

Validation of Each Category of Kihon Checklist for Assessing Physical Functioning, Nutrition and Cognitive Status in a Community-Dwelling Older Japanese Cohort

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Abstract

Background: Kihon Checklist is a self-reported comprehensive health checklist used as a screening tool to identify frailty. The Kihon Checklist is a 25-item questionnaire including seven categories: daily life, physical ability, nutrition, oral condition, the extent to which one is housebound, cognitive status, and depression risk. We aimed to clarify the consistency in assessments of three important categories: physical strength, nutritional status, and cognitive function of Kihon Checklist using assessments of actual physical, nutritional, and cognitive statuses.

Methods: The study sample consisted of 5341 elderly individuals aged ≥ 65 years who participated in the Japanese Long-Term Care Prevention Project. We evaluated the Kihon Checklist scores except the depression risk. Physical functioning was evaluated using handgrip strength, one-leg standing-balance time, the Timed Up & Go test, and a walking test at usual or maximum speed. Nutritional status was assessed using the Mini Nutritional Assessment questionnaire. Cognitive functioning was evaluated using Sweet 16. Associations between each category of Kihon Checklist and physical, nutritional, and cognitive functioning assessments were analyzed.

Results: There were significant differences in all categories of Kihon Checklist between participants with and without functional decline in physical, nutritional, and cognitive functioning. Multivariate analyses showed that the Kihon Checklist physical strength category correlated with physical functioning assessments, the Kihon Checklist nutritional status category correlated with the Mini Nutritional Assessment, and the Kihon Checklist physical strength category correlated with the Sweet 16 scores. Moreover, the analysis of receiver operating characteristic curve exhibited a moderately accurate relationship of the Kihon Checklist physical strength category with overall physical functioning assessments.

Conclusions: We found significant associations of the Kihon Checklist physical strength, nutritional status, and cognition categories, with assessments of physical, nutritional, and cognitive functioning, respectively. Especially, the Kihon Checklist physical strength category is a valid tool for predicting physical functioning for general frailty aspects in older adults.

Keywords: Elderly; Physical function; Nutritional status; Cognitive function; Activities of daily living

Introduction

The Japanese population is aging (it is the most aged society in the world with 25% of the population being over 65 years old in 2013) and this rate will increase further to 40% in 2060 [1]. Aging is a continuous and multidimensional process involving an interaction of the effects of personal lifestyle such as physical, nutritional, cognitive, and social factors. Advancing age is associated with increased frailty and decline in the ability to perform activities of daily living (ADLs) in elderly individuals [2]. Even though geriatric frailty is described as global

impairment of physiological reserves involving multiple organ systems, ADL decline in the elderly is due in large part to decrements in physical function [3,4]. Several studies have identified factors associated with physical function in elderly individuals [5-8]. In particular, nutritional state [7] and cognitive functioning [8] greatly influence physical functioning.

Long-term care insurance (LTCI) is a form of mandatory social insurance system that assists frail and disabled older adults with impairments in ADL. In this system, the Kihon Checklist (KCL), a self-reported comprehensive health checklist designed by a study group from the Ministry of Health, Labour and Welfare (MHLW), is used as a screening tool to identify community-dwelling older adults who are

vulnerable to frailty and have a higher risk of becoming dependent [9]. Based on the results regarding impairment in specific categories, municipalities provide intervention programs to prevent future disability and promote the need for care among older adults. The KCL is a 25-item questionnaire including seven categories: daily life (five points), physical strength (five points), nutrition (two points), oral

condition (three points), the extent to which one is housebound (two points), cognitive function (three points), and depression risk (five points) (Appendix Table 1). Each category is rated on a pass/fail basis and the time required for older adults to answer the KCL is approximately 15 min.

Variables	Number or Mean (SD)	Analyzed number
Female/Male	4397/928	5325
Age (years)	80.3 (6.7)	5341
Height (cm)	148.7 (8.3)	2859
Weight (kg)	50.6 (9.4)	2981
BMI (kg/m ²)	22.8 (3.5)	2845
Living alone	602	2253
Lower back pain	1505	2239
Knee pain	1493	2276
History of falls	350	3346
Previous fractures	1115	4026
Hip fractures	303	3104
Cerebral stroke	348	3104
Heart disease	552	3104
Diabetes	217	3104
KCL lifestyle category	5.68 (4.04)	3495
KCL physical strength category	2.13 (1.58)	3497
KCL nutritional status category	0.33 (0.58)	3483
KCL cognitive category	0.87 (0.98)	3495
HGS (kg)	19.8 (7.0)	4923
OLS (s)	29.9 (36.9)	4752
TUG (s)	15.6 (20.1)	5101
WTU (s)	6.3 (3.7)	4520
WTM (s)	5.1 (3.2)	4200
MNA-SF	11.2 (2.1)	1649
Sweet 16	13.5 (2.6)	1531

SD: Standard deviation; BMI: Body mass index; KCL: Kihon Checklist; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form

Table 1: Participant characteristics.

The KCL, originally developed in Japan, has been used in several studies carried out in multiple countries with distinct purposes. Sewo Sampaio et al. [10] reported that the KCL was suitable to address frailty demands among both elderly individuals who are community-dwelling and those who use daycare centers and is adequate for cross-cultural studies. However, evaluations of validity of each category of KCL with respect to assessments of actual physical, nutritional, and cognitive

statuses are still unknown. In addition, the samples in such studies were small in size and limited to home and community-based services. The purpose of this study was to clarify the validity of KCL using assessments of actual physical, nutritional, and cognitive statuses. We evaluated muscle strength, walking, and both static and dynamic balance as actual physical measures. Nutritional and cognitive statuses were evaluated using the gold standard assessments, Mini Nutritional

Assessment-Short Form (MNA-SF) and the 16-point Brief Cognitive Assessment Tool (Sweet 16), respectively.

