and those with a score of 23 or less are considered to have cognitive impairment [23].

The study protocol (IRB No. A-ER-110-249) was approved by the Institute of Review Board in the National Cheng Kung University Hospital to ensure that all procedures adhere strictly to the declaration

of Helsinki and ensure the human rights of all participants. Moreover, no conflicts of interest were declared for any of the present authors.

Data analysis

Descriptive statistics (including frequency and mean) were used to analyze the participants' characteristics, including their demographic information, functional ability, and cognitive performance. The receiver operating characteristic (ROC) curve was then used to examine how the ICOPES-TW cognitive test screens older adults for their potential cognitive impairment alongside the gold standard measure of the MMSE. In the ROC curve, area under ROC curve (AUC) was calculated and an AUC > 0.8 indicates good criterion-related validity [25, 26]. Apart from the AUC, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated for the ICOPES-TW cognitive test using different cutoff scores, especially the comparison between the original suggested cutoff score at 1 [11] and a slightly looser cutoff score at 2.

The ICOPES-TW cognitive test was then additionally compared with the MMSE total score regarding their known-group validity (i.e., abilities in distinguishing older adults with different age and educational levels). More specifically, it was hypothesized that the younger-older adults would have a higher cognitive score (on both ICOPES-TW cognitive test and MMSE) than older-older adults, i.e., that the older adults with higher educational level (i.e., high school education or above) would have a higher cognitive score (in both ICOPES-TW cognitive test and MMSE) than those with lower educational level (i.e., primary school education or below). Independent *t*-tests with Cohen's *d* were used to examine the known-group validity. Moreover, given that characteristics of older adults from community or medical center are different, sensitivity analyses were performed using the ROC and known-group validity by separating the dataset into two subsamples (i.e., community subsample and hospital subsample).

Convergent and divergent validity of the ICOPES-TW cognitive test was examined using Spearman's correlations with the following external measures: MMSE total score, BI, and Lawton IADL

Scale score. Convergent validity of the ICOPES-TW cognitive test was examined using the MMSE because both measures assess cognition. Divergent validity of the ICOPES-TW cognitive test was examined using both BI and Lawton IADL Scale because these two instruments do not assess cognition. Accordingly, a higher correlation was expected for the association between ICOPES-TW cognitive test and MMSE, and a lower correlation was expected for the associations between ICOPES-TW cognitive test with both BI and Lawton IADL Scale [27]. Lastly, internal consistency of the ICOPES-TW cognitive test was examined using the ordinal α with item-rest correlation. An ordinal $\alpha > 0.7$ together with item-rest correlations > 0.4 indicate good internal consistency of the three items in the ICOPES-TW cognitive test [28, 29]. All the analyses were conducted using the SPSS 17.0 (SPSS Inc.: Chicago, IL) and JASP 0.17.2.1 (JASP team: Amsterdam, The Netherlands).

Results

Among the 553 participants, their mean age was 75.80 years (*SD*=8.32; range=60-101 years). Slightly more than three-fifths of the participants were women (*n*=336; 60.8%) and over half of the participants were currently married (*n*=304; 54.9%). Nearly a quarter of the participants only completed primary school education or received no education (*n*=243; 43.9%). Nearly one-third of the participants were considered as having cognition impairment (*n*=180; 32.5%) based on the MMSE score. Additional characteristics of the participants, including their scores on the ICOPES-TW cognitive tests, are reported in Table 1.

(Insert Table 1 here)

The ROC curve showed that the ICOPES-TW cognitive test had good properties in screening older adults' cognitive impairment. More specifically, the AUC was 0.863, the sensitivity was 0.69, specificity was 0.90, positive predictive value was 0.78, negative predictive value was 0.86, and accuracy was 83% when using the cutoff score of 2 in the ICOPES-TW cognitive test. When using the cutoff score of 1 that the original ICOPES-TW cognitive test suggests, the sensitivity was 0.98, specificity was 0.41, positive predictive value was 0.45, negative predictive value was 0.98, and accuracy was 60% (Supplementary Figures S1 and S2). Therefore, as this is a screening test that would

typically be accompanied with a more detailed confirmation assessment. and the major aim is not to lose any true cases, the current Taiwan HPA adopts a score of 1 as the cut-off score. Alternatively, if the cost of false negatives might be easily overcome by repeated tests in the same community, then the cutoff score could be adjusted from 1 to 2. Moreover, sensitivity analyses on the two subsamples showed that the three ICOPES-TW cognitive test items performed better among those in the community subsample (sensitivity = 0.95, specificity = 0.78, and accuracy = 0.83 using cutoff score 1; sensitivity = 0.77, specificity = 0.95, and accuracy = 0.90 using cutoff score 2) than among those in the hospital subsample (sensitivity = 0.98, specificity = 0.05, and accuracy = 0.36 using cutoff score 1; sensitivity = 0.64, specificity = 0.84, and accuracy = 0.77 using cutoff score 2; Supplementary Figure S3).

