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AN OPTIMAL QUESTIONNAIRE REPRESENTING SLOW GAIT SPEED(<1M/S) IN COMMUNITY-DWELLING OLDER ADULTS: THE KOREAN FRAILTY AND AGING COHORT STUDY (KFACS)

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Abstract: *Objectives:* This study was conducted to find an optimal questionnaire to evaluate the slow gait speed seen in community dwelling elderly. *Design:* Four questions asking about difficulty in walking were compared against the measured usual gait speed. The questions were: 1) Is it difficult to walk 100 m without help? 2) Is it difficult to walk 300 m without help? 3) Is it difficult to walk around one lap of a 400-meter track without help? 4) Can you cross a crosswalk before the green on the crosswalk light turns red? *Participants:* The subjects were 1479 older adults aged 70 to 84 years who had responded to the four questions and completed gait speed measuring in the first baseline year (2016) of the Korean Frailty and Aging Cohort Study. *Results:* Of the four questions, "Is it difficult to walk around one lap of track (400 m) without help?" showed the highest kappa coefficient (0.357), sensitivity (0.61), and negative predictive value (0.82). *Conclusion:* Based on the results of this study, the authors suggest that "Difficulty in walking around one lap of a 400-m track without help" may be the best question to use when evaluating slow gait speed.

Key words: FRAIL scale, questionnaire, gait speed, frailty, Korea.

Introduction

Frailty is defined as an increased vulnerability to stress in the elderly population and is associated with adverse clinical outcomes, including increased mortality and functional dependence (1-3) and increased health expenditures (4, 5). In Korea, the proportion of the elderly population is rapidly increasing, and accurate aging evaluation of elderly people is becoming important with increasing concern about frailty (6, 7). To diagnose frailty based on the Fried phenotype (Cardiovascular Health Study [CHS] frailty criteria), gait speed and grip strength must be measured, which brings about a big limitation to the diagnosis of frailty in many clinical settings. For an easy screening of frailty, the FRAIL (fatigue, resistance, ambulation, illness, and loss of weight) questionnaire has been developed and validated by Morley et al. This questionnaire enables rapid screening for frailty, and has been shown to identify persons at risk for functional deterioration (8, 9).

The original question regarding ambulation in the 2008 FRAIL scale was "Ability to walk one block" (10). This question was changed to "Any difficulty walking several hundred yards alone and without aids" in 2012 (8). Thereafter, the Korean version of the FRAIL questionnaire (K-FRAIL scale) was published with translation and validation (4). The ambulation part was translated into "Difficulty walking 300 m without help." However, when translating a questionnaire from a foreign to a native language, cultural differences should be considered.

In fact, it was translated into "Cannot walk 100 m" in China (6), and the study conducted in Hong Kong translated it into "Cannot walk two to three blocks" (9). In addition, the systematic review of the frailty evaluation tool conducted in Europe demonstrated that there are a variety of questionnaires to evaluate ambulation (11). In the INTER-FRAIL questionnaire study conducted in Italy, "Difficulty in walking 400 m'" was used and best predicted disability and frailty (12). Since gait speed is sometimes used as a single index in assessing frailty (13, 14), it is essential to develop an optimum questionnaire to represent slow gait speed, but there has been controversy as to the specific question that is best for indicating actual gait speed or ambulation capacity (3). Therefore, this study aimed to find the optimum questionnaire to detect slow gait speed in community-dwelling older adults.

Materials and methods

Study participants

This study was conducted in subjects aged 70 to 84 years old who participated in the Korean Frailty and Aging Cohort Study (KFACS). The KFACS is a nationwide, multicenter, cohort study initiated in 2016 with 3,014 participants, stratified by age and gender (15). This cohort study aimed to identify risk factors for frailty and measures to prevent it in community-dwelling older adults. The inclusion criteria were elder adults who did not have serious cognitive impairment and who could provide informed consent on their own. Among 1,559 KFACS participants in the first year, 1,479 persons who were evaluated completely for the Fried frailty phenotype were included as study subjects.