Methods

Participants

Participants included 5,597 elderly individuals (mean age: 80.1 years) who consented to provide data. We collected data from the database of the Kumamoto Prefecture Community-based Rehabilitation Support System Promotion Project. This project included 17 community-based rehabilitation centers and community general-support centers in 11 regions (31 municipalities) from April 2012 to March 2013. We excluded participants aged <65 years. The Community-based Rehabilitation Support System Promotion Project was officially started in 2000 and revised in 2006, led by the Office of Elderly Health Care of the MHLW. The project participants were both healthy and in the “assistance required” category of elderly individuals, which form the lowest of the seven levels of frailty in elderly individuals who need public LTCI support because of physical and mental disabilities [11,12]. Elderly individuals certified in the “assistance required” category use community care or preventive services to lead self-supporting lives while maintaining their present physical condition as long as possible. In contrast, those certified in other “care required” categories belonging in the higher five LTCI levels can receive home-based, community-based, or institutional care services.

We recorded participants’ details such as gender, age, whether they lived alone, presence of lower back pain or knee pain, history of falls and fractures, previous medical history (e.g.: hip fractures, cerebral stroke, heart disease, diabetes), and KCL scores. We evaluated KCL scores using all items except the five points for depression risk as per the MHLW criteria to identify elderly individuals who may be eligible for Japanese LTCI in the near future as a lifestyle category. Scores <10 points indicated no functional decline and 10-20 indicated functional decline (Appendix Table 1). We checked each category of physical strength (Q.6-10), nutritional status (Q.11-12), and cognition (Q. 18-20). The scores indicate functional decline in case of ≥ 3 negative answers for physical strength, 2 negative answers for nutritional status, and ≥ 1 negative answer for cognitive function. We also measured height, weight, and body mass index (BMI); evaluated physical functioning, nutritional status, and cognitive function; and conducted a geriatric assessment. Data including survey results and evaluations were stored without participants’ names in the Department of Rehabilitation of Kumamoto University Hospital. This study was approved by the Institutional Review Board of Kumamoto University Hospital and was conducted in accordance with the Declaration of Helsinki.

Physical functioning

Physical functioning was evaluated according to the physical function improvement manual issued by the MHLW. Muscle strength was evaluated using handgrip strength (HGS). Physical performance was evaluated in terms of one-leg standing time with eyes open (OLS), the Timed Up & Go (TUG) test, a five-meter walking test at usual speed (WTU), and a five-meter walking test at maximum speed (WTM). HGS and OLS were measured on both sides and the better values were used in this study.

Nutritional status

Participants’ nutritional state was evaluated using the MNA-SF [13] which has a total score of 14 points. Participants with scores of 0-7 were considered malnourished, 8-11 were considered at risk for malnutrition, and 12-14 were considered well nourished.

Cognitive function

Cognitive function was evaluated using the Sweet 16 including eight orientation items, three registration items, two digit spans, and three recall items [14] (Appendix Table 2). A score of 0-13 indicates cognitive impairment and 14-16 indicates no cognitive impairment. Although the items overlap with those of Mini-Mental State Examination (MMSE), all the cognitive subtests used in the Sweet 16 are widely applied independent of the MMSE, separately, and in other batteries.

Statistical analyses

Differences in continuous variables between genders and in each KCL category in the different physical strength and cognitive functioning groups were analyzed using Mann-Whitney U tests. An analysis of variance (ANOVA) and post-hoc comparisons using the Scheffé test were applied to evaluate differences in each KCL category by nutritional status. The associations between KCL lifestyle category and other participant characteristics were tested with univariate analyses using Pearson’s correlation coefficients or Spearman’s rank-correlation coefficients and multivariate stepwise regressions. Using the independent variables with a significance level of 0.05, multivariate stepwise regression analysis was performed. We generated a standard receiver operating characteristic (ROC) curve for each KCL category, plotting sensitivity versus 1-specificity. The area under the ROC curve (AUC) was used to evaluate the discriminatory ability of each system to detect postoperative morbidity. Statistical tests were performed with SPSS statistics 16 software package (SPSS Inc., Chicago, IL) and the EZR (Saitama Medical Center, Jichi Medical University). <http://www.jichi.ac.jp/saitama-sct/SaitamaHP.files/statmedEN.html>[15]. The probability threshold for significance was <5%.

Results

Participant characteristics

We included 5,341 participants (82.6% female) with a mean age of 80.3 years (range, 65–102 years; Table 1). The scores in the KCL lifestyle category of participants without functional decline in all physical, nutritional, and cognitive functioning assessments were significantly inferior to those with decline in physical and cognitive status, and malnourished participants or those at risk for malnutrition (Table 2). There were similar statistical differences in the KCL physical strength category in physical functioning and nutritional status. Additionally, the KCL scores in the nutritional status category and cognitive category were statistically inferior in the participants without functional decline in all physical functioning evaluations compared to the participants with functional decline in physical functioning. There were significant differences in scores on both KCL nutritional status and cognitive categories between well-nourished participants and those at risk for malnutrition.