However, because the sensitivity and specificity were rated as fair (i.e., were not higher than 0.8 simultaneously) rather than promising, three combinations of the ICOPES-TW (including the combinations [i] Items 1 and 2, [ii] Items 1 and 3, and [iii] Items 2 and 3) were further tested to obtain the optimal screening ability. Further ROC analyses indicated that the combination of Items 1 and 2 had the best sensitivity (0.75) and specificity (0.85) with the cutoff score at 1 (Supplementary Figure S4). Additional sensitivity analyses showed that this combination performed better among thise in the community subsample (sensitivity = 0.93, specificity = 0.83, and accuracy = 0.86 using cutoff score 1) than among those in the hospital subsample (sensitivity = 0.73, specificity = 0.80, and accuracy = 0.78 using cutoff score 1; Supplementary Figure S5).

The ICOPES-TW cognitive test also showed similar properties to the MMSE in identifying participants in different age groups (i.e., 60-75 years [n=276] vs. 76 years or above [n=277]) and different educational levels (i.e., primary school or below [n=243] vs. high school or above [n=310]). For younger-older participants, they had lower scores on the ICOPES-TW cognitive test and higher scores on the MMSE when compared to their older-older counterparts (Cohen's d = 0.79 [ICOPES-TW; p = 6.60E-19] and 1.03 [MMSE; p = 9.44E-30]). For participants with high school education or above, they had lower scores on the ICOPES-TW cognitive test and higher scores on the MMSE when compared to their counterparts with primary school education or below (Cohen's d = 0.70 for ICOPES-

TW [p = 3.79E-15] and 0.99 for MMSE [p = 8.35E-27]; Supplementary Table S1). Similar findings were found after separating the sample into a community subsample and a hospital subsample; however, the ICOPES-TW performed better in the community subsample than in the hospital subsample (Supplementary Table S1).

The ICOPES-TW cognitive test was further found to have good convergent validity with the MMSE total score (r = -0.730) and divergent validity with other non-cognitive measures (r = -0.541 with Lawton IADL Scale; = -0.479 with BI). Moreover, the internal consistency of the ICOPES-TW cognitive test was acceptable (ordinal $\alpha = 0.78$; item-rest correlations of the three items were 0.68, 0.73, and 0.47).

Discussion

The WHO developed the concept of intrinsic capacity for geriatric care to have a good program to help all older adults for smooth transition into their older age, and they proposed the Integrated Care for Older People (ICOPE) program to tackle the challenge [2-4, 6-10, 12]. One essential requirement in geriatric care to successfully launch the ICOPE program is to identify those older adults who are at risk of intrinsic capacity problems. Therefore, using the ICOPES-TW is a good beginning for healthcare providers in Taiwan to identify older adults who need the benefit of the ICOPE program.

Taking cognition as an example, the ICOPES-TW cognitive test may help healthcare providers in Taiwan earlier identification of older adults who have some degree of cognitive decline but who do not yet have dementia. The present study provided fair psychometric evidence for the ICOPE-TW cognitive test in its ability to detect cognition impairment among older adults. When using a cutoff score of 2 on the ICOPES-TW cognitive test, the accuracy in identifying cognitive impairment indicated by the MMSE was 83%. This indicates that the ICOPES-TW cognitive test in the present study correctly identified 83% of the older adults regarding their cognitive functions. However, 14% of true cases would be lost during the screening process (because the negative predictive value was 86%). Moreover, the positive predictive value of 0.78 indicates that 22% of older adults screened as having cognitive

impairment would not be classified as confirmed cases. This may be a concern from a public health perspective, where millions are submitted to a proposed action, and especially given the 32% prevalence of cognitive impairment in the present study. These findings concur with prior findings [30,31] and suggest there is a need to revise and adapt the use of ICOPES-TW cognitive test. In the present study, different combinations of ICOPES-TW cognitive test were examined in an exploratory way. The exploratory findings indicated that using the first two items of the ICOPES-TW cognitive test performed the best-balanced sensitivity and specificity values, especially in the community subsample. Therefore, ICOPES-TW cognitive test may be more appropriate to use in a community setting than in a hospital setting.