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Table 1
General characteristics of the study subjects

Characteristic	Gait speed			P-value †
	Total (n=1479)	≤1.0 m/sec (n=438)	>1.0 m/sec (n=1041)	
Age, mean ± SD	76.1 ± 3.9	77.8 ± 4.0	75.5 ± 3.7	<0.001
Sex, Female, n(%)	781 (52.8)	285 (65.1)	496 (47.6)	<0.001
Residence, n(%)				
Metropolitan	459 (31.1)	120 (27.4)	339 (32.7)	0.045
Others	1016 (68.9)	318 (72.6)	698 (67.3)	
Education, n(%)				
≤ 6 years	698 (47.3)	282 (64.5)	416 (40.0)	<0.001
7~12 years	536 (36.3)	117 (26.8)	419 (40.3)	
≥ 13 years	242 (16.4)	38 (8.7)	204 (19.6)	
Marital status, n(%)				
Married	958 (64.8)	236 (53.9)	722 (27.4)	<0.001
Widow	473 (32.0)	188 (42.9)	285 (27.4)	
Divorced/separated	45 (3.0)	13 (3.0)	32 (3.1)	
Unmarried	2 (0.1)	1 (0.2)	1 (0.1)	
Smoking (lifetime), n(%)				
< 5 packs	11 (0.7)	2 (0.5)	9 (0.9)	0.001
≥ 5 packs	565 (38.2)	133 (30.4)	432 (41.5)	
never smoker	902 (61.0)	303 (69.2)	599 (57.5)	
Alcohol drinking, n(%)				
< 1 /month	529 (49.3)	180 (62.5)	349 (44.5)	<0.001
1~4 /month	269 (25.1)	59 (20.5)	210 (26.8)	
≥ 2~3 /week	274 (25.6)	49 (17.0)	225 (28.7)	
Cognition, n(%)				
K-MMSE score ≥ 23	1236 (83.6)	378 (86.3)	858 (82.4)	0.038
Mood , n(%)				
K-GDS score ≥ 8	230 (15.6)	118 (26.9)	112 (7.6)	<0.001
Nutrition, MNA score	12.86 ± 1.47	12.62 ± 1.63	12.97 ± 1.38	<0.001
No. of medications	4.23 ± 8.0	5.84 ± 11.43	3.55 ± 5.84	<0.001
Comorbidity‡	1.33 ± 1.02	1.63 ± 0.99	1.20 ± 1.01	<0.001
Physical performance, TUGT	10.69 ± 2.87	12.96 ± 3.55	9.74 ± 1.83	<0.001
Grip strength, Kg	25.75 ± 7.65	22.17 ± 6.89	27.25 ± 7.45	<0.001
Frailty, n(%)*	169 (11.4)	151 (36.0)	18 (1.7)	<0.001

†P-value of t test for continuous variables or $\chi 2$ for categorical variables; ‡Self-reported comorbidities: hypertension, diabetes mellitus, Cancer, chronic obstructive pulmonary disease(COPD), myocardial infarct, heart failure, angina, asthma, arthritis, Cerebral infarction, kidney disease; MMSE: mini-mental state exam, K-GDS: Korean Geriatric Depression Scale, MNA:mininutritional assessment, TUGT: timed up and go test; *CHS Frailty index ≥ 3

Self-reported ambulation difficulty

The subjective evaluation included asking about difficulty in ambulation. Ambulation difficulty was assessed by using four interview questions: 1) Is it difficult to walk 100m without help? (16) 2) Is it difficult to walk 300m without help? (17, 18) 3) How difficult is it to walk around one lap (400m) without help or assistance? (19) 4) Can you cross a crosswalk before the green light on the crosswalk traffic light turns red? (20)

The response options for questions 1, 2, and 4 were "yes" or "no". The response options for question 3 were: 1) "Not

Table 2
Mean usual gait speed (m/s) by different questions about ambulation difficulty without help