KCL	Variables	No decline	Decline	At risk	P value
Lifestyle Category	HGS (kg)	3.84 (3.41)	7.21 (3.95)	-	<0.001
	OLS (s)	3.32 (3.03)	7.07 (3.81)	-	<0.001
	TUG (s)	3.80 (3.19)	8.76 (3.32)	-	<0.001
	WTU (s)	5.12 (3.83)	9.64 (3.22)	-	<0.001
	WTM (s)	4.57 (3.65)	9.09 (3.16)	-	<0.001
	MNA-SF	5.99 (3.96)	8.59 (3.72)*	7.95 (4.04)*	<0.001
	Sweet 16	6.80 (4.02)	8.06 (3.97)	-	<0.001
Physical Strength Category	HGS (kg)	1.60 (1.51)	2.58 (1.51)	-	<0.001
	OLS (s)	1.35 (1.39)	2.66 (1.44)	-	<0.001
	TUG (s)	1.57 (1.43)	3.04 (1.34)	-	<0.001
	WTU (s)	1.99 (1.54)	3.10 (1.47)	-	<0.001
	WTM (s)	1.81 (1.50)	3.10 (1.40)	-	<0.001
	MNA-SF	2.25 (1.53)	2.89 (1.55)*	2.54 (1.60)*	<0.001
	Sweet 16	2.49 (1.56)	2.54 (1.56)	-	0.128
Nutritional Status Category	HGS (kg)	0.25 (0.50)	0.42 (0.64)	-	<0.001
	OLS (s)	0.23 (0.49)	0.36 (0.58)	-	<0.001
	TUG (s)	0.25 (0.50)	0.46 (0.66)	-	<0.001
	WTU (s)	0.30 (0.55)	0.54 (0.70)	-	<0.001
	WTM (s)	0.28 (0.53)	0.51 (0.68)	-	<0.001
	MNA-SF	0.30 (0.57)	0.50 (0.67)	0.67 (0.71)*	<0.001
	Sweet 16	0.43 (0.65)	0.52 (0.70)	-	0.089
Cognitive Category	HGS (kg)	0.69 (0.91)	1.05 (1.03)	-	<0.001
	OLS (s)	0.69 (0.91)	0.98 (0.99)	-	<0.001
	TUG (s)	0.72 (0.92)	1.12 (1.05)	-	<0.001
	WTU (s)	0.84 (0.97)	1.13 (1.06)	-	<0.001
	WTM (s)	0.80 (0.96)	1.11 (1.05)	-	<0.001
	MNA-SF	0.94 (1.01)	1.13 (1.08)	1.15 (1.01)*	<0.001
	Sweet 16	1.04 (1.01)	1.17 (1.07)	-	0.268

KCL: Kihon Checklist; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at Maximum speed; MNA-SF: Mini nutritional assessment-short form

*: ANOVA

Table 2: Comparison of scores in each category of KCL of those with and without functional decline in total lifestyle, physical strength, nutritional status, and cognitive function.

Association with the KCL and the status of physical functioning, nutrition, and cognition

Univariate analyses of the factors associated with KCL lifestyle category revealed that age, height, weight, BMI, living alone, lower back pain, knee pain, history of falls, previous fractures, hip fractures,

cerebral stroke, all assessments of physical functioning, MNA-SF scores, and Sweet 16 scores were significantly correlated with lower KCL lifestyle category (Table 3). The multivariate analysis showed that there were significant associations of age, lower back pain, history of falls, cerebral stroke, HGS, OLS, TUG, MNA-SF, and Sweet 16 with KCL lifestyle category.

Variables	Univariate analyses		Multivariate analyses	
	r/p	P	r/p	P
Gender	0.275	0.814	-	-
Age	0.35	<0.001	0.235	<0.001
Height	-0.088	0.014	-3.432	0.563
Weight	-0.141	<0.001	0.006	0.939
BMI	-0.115	0.001	-0.046	0.805
Living alone	0.176	0.024	-0.541	0.092
Lower back pain	0.343	<0.001	0.743	0.047
Knee pain	0.348	<0.001	0.71	0.058
History of falls	0.473	<0.001	1.553	<0.001
Previous fractures	0.276	<0.001	0.436	0.177
Hip fractures	0.403	<0.001	0.064	0.896
Cerebral stroke	0.449	<0.001	2.178	<0.001
Heart disease	0.271	0.842	-	-
Diabetes	0.417	0.23	-	-
HGS	-0.284	<0.001	-0.053	0.004
OLS	-0.408	<0.001	-0.044	<0.001
TUG	0.422	<0.001	0.122	<0.001
WTU	0.351	<0.001	-0.033	0.513
WTM	0.349	<0.001	0.057	0.516
MNA-SF	-0.165	<0.001	-0.305	<0.001
Sweet 16	-0.22	<0.001	-0.112	0.027

KCL: Kihon Checklist; BMI: Body mass index; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form; r: Pearson's correlation coefficient; p: Spearman's rank-correlation coefficient.

Table 3: Factors associated with KCL lifestyle category.

Concerning each category of KCL, the multivariate analysis of participants' background showed that age, height, weight, lower back pain, knee pain, history of falls, and cerebral stroke were significantly correlated with lower scores in KCL physical strength category (Table 4). There were significant correlations of age, BMI, and history of falls with KCL nutritional status category (Table 5); gender, age, weight, and

heart disease correlated with KCL cognitive category (Table 6). Evaluating physical, nutritional, and cognitive functioning assessments revealed significant correlations of HGS, OLS, TUG, and WTU with KCL physical strength category; TUG, WTU, WTM, MNA-SF, andmm Sweet 16 with KCL nutritional status category; and Sweet 16 with KCL cognitive category.

Variables	Univariate analyses		Multivariate analyses	
	r/p	P	r/p	P
Gender	0.256	0.001	0.073	0.481
Age	0.257	<0.001	0.062	<0.001
Height	-0.188	<0.001	-3.6	<0.001

Weight	-0.103	0.004	0.021	<0.001
BMI	0.011	0.767	-	-
Living alone	0.23	0.955	-	-
Lower back pain	0.387	<0.001	0.471	<0.001
Knee pain	0.392	<0.001	0.447	<0.001
History of falls	0.494	<0.001	0.997	<0.001
Previous fractures	0.272	<0.001	0.156	0.146
Hip fractures	0.404	0.01	0.274	0.098
Cerebral stroke	0.428	<0.001	0.636	<0.001
Heart disease	0.287	0.871	-	-
Diabetes	0.42	0.955	-	-
HGS	-0.19	<0.001	-0.019	0.008
OLS	-0.347	<0.001	-0.019	<0.001
TUG	0.229	<0.001	0.031	0.005
WTU	0.14	<0.001	-0.044	0.029
WTM	0.171	<0.001	0.022	0.517
MNA-SF	0	0.996	-	-
Sweet 16	-0.103	0.004	0.035	0.07

KCL: Kihon Checklist; BMI: Body mass index; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form; r: Pearson's correlation coefficient; p: Spearman's rank-correlation coefficient.