The ICOPES-TW cognitive test had a higher correlation with MMSE total score (r = -0.752) and lower correlations with ADL measures (r = -0.426 and -0.390), indicating good convergent validity and divergent validity [27]. The ICOPES-TW cognitive test also showed comparable known-group validity with the MMSE [19]. Both measures clearly identified older adults between different ages and different educational levels in moderate or above magnitudes (Cohen's d = 0.51 to 1.20). Moreover, acceptable internal consistency was found for the ICOPES-TW cognitive test, indicating that the three items were assessing the same cognition construct.

The entire ICOPES-TW has been found to be a good instrument in identifying ADL problems for older adults in Taiwan [11]. The present findings extend the utility of the entire ICOPES-TW to one of its specific tests (i.e., the cognitive test). The ICOPES-TW cognitive test contains only three short items that can be completed within two minutes and helps screen possible cognitive impairment among older adults. Considering the modest accuracy rate (~83%) in detecting potential cognitive impairment [30], which is comparable to other intrinsic capacity measures (e.g., 73.8% accuracy in the cognition domain of the Spanish ICOPE screening tool) [31], the ICOPES-TW cognitive test appears to be feasible for large-scale screening of cognitive impairment. However, further refinement is needed.

Because the ICOPES-TW cognitive test only had fair and modest properties in detecting cognition impairment, additional testing may be needed. In the present study, the optimal cutoff score

for the ICOPES-TW cognitive test was 2 based on accuracy (i.e., 83%). However, its sensitivity (i.e., failing to identify any older adults with cognitive impairment) was somewhat low (0.69). In other words, using cutoff score at 2 in the ICOPES-TW may not detect some older adults with minor levels of cognitive impairment. In contrast, the original cutoff score (i.e., a score of 3) for the ICOPES-TW had the highest sensitivity (0.98) [11]. However, the specificity (i.e., identifying those with intact cognition as cognitive impairment) for the cutoff score of 1 was low (0.41). Therefore, whether using 1 or 2 as the cutoff score for the ICOPES-TW cognitive test may depend on needs [25, 26]. For example, healthcare providers in a facility with sufficient resources may want to use the original cutoff score proposed by the Taiwan Health Promotion Administration (i.e., a score of 1) because they will not miss identifying any older adults with cognitive impairment for early intervention. In contrast, research studies having limited resources for data collection may want to use cutoff score at 2 to examine their research questions. Moreover, given that using a cutoff score of 2 might lead to an improved accuracy than using cutoff score at 1, the best recommended cutoff score may be 2 in the community settings of Taiwan where repeated assessment are usually feasible and covered in the ICOPES-TW program.

The present study has some limitations. First, the present participants were recruited using convenience sampling. Therefore, the representativeness of the present sample is restricted. Second, test-retest reliability and inter-rater reliability of the ICOPES-TW cognitive test were not examined in the present study. Therefore, it is unclear if the stability of the ICOPES-TW cognitive test is satisfactory across time periods or across raters. Third, although the MMSE is a common measure assessing cognitive impairment with promising psychometric properties, the present study did not use neuroimaging data to support the detection of cognitive impairment. Future studies may want to use the biological evidence to further corroborate the present psychometric findings. Lastly, the present study did not use any objective measures to exclude participants who had any problems of intelligence or mental health. Although the participants were screened by an occupational therapist to identify those who had difficulties in communications and cognitive function, this method may have caused selection biases.

Conclusion

The ICOPES-TW cognitive test appears to be a feasible tool for screening because it only takes up to two minutes for administration. However, its screening ability was deemed to be fair rather than good. Therefore, additional consideration may needed when using the ICOPES-TW cognitive test, such as using different cutoff scores based on the needs or only using the first two items among community dwelling older adults. Future studies are needed to further refine the ICOPES-TW cognitive test.

Statements

Acknowledgement

The authors would like to thank all the individuals who participated in the study.

Statement of Ethics

All participants provided written informed consent for participating in study. The study was approved by the Institutional Review Board at the National Cheng Kung University Hospital (IRB No. A-ER-110-249).

Conflict of Interest Statement

The authors have no conflict of interest to declare.