		N	Mean gait speed (m/s)	SD	t	P-value†
walking 300 m	difficulty	391	0.98	0.25	-14.086	<0.001
	no difficulty	1088	1.18	0.25		
Walking 100 m	difficulty	238	0.94	0.25	-12.559	<0.001
	no difficulty	1241	1.17	0.25		
Walking one lap of a track (400 m)	difficulty	511	0.99	0.25	-15.597	<0.001
	no difficulty	968	1.20	0.25		
Walking crosswalk during green light	difficulty	75	0.94	0.30	-5.541	<0.001
	no difficulty	1404	1.14	0.26		

†P-value of independent t test

difficult", 2) "A little difficult", 3) "Very difficult", and 4) "unable". The authors defined (1) "Not difficult" as "No difficulty" and the rest as "Difficulty".

Usual gait speed

The usual gait speed over 4m was measured using an automatic timer (Gaitspeedometer, Dynamicphysiology, Daejeon, Korea). A flat 7-m walking path was marked with tape at 0-, 1.5-, 5.5-, and 7-m points, and an automated timing system using ultrasonic sensor beams was set up at 1.5-m and 5.5-m points. This provided a 1.5-m acceleration zone, a 4-m timing area, and a 1.5-m deceleration zone. Gait speed was measured over a 4-m distance with acceleration and deceleration phases of 1.5m each at a usual gait speed. Participants performed two trials with results averaged to the nearest 0.01 m/s (21). Slow gait speed was defined as gait speed less than 1m/sec (22-26).

Demographic and health-related information

The subjects' demographics including age, sex, residence, health status (comorbidities, number of medications), smoking, drinking, educational level, and marital status were investigated through face-to-face interviews. Other domains were also evaluated: mood status using the Korean version of the short form geriatric depression scale (SGDS-K, cut-off ≥ 8 indicates likely depressive disorder) (27), nutritional status using the mini nutritional assessment (MNA), cognitive function using Korean Mini-Mental State Examination (K-MMSE, cutoff ≤23 means high likelihood of dementia), and frailty status (CHS frailty criteria, cutoff ≥ 3 indicates frailty). CHS frailty criteria consist of five components as follows: unintentional weight loss, exhaustion, low physical activity, weakness, and slowness. The CHS frailty scale score, with the sum of each component scored as one point, was classified as frail (3–5). Weakness was evaluated by grip strength and physical performance using the timed up and go test (TUG). For hand grip strength, a digital hand grip gauge (Takei TKK 5401, Takei Scientific Instruments, Tokyo, Japan) was used. The grip strength of each hand was measured once, one at a time. After three minutes, a second round of measurement was performed. The highest value for each hand was included in the analysis. For the 3-m TUG test, the participant stands up from a chair without armrests and walks 3 m at their usual pace, turns at a marker, returns to the chair, and sits down. The TUG time was defined as the time from standing up to sitting back down.

Statistical analysis

Continuous variables were analyzed by the independent t-test and categorical variables by the chi square test. The data are presented as means ± SD or as numbers (percentages). Sensitivity, specificity, positive predictive value(PPV), and negative predictive value(NPV) were calculated for each of the four questions.

The kappa coefficient was used to evaluate the agreement between self-reported difficulty in ambulation and observed slowness. Values <0 kappa coefficient indicates no agreement, 0–0.2 slight, 0.21–0.40 fair, 041–0.60 moderate, 0.61–0.80 substantial, and 0.81–1 almost perfect agreement (28). Statistical analysis was performed using IBM SPSS Statistics software Version 23.0 (IBM Corp., Armonk, New York, USA:) and significance was defined as a P value less than 0.05.

Results

General characteristics of the study population

A total of 1479 subjects were analyzed for demographic characteristics; of these, 419 had slow gait speed (<1 m/s). (Table 1). The median ages of the slow gait group and normal gait speed group were 77.7 and 75.5 years, respectively ($p < 0.001$). The proportion of females was higher in the slow gait speed group than in the normal gait group (65.1% vs. 47.6%). The mean grip strength was significantly lower in the slow gait group than in the normal gait group. The proportion of frailty was much higher in the slow gait group than in the normal gait group (36.0% vs 1.7%). Cognitive status was similar between two groups.