Table 4: Factors associated with KCL physical strength category.

Variables	Univariate analyses		Multivariate analyses	
	r/p	P	r/p	P
Gender	0.477	0.401	-	-
Age	0.125	0.001	0.012	<0.001
Height	0.059	0.101	-	-
Weight	-0.118	0.001	0.001	0.773
BMI	-0.191	<0.001	-0.032	<0.001
Living alone	0.357	0.385	-	-
Lower back pain	0.305	0.066	-	-
Knee pain	0.301	0.056	-	-
History of falls	0.571	<0.001	0.18	<0.001
Previous fractures	0.394	0.017	0.051	0.08
Hip fractures	0.53	0.394	-	-
Cerebral stroke	0.535	0.011	0.099	0.216
Heart disease	0.449	0.334	-	-

Diabetes	0.579	0.178	-	-
HGS	-0.129	<0.001	0	0.469
OLS	-0.093	0.009	0.001	0.615
TUG	0.234	<0.001	-0.004	0.01
WTU	0.275	<0.001	0.005	<0.001
WTM	0.254	<0.001	0.042	0.012
MNA-SF	-0.266	<0.001	-0.071	<0.001
Sweet 16	-0.098	0.006	-0.024	0.012

KCL: Kihon Checklist; BMI: Body mass index; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form; r: Pearson's correlation coefficient; p: Spearman's rank-correlation coefficient.

Table 5: Factors associated with KCL nutritional status category.

Variables	Univariate analyses		Multivariate analyses	
	r/p	P	r/p	P
Gender	0.364	0.019	0.24	0.001
Age	0.181	<0.001	0.024	<0.001
Height	-0.026	0.461	-	-
Weight	-0.114	0.001	-0.013	0.01
BMI	-0.127	<0.001	0.011	0.354
Living alone	0.235	0.117	-	-
Lower back pain	0.283	<0.001	0.123	0.119
Knee pain	0.271	0.001	0.019	0.814
History of falls	0.455	<0.001	0.179	0.08
Previous fractures	0.289	0.004	-0.03	0.644
Hip fractures	0.422	0.197	-	-
Cerebral stroke	0.42	0.04	0.086	0.387
Heart disease	0.365	0.003	0.374	<0.001
Diabetes	0.466	0.198	-	-
HGS	-0.148	<0.001	-0.01	0.064
OLS	-0.151	<0.001	-0.001	0.438
TUG	0.22	<0.001	0.012	0.152
WTU	0.18	<0.001	-0.011	0.457
WTM	0.173	<0.001	0.015	0.564
MNA-SF	-0.137	<0.001	-0.034	0.082
Sweet 16	-0.119	0.001	-0.037	0.015

KCL: Kihon Checklist; BMI: Body mass index; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form; r: Pearson's correlation coefficient; ρ: Spearman's rank-correlation coefficient.

Table 6: Factors associated with KCL cognitive category.

The ROC curves exhibited a moderately accurate relationship of the KCL lifestyle category with all physical functioning assessments (Table 7, Figure 1). The physical strength, nutritional status, and cognitive categories of KCL were also correlated with all physical functioning

assessments (Figures 2-4). However, AUCs were very low in the KCL nutritional status and cognitive categories. In addition, there were significant correlations between Sweet 16 and the KCL lifestyle, nutritional status, and cognitive categories.

KCL	Variables	AUC	95% CI	P
Lifestyle Category	HGS (kg)	0.746	0.729-0.764	<0.001
	OLS (s)	0.784	0.768-0.800	<0.001
	TUG (s)	0.86	0.847-0.872	<0.001
	WTU (s)	0.814	0.795-0.833	<0.001
	WTM (s)	0.826	0.811-0.842	<0.001
	MNA-SF	0.551	0.473-0.629	0.186
	Sweet 16	0.595	0.565-0.625	<0.001
Physical Strength Category	HGS (kg)	0.676	0.657-0.695	<0.001
	OLS (s)	0.741	0.723-0.758	<0.001
	TUG (s)	0.767	0.751-0.783	<0.001
	WTU (s)	0.698	0.671-0.725	<0.001
	WTM (s)	0.731	0.711-0.751	<0.001
	MNA-SF	0.439	0.360-0.517	0.126
	Sweet 16	0.509	0.479-0.539	0.571
Nutritional Status Category	HGS (kg)	0.438	0.422-0.454	<0.001
	OLS (s)	0.551	0.536-0.566	<0.001
	TUG (s)	0.582	0.566-0.599	<0.001
	WTU (s)	0.589	0.563-0.616	<0.001
	WTM (s)	0.586	0.566-0.606	<0.001
	MNA-SF	0.567	0.495-0.639	0.067
	Sweet 16	0.533	0.507-0.559	0.014
Cognitive Category	HGS (kg)	0.598	0.580-0.617	<0.001
	OLS (s)	0.583	0.564-0.602	<0.001
	TUG (s)	0.608	0.590-0.627	<0.001
	WTU (s)	0.576	0.547-0.605	<0.001
	WTM (s)	0.583	0.561-0.606	<0.001
	MNA-SF	0.511	0.429-0.592	0.8
	Sweet 16	0.533	0.504-0.562	0.028

AUC: Area under the receiver operating characteristic curve; KCL: Kihon checklist; CI: Confidence interval; HGS: Handgrip strength; OLS: One-leg standing time with eyes open; TUG: Timed up & go test; WTU: 5-Meter walk test at usual speed; WTM: 5-Meter walk test at maximum speed; MNA-SF: Mini nutritional assessment-short form; r: Pearson's correlation coefficient; ρ : Spearman's rank-correlation coefficient.

Table 7: AUC of each KCL category.