Funding Sources

This work was supported by the National Health Research Institutes (NHRI-13A1-CG-CO-04-2225-1) and the Ministry of Science and Technology, Taiwan (NSTC 112-2627-M-006-002).

Author Contributions

Conceptualization: C-YLin, H-LL, L-FL, J-DW; Data curation: H-LL, Y-CY, C-YLi, L-FL; Formal analysis: C-YLin; Funding acquisition: C-YLin, Y-CY, C-YLi, L-FL, J-DW; Investigation: Y-CY, C-YLi, L-FL, J-DW; Methodology: all authors; Project administration: L-FL, J-DW; Resources: C-YLin, Y-CY, C-YLi, L-FL, J-DW; Software: C-YLin; Supervision: L-FL, J-DW; Validation: C-YLin, H-LL, Y-CY, C-YLi, MDG, L-FL; Visualization: C-YLin; Roles/Writing - original draft: C-YLin, H-LL, L-FL; Writing - review & editing: all authors.

Data Availability Statement

The data and code that support the present findings are available from the corresponding author upon reasonable request.

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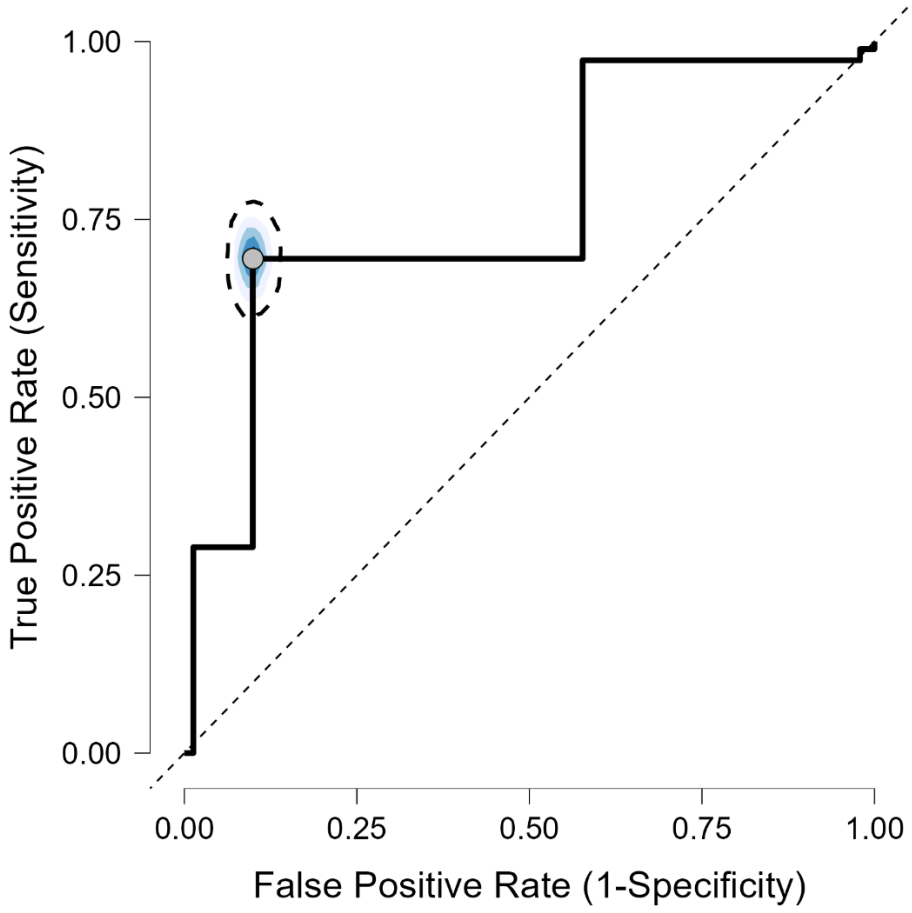
Supplementary Table S1. Known-group validity of the ICOPES-cognitive test total score.