Table 3
Accuracy of four questionscomparing about ambulation difficulty without help

Self-reported difficulties	Slow gait speed		Sensitivity	Specificity	PPV	NPV
	Yes	No				
Walking 100 m						
difficulty	10%	6%	33%	91%	61%	76%
no difficulty	20%	64%				
Walking 300 m						
difficulty	15%	12%	49%	83%	55%	79%
no difficulty	15%	58%				
Walking one lap of a track (400 m)						
difficulty	18%	16%	61%	77%	52%	82%
no difficulty	12%	54%				
Walking crosswalk during green light						
difficulty	3%	2%	11%	97%	61%	72%
no difficulty	27%	68%				

PPV = positive predictive value; NPV = negative predictive value

Mean usual gait speed according to questions about ambulation difficulty

When participants were asked four questions including "Difficulty walking 100 m without help," "Difficulty walking 300 m without help," "Difficulty walking around 1 lap (400 m) of a track without help," "Difficulty crossing a crosswalk before the green light turns red," the average of usual gait speed was slower in the «difficult» respondent group than in the "no difficulty" respondent group for all the four questions ($p < 0.001$) (Table 2).

Agreement between slow gait speed and questions about ambulation difficulty

The question of difficulty walking 400 meters (one lap of a track) had the highest sensitivity of 0.61 and the highest negative predictive value of 0.82 for slow gait speed. (Table 3) The agreement (kappa score) between slow gait speed and self-reported difficulties was highest for the question asking about the difficulty walking 400 meters (one lap of a track) (kappa 0.357). (Table 4)

In addition, subgroup analysis was performed regarding age, gender, residence, education, marital status, K-MMSE score, and SGDS-K score. Difficulty in walking 400 meters (one lap of a track) showed the highest kappa value for all subgroups except for those with less than six years of education.

Discussion

The purpose of this study was to determine the most optimal questionnaire for assessing slow gait speed in the elderly by confirming the agreement between measured slow gait speed and the questions. In this study, "slow gait speed" was defined as less than 1 m/sec, which has been used to define slow walking speed in Taiwan and Japan (22-25). Cesari et al. also suggested that a cut-off of 1.0m/s should be identified as a clinically meaningful threshold marker (26).

In this study, the question "How difficult is it to walk around one lap of a track (400 m) without help?" showed the highest agreement with the measured slow gait speed. This result can be supported by the INTER-FRAIL questionnaire study, which showed that "difficulty walking 400 m" accurately predicted disability and frailty (12). The kappa value was between 0.21 and 0.41, and the strength of agreement was fair, but not excellent. One possible explanation is that self-reported assessment tools can be influenced by physiological, environmental, cultural, and personal factors, and underestimation or overestimation can result in differences from the actual state (29-31). Even though 4-meter walking speed is a measure of short-range walking ability, the 400-meter walking question—the longest distance out of the four questions—was the best question predicting slow gait speed. This may be due to the fact that the question asks about one lap around a track, which can allow for a clearer idea of the distance than the other questions asking only about a measurement of distance. Thus, it cannot be ruled out that the possibility this question was the best predictor of slow gait speed due to the additive descriptor, "one lap of a track." In fact, laypersons may have difficulty grasping distance magnitude when they think of 100 m, 200 m, or 300 m. That may be the reason why the original question for the FRAIL ambulation scale in 2008 was uninformative: "Ability to walk one block"(10), as well as the 2012 question, "Any difficulty walking several hundred yards alone and

Table 4
Agreement between questions for difficulty in ambulation and slow gait speed(<1m/s)