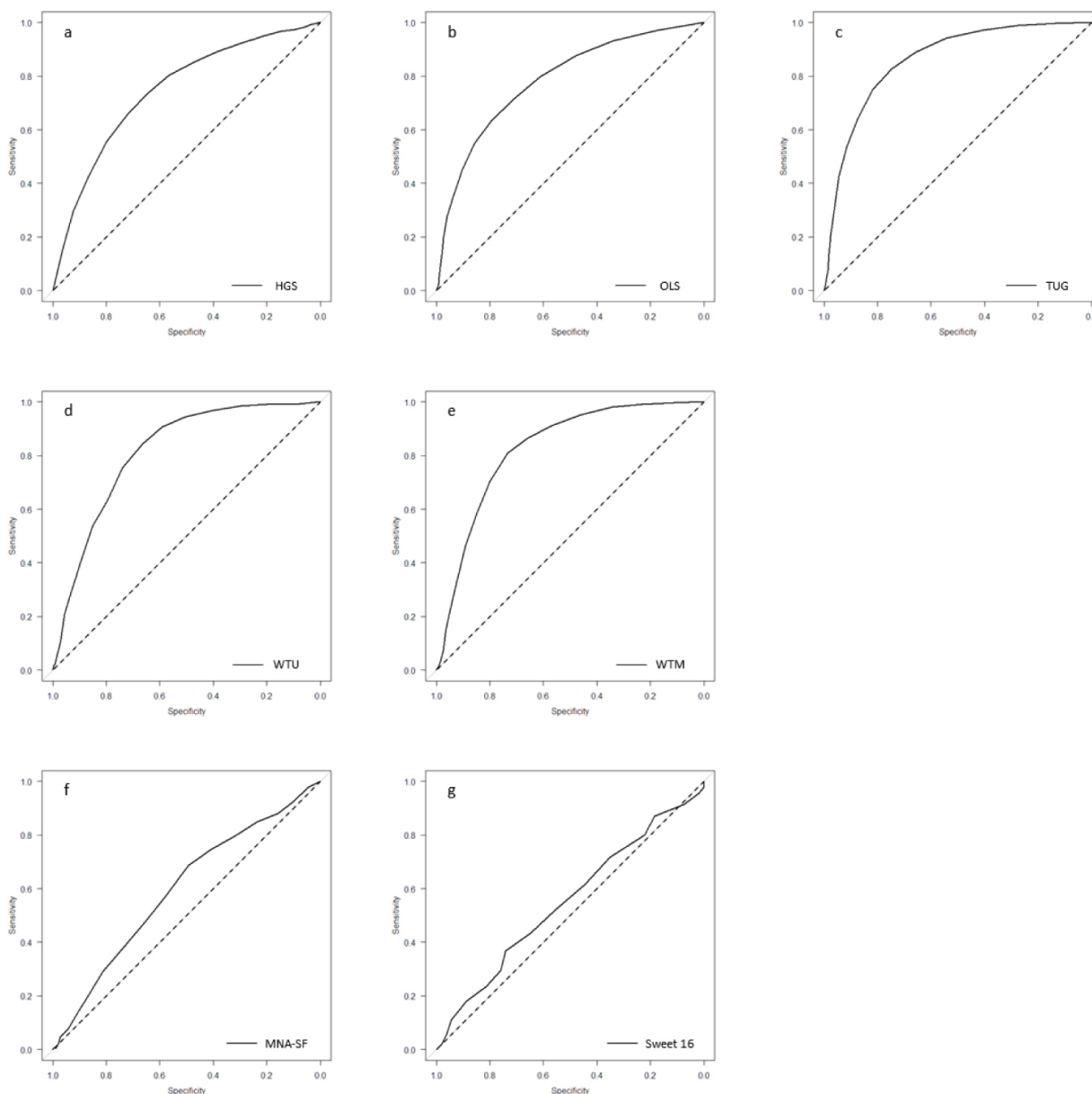
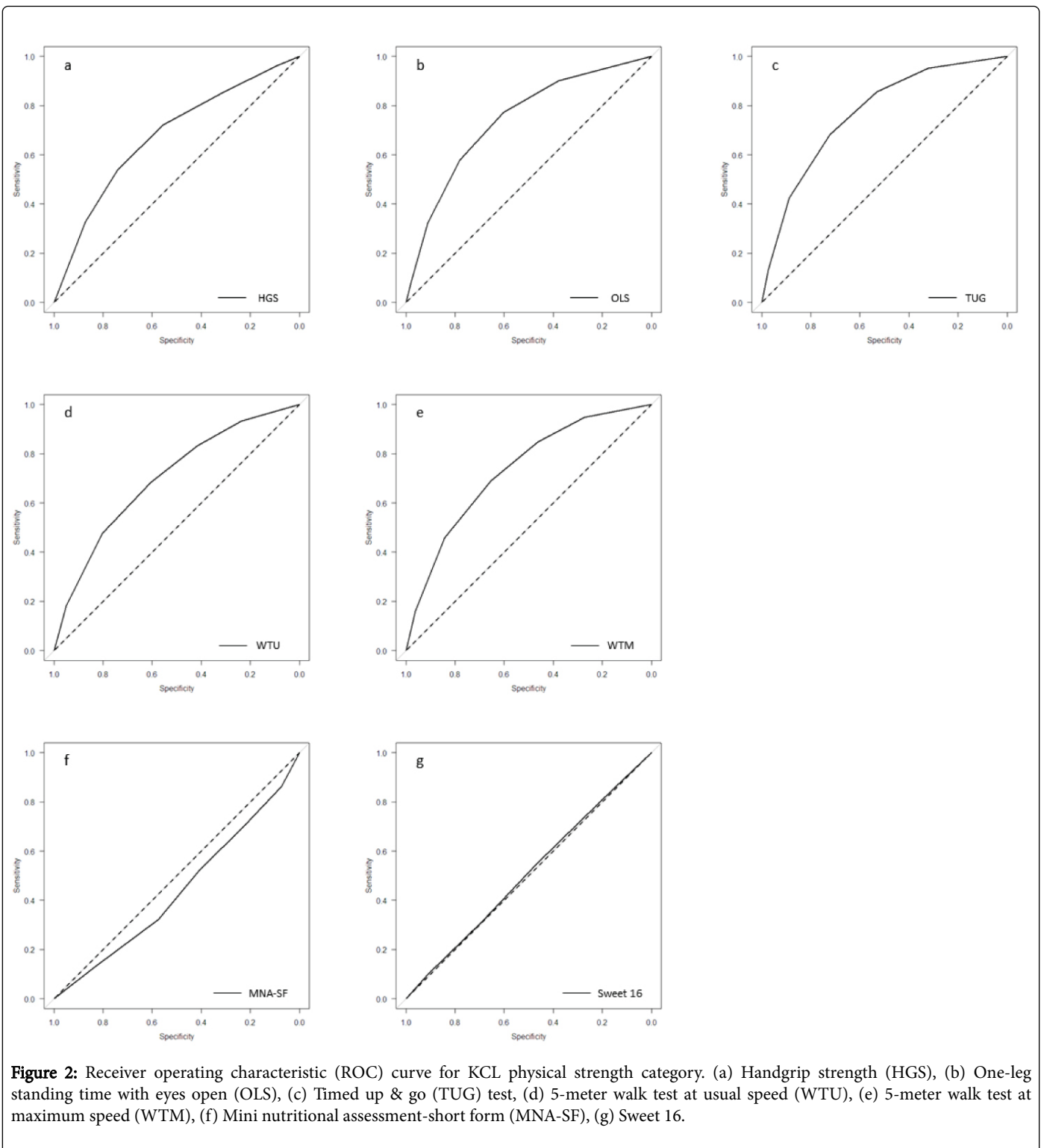