	ICOPES cognitive test total score			**MMSE total score**		
	Mean (SD)	***t* (*p*-value)**	***d***	**Mean (SD)**	***t* (*p*-value)**	***d***
Entire sample						
Age		9.23 (6.60E-19)	0.79		12.08 (9.44E-30)	1.03
60 to 75 years (n=276)	0.76 (0.75)			26.37 (4.81)		
76 years or above (n=277)	1.43 (0.94)			20.52 (6.45)		
Educational level		8.20 (3.79E-15)	0.70		11.55 (8.35E-27)	0.99
Primary school or below (n=243)	1.44 (0.90)			20.26 (6.12)		
High school or above (n=310)	0.83 (0.83)			25.94 (5.43)		
Community subsample						
Age		8.27 (8.70E-15)	0.98		9.83 (1.35E-19)	1.16
60 to 75 years (n=141)	0.36 (0.75)			27.13 (4.75)		
76 years or above (n=143)	1.31 (1.15)			20.50 (6.50)		
Educational level		5.64 (7.65E-8)	0.72		9.39 (3.56E-17)	1.20
Primary school or below (n=98)	1.35 (1.18)			19.21 (6.25)		
High school or above (n=186)	0.58 (0.93)			26.20 (5.38)		
Hospital subsample						
Age		5.51 (9.25E-8)	0.67		7.28 (4.47E-12)	0.89

60 to 75 years (n=135)	1.18 (0.47)		25.57 (4.76)	
76 years or above (n=134)	1.55 (0.63)		20.55 (6.41)	
Educational level		4.23 (3.21E-5)		6.57 (2.73E-10) 0.80
Primary school or below (n=145)	1.50 (0.66)		20.96 (5.94)	
High school or above (n=124)	1.21 (0.45)		25.54 (5.50)	

MMSE=Mini-Mental State Examination, higher score indicates better cognition; ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition*; d*=Cohen's *d***.**



	Cut-off score		
	1	2	3
Sensitivity (95% CI)	0.98 (0.95, 0.997)	0.69 (0.62, 0.76)	0.26 (0.20, 0.33)
Specificity (95% CI)	0.41 (0.36, 0.46)	0.90 (0.87, 0.93)	0.99 (0.98, 0.998)
PPV (95% CI)	0.45 (0.43, 0.47)	0.78 (0.71, 0.83)	0.94 (0.83, 0.98)
NPV (95% CI)	0.98 (0.94, 0.99)	0.86 (0.83, 0.88)	0.74 (0.72, 0.75)
Accuracy (95% CI)	0.60 (0.56, 0.64)	0.83 (0.80. 0.86)	0.75 (0.72, 0.79)

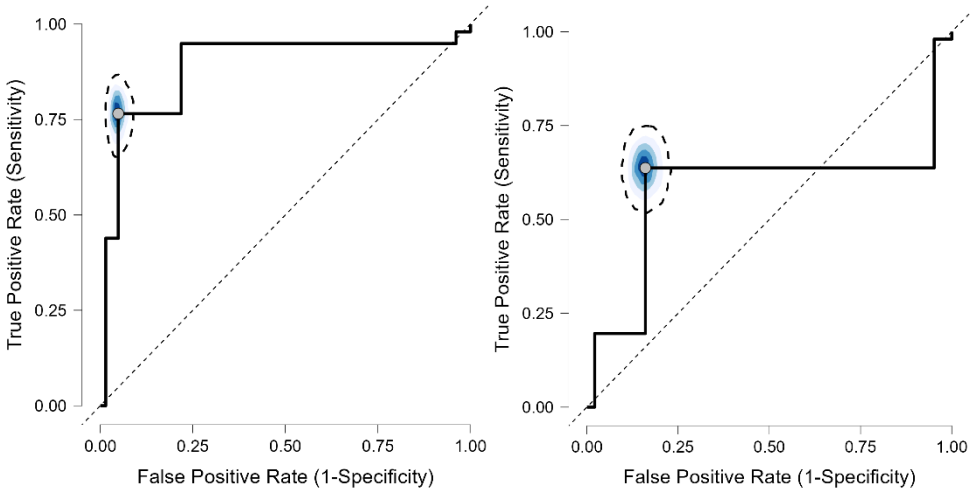
Supplementary Figure S1. Receiving Operating Characteristic Curve of the ICOPES-cognitive test

ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition; PPV=positive predictive value; NPV=negative predictive value; CI=confidence interval.

(a) (b)

Supplementary Figure S2. ICOPES-cognitive test properties in classifying cases using cut score at 2. (a) Icon plot; (b) Test characteristics.

ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition.

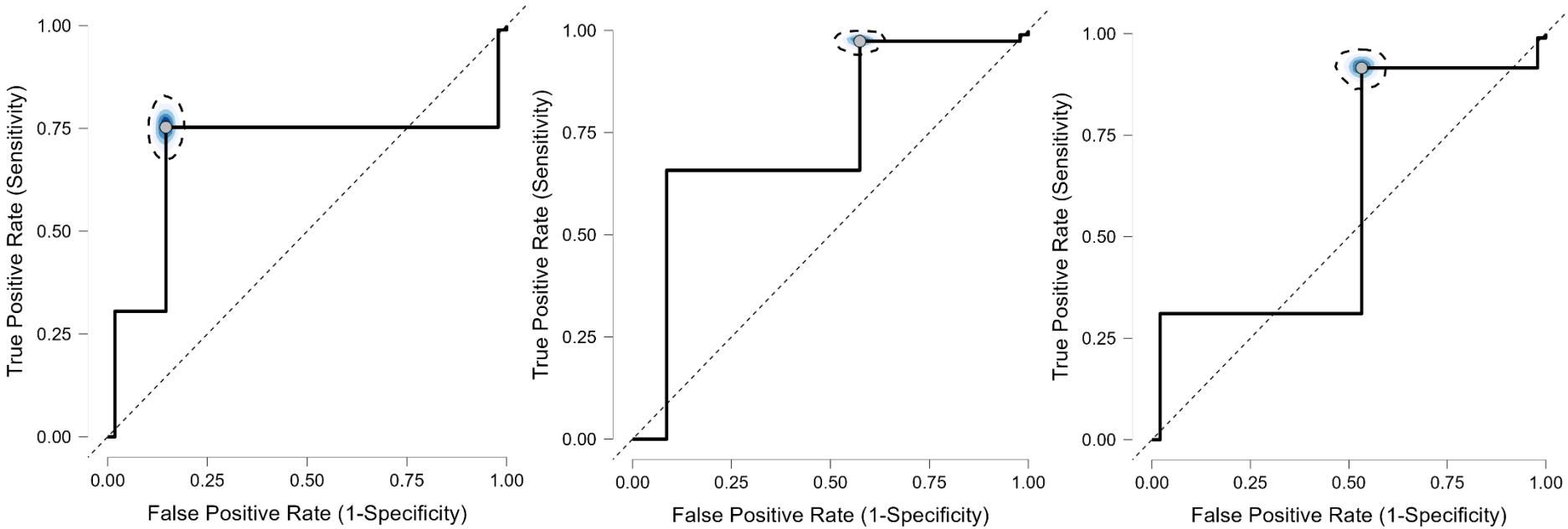


(a) Community subsample **(b) Hospital subsample**

	Cut-off score					
	Community subsample			Hospital subsample		
	1	2	3	1	2	3
Sensitivity (95% CI)	0.95 (0.90, 0.98)	0.77 (0.68, 0.84)	0.44 (0.34, 0.54)	0.98 (0.96, 0.998)	0.64 (0.54, 0.73)	0.20 (0.12, 0.28)
Specificity (95% CI)	0.78 (0.72, 0.84)	0.95 (0.92, 0.98)	0.99 (0.97, 0.997)	0.05 (0.02, 0.08)	0.84 (0.79, 0.89)	0.98 (0.95, 0.99)
PPV (95% CI)	0.65 (0.57, 0.73)	0.87 (0.79, 0.94)	0.93 (0.83, 0.99)	0.34 (0.29, 0.40)	0.67 (0.56, 0.76)	0.82 (0.64, 0.95)
NPV (95% CI)	0.97 (0.94, 0.99)	0.90 (0.86, 0.94)	0.80 (0.75, 0.85)	0.85 (0.68, 0.98)	0.82 (0.77, 0.87)	0.71 (0.65, 0.76)
Accuracy (95% CI)	0.83 (0.79, 0.87)	0.90 (0.86, 0.93)	0.82 (0.78, 0.86)	0.36 (0.31, 0.42)	0.77 (0.72, 0.82)	0.72 (0.66, 0.77)

Supplementary Figure S3. Receiving Operating Characteristic Curve of the ICOPES-cognitive test (stratified by settings)

ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition; PPV: positive predictive value; NPV=negative predictive value; CI=confidence interval.