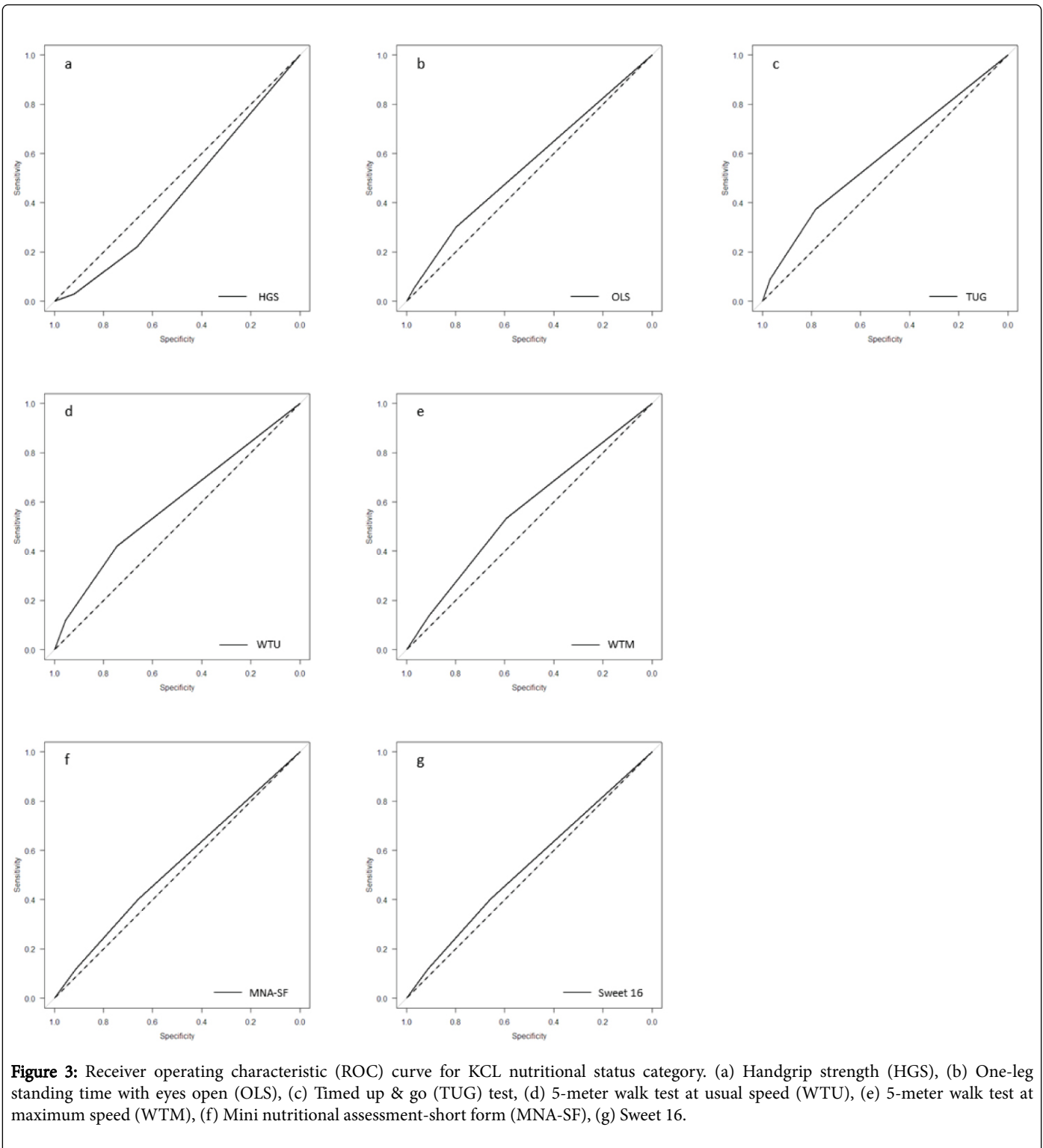