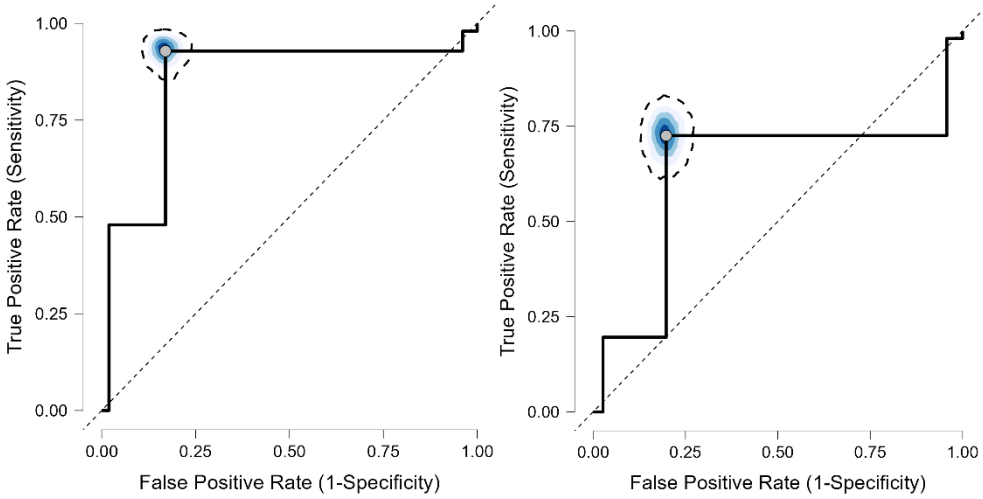
(a) Combination of Items 1 and 2 **(b) Combinations of Items 1 and 3** **(c) Combinations of Items 2 and 3**

	Cut-off score					
	Items 1 and 2		Items 1 and 3		Items 2 and 3	
	1	2	1	2	1	2
Sensitivity (95% CI)	0.75 (0.69, 0.81)	0.30 (0.24, 0.37)	0.97 (0.95, 0.99)	0.66 (0.59, 0.72)	0.92 (0.87, 0.95)	0.31 (0.25, 0.38)
Specificity (95% CI)	0.85 (0.82, 0.89)	0.98 (0.97, 0.99)	0.43 (0.38, 0.48)	0.91 (0.88, 0.94)	0.47 (0.42, 0.52)	0.98 (0.96, 0.99)
PPV (95% CI)	0.71 (0.64, 0.77)	0.89 (0.80, 0.95)	0.45 (0.40, 0.49)	0.78 (0.72, 0.85)	0.45 (0.40, 0.50)	0.88 (0.79, 0.94)
NPV (95% CI)	0.88 (0.85, 0.91)	0.75 (0.71, 0.79)	0.97 (0.94, 0.99)	0.85 (0.81, 0.88)	0.92 (0.88, 0.96)	0.75 (0.71, 0.79)

Accuracy (95% CI)	0.82 (0.79, 0.64)	0.76 (0.73. 0.80)	0.60 (0.56, 0.64)	0.83 (0.80, 0.86)	0.61 (0.57, 0.65)	0.76 (0.73, 0.80)

Supplementary Figure S4. Receiving Operating Characteristic Curve of the ICOPES-cognitive test (Using different combinations)

ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition; PPV=positive predictive value; NPV: negative predictive value; CI=confidence interval.



(a) Community subsample **(b) Hospital subsample**

	Cut-off score			
	Community subsample		Hospital subsample	
	1	2	1	2
Sensitivity (95% CI)	0.93 (0.87, 0.97)	0.48 (0.38, 0.58)	0.73 (0.63, 0.81)	0.20 (0.13, 0.28)
Specificity (95% CI)	0.83 (0.78, 0.88)	0.98 (0.96, 0.995)	0.80 (0.74, 0.86)	0.97 (0.95, 0.99)
PPV (95% CI)	0.70 (0.62, 0.78)	0.92 (0.82, 0.98)	0.65 (0.55, 0.74)	0.79 (0.60, 0.92)
NPV (95% CI)	0.96 (0.93, 0.99)	0.81 (0.76, 0.86)	0.85 (0.80, 0.90)	0.21 (0.08, 0.40)
Accuracy (95% CI)	0.86 (0.82, 0.90)	0.83 (0.79, 0.87)	0.78 (0.73, 0.82)	0.72 (0.66, 0.77)

Supplementary Figure S5. Receiving Operating Characteristic Curve of the ICOPES-cognitive test (Stratified by settings with combination of Items 1 and 2)

ICOPES=Integrated Care for Older People Screening Tool for Taiwanese, higher score indicates poorer cognition; PPV=positive predictive value; NPV=negative predictive value; CI: confidence interval.