Figure 1: Receiver operating characteristic (ROC) curve for KCL lifestyle category. Handgrip strength (HGS), (b) One-leg standing time with eyes open (OLS), (c) Timed up & go (TUG) test, (d) 5-meter walk test at usual speed (WTU), (e) 5-meter walk test at maximum speed (WTM), (f) Mini nutritional assessment-short form (MNA-SF), (g) Sweet 16.





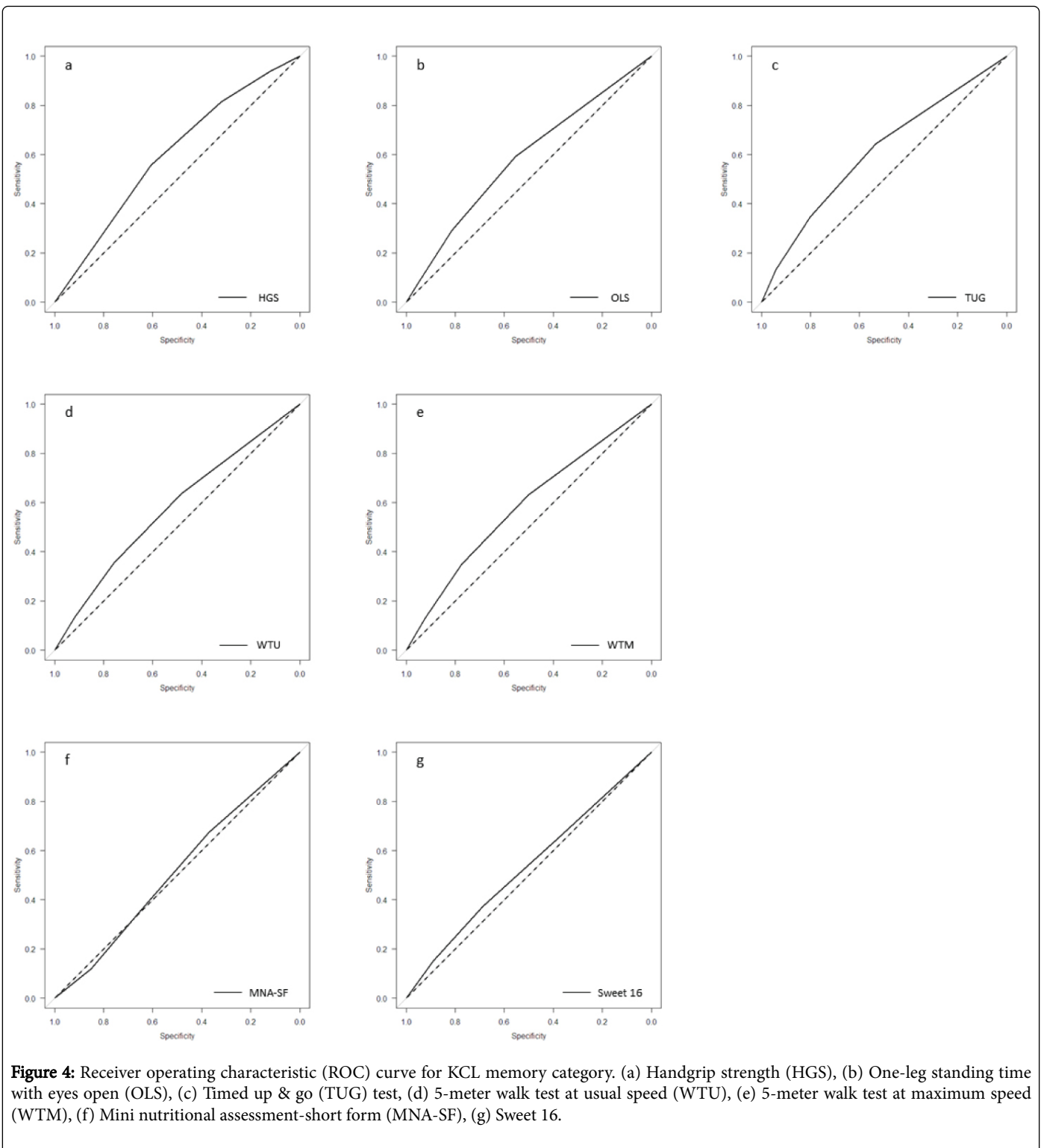


Figure 4: Receiver operating characteristic (ROC) curve for KCL memory category. (a) Handgrip strength (HGS), (b) One-leg standing time with eyes open (OLS), (c) Timed up & go (TUG) test, (d) 5-meter walk test at usual speed (WTU), (e) 5-meter walk test at maximum speed (WTM), (f) Mini nutritional assessment-short form (MNA-SF), (g) Sweet 16.

Discussion

We evaluated the validity of KCL including 20 items of its lifestyle category and each category of physical strength, nutritional status, and cognitive function in community-living elderly. There were significant differences in scores in each KCL category between participants with and without functional decline seen in physical, nutritional, and

cognitive functioning assessments. Multivariate analyses showed that the KCL lifestyle category was associated with age, lower back pain, history of falls, cerebral stroke, each individual physical functioning assessment (HGS, OLS, and TUG), MNA-SF, and Sweet 16. The KCL physical strength category correlated with physical functioning assessment except for WTM; the KCL nutritional status category correlated with MNA-SF; and the KCL physical strength category

correlated with Sweet 16. The ROC curves exhibited a moderately accurate relationship of the KCL physical strength category with overall physical functioning assessments.

The KCL physical strength category contains 5 questionnaires including upstairs, standing, walking, and fall. We studied 4 kinds of physical functioning in this research. The OLS test is a clinical tool that assesses postural steadiness in a static position using a quantitative measurement [16]. The TUG involves components of walking, turning, and transferring from sitting to standing. The KCL questionnaires of physical ability are directly concerning OLS, TUG, and two kinds of walking tests. HGS was also associated with the KCL physical strength category. Muscle strength of handgrip was associated with the TUG, functional balance measured by the Berg Balance Scale score, and walking speed [17-19]. The above results may have been obtained for these reasons. Concerning the relationships between the KCL physical strength category and participants' background, the multivariate analysis showed that age, lower back pain, history of falls, and cerebral stroke were significant predictors of the KCL physical strength category. The decline in physical functioning among elderly individuals may be explained by increasing age and previous trauma history because these complications can exacerbate age-related decline in physical, social, and psychological functioning, creating a vicious circle [20].

The KCL nutritional status category has 2 questionnaires of weight loss and BMI, both of which are included in the MNA-SF that basically comprises of 5 questionnaires. Our multivariate analysis indicates that the KCL nutritional status category correlated with BMI. There were also significant associations of the KCL nutritional status category with TUG, WTU, and WTM by the multivariate analysis and with all physical functioning assessments by the ROC analyses. These results are consistent with those of previous studies [7].

The KCL cognitive category includes 3 questionnaires about memory. Sweet 16 is an interactive and actual memory test [14]. These two evaluations differ in terms of subjective and objective assessment, although both evaluate memory function. The multivariate analyses showed that the KCL cognitive category was associated with Sweet 16. There were no correlations between the KCL cognitive category and all measures of physical functioning or the NMA-SF. Atkinson et al. [21] reported that baseline global cognitive functioning and changes in global cognitive functioning were associated with changes in physical performance, but baseline physical performance was not associated with cognitive changes in their elderly sample. On the other hand, several previous studies have shown that cognitive functioning greatly influence physical functioning [8,22,23]. Furthermore, the nutritional status correlated with cognitive function [24]. Only 3 questionnaires in the KCL cognitive category may have been inadequate to predict both, physical functioning and nutritional status.

KCL lifestyle category including daily life, physical strength, nutritional status, oral function, the extent to which one is housebound, and cognitive status are useful to objectively assess frailty among elderly individuals. The geriatric assessment is a multidimensional and multidisciplinary assessment designed to evaluate an older person's functional ability, physical health, cognition, mental health, and socioenvironmental circumstances. In a cross-sectional study, Fukutomi et al. [9] showed that at-risk groups in all KCL categories exhibited lower ADLs, lower subjective quality of life scores, and higher scores on a geriatric depression scale. The results of our multivariate analyses are consistent with previous studies reporting that age [19], lower back pain [25], falls [17], previous fractures [26],

and cerebral stroke [27], are all factors associated with poorer scores in the KCL lifestyle category.

There are several limitations in the present study. First, there is an over-representation of women in this project. This difference may be because the population of women aged 65 and older is 1.5 times higher than that of men [28] in Japan; in addition, women tended to more actively participate in this project despite the efforts of the office of Kumamoto Prefecture Community-based Rehabilitation Support System Promotion Project to recruit all elderly residents in the prefecture. Second, as this investigation is a cross-sectional study, causal relationships could not be determined. In our cohort, longitudinal studies of changes in physical functioning may provide further information. Third, as this was an observational study, there were instances of missing data. We used a pairwise-deletion method for handling missing data [29].

Conclusion

We investigated validity of the KCL in physical strength, nutritional status, and cognitive categories against the physical, nutritional, and cognitive assessments in a group of healthy elderly participants and those requiring long-term care. We confirmed significant associations of the KCL categories of physical strength, nutritional status, and cognitive functioning with the assessments of physical functioning, nutrition, and cognitive status, respectively. The KCL physical strength category is especially a valid tool for predicting physical functioning and general frailty aspects in older adults. The KCL is recommended for use in community and clinical practice as a screening tool to assess frailty status or a higher risk of dependence because of its short questionnaire and easy administration.

Competing Interests

The author reports no conflicts of interest pertaining to this work.

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1	Do you use public transportation (bus or train) to go out on your own?	Q.1-20 Score more than 9 out of 1-20 items (risk group ≥10 negative answers)
2	Do you shop for daily necessities?	
3	Do you manage financial matters such as savings or deposits by yourself?	
4	Do you visit homes of friends?	
5	Do you give advice to friends or family members who confide in you?	
6	Are you able to go upstairs without using handrails or the wall for support?	Q.6-10 Physical strength (risk group ≥3 negative answers)
7	Are you able to stand up from a sitting position without support?	
8	Are you able to walk continuously for 15 min?	
9	Have you experienced a fall in the past year?	
10	Do you feel anxious about falling when you walk?	
11	Has your weight declined by 2-3 kg in the past 6 months?	Q.11-12 Nutritional status (risk group = 2 negative answers)
12	Height: cm; Weight: kg; BMI	
13	Have you experienced more difficulty chewing tough foods lately than you did 6 months ago?	Q.13-15 Oral function (risk group ≥2 negative answers)
14	Do you ever experience choking or coughing when drinking tea or soup?	

15	Are you bothered by feelings of thirst or dry mouth?	
16	Do you go out at least once a week?	Q.16 Being Housebound (risk group = answered negatively in Q.16. Q.17 is referred question.)
17	Do you go out less often than you did last year?	
18	Do others point out your forgetfulness or tell you, "You always ask the same thing."	Q.18–20 Cognitive function (risk group ≥1 negative answers)
19	When you want to make a call, do you usually search for the telephone number and call on your own?	
20	Do you sometimes not know what the date is?	
21	(In the past 2 weeks) Have you felt no sense of fulfillment in your life?	
22	(In the past 2 weeks) Have you been unable to enjoy things that you enjoyed before? group ≥2 negative answers)	Q.21–25 Depression risk (risk group ≥2 negative answers)
23	(In the past 2 weeks) Are the things that you could do easily before, difficult now?	
24	(In the past 2 weeks) Have you felt that you are not a useful person?	
25	(In the past 2 weeks) Have you felt exhausted for no apparent reason?	
BMI, body mass index		

Appendix Table 1: Criteria for high risk in each category of the “25-item Kihon Checklist (KCL)” defined by Japanese Ministry of Health, Labour and Welfare.

Item No.	Item Description	Cognitive Domain	Points
1 – 8	Orientation to time and place	Temporal/spatial orientation	8
9 – 11	Immediate repetition (3 items)	Registration	3
12 – 13	Digit span backward	Sustained attention	2
14 – 16	Recall (3 items)	Short-term memory	3

Appendix Table 2: Description of Sweet 16 items.