	Walking 100 m		Walking 300 m		Walking one lap of a track (400 m)		Walking crosswalk during green light	
	kappa	95% CI	kappa	95% CI	kappa	95% CI	kappa	95% CI
Total	0.275	0.221~0.322	0.329	0.273~0.380	0.361	0.308~0.409	0.102	0.062~0.139
Sex								
Male	0.252	0.171~0.334	0.344	0.257~0.426	0.386	0.310~0.466	0.076	0.014~0.141
Female	0.260	0.189~0.333	0.282	0.207~0.349	0.305	0.237~0.371	0.112	0.058~0.162
Age, years								
< 75	0.208	0.117~0.306	0.228	0.130~0.323	0.300	0.212~0.398	0.142	0.058~0.231
≥ 75	0.278	0.216~0.343	0.343	0.279~0.411	0.352	0.289~0.415	0.083	0.04~0.128
Residential area								
Metropolitan	0.120	0.027~0.211	0.227	0.128~0.323	0.249	0.144~0.342	0.007	-0.025~0.047
Others	0.327	0.262~0.389	0.368	0.304~0.430	0.400	0.341~0.458	0.13	0.08~0.184
Education								
≤ 6 years	0.298	0.230~0.369	0.333	0.259~0.409	0.307	0.259~0.409	0.106	0.064~0.154
> 6 years	0.170	0.092~0.254	0.236	0.159~0.318	0.336	0.159~0.318	0.082	0.022~0.142
Marital status								
Married	0.252	0.186~0.318	0.354	0.282~0.422	0.377	0.310~0.441	0.088	0.037~0.145
Others	0.273	0.189~0.353	0.254	0.169~0.347	0.285	0.208~0.368	0.111	0.055~0.169
MMSE score								
< 23	0.262	0.117~0.401	0.300	0.168~0.429	0.404	0.285~0.530	0.179	0.068~0.301
≥ 23	0.278	0.220~0.334	0.334	0.279~0.392	0.352	0.298~0.409	0.088	0.05~0.126
K-GDS score								
< 8	0.232	0.171~0.293	0.293	0.231~0.355	0.326	0.267~0.383	0.047	0.01~0.087
≥ 8	0.275	0.151~0.393	0.295	0.162~0.417	0.344	0.223~0.469	0.181	0.09~0.270

CI : confidence interval; kappa coefficient : values <0 indicates no agreement and 0-0.2 as slight, 0.21-0.40 as fair, 041-0.60 as moderate, 0.61-0.80 as substantial, and 0.81-1 as almost perfect agreement

without aids"(8). In fact, the original question did not indicate an exact distance for the question. In terms of distance, a question on crossing a crosswalk (10-20 meters) during a green light should have shown the highest agreement with slow gait speed (4 meters), but ended up showing the lowest agreement between measured gait speed and self-reported gait speed. The crosswalk signal time is known to be insufficient in Korea and that may explain why difficulty crossing a crosswalk (10-20 meters) during a green light showed the poorest agreement with slow gait speed (32). Another possible explanation may be related to the slow cognitive response and late start on crosswalk traffic for pedestrians over 65 years of age (33).

In subgroup analyses, gender, residential area, education, and marital status were not associated with high agreement between measured slow gait speed and difficulty in walking around one lap of a track (400 m) compared with the other questions. For the subgroup with less than six years of education, difficulty in 300 m walking showed the highest kappa, but difficulty in 400 m walking showed the next highest kappa. This exception for the less than six years of education subgroup may be chance.

The Korean FRAIL (K-FRAIL) scale involves asking the question, "Is it difficult to walk 300 m without help?" to evaluate ambulation. The current study found that the question is also a good predictor of slow gait speed, but study results more strongly support the question, "Is it difficult to walk around one lap of a track (400 m) without help?" This result may have originated from the differences in the study subjects. The K-FRAIL scale was developed and validated for outpatients of a hospital, but the current study was conducted with community- dwelling older adults. Thus, the question about difficulty in walking one lap of a track (400 m) could be better than the question about difficulty in walking 300 m in predicting frailty for community-dwelling older adults.

Questions about ambulation difficulty should differ by

country, depending on the structure of streets and commuting systems (34, 35). In Shanghai, Yanpei et al. used the question about difficulty walking 100 meters for the FRAIL questionnaire (6) and a study in Hong Kong used a question about difficulty walking a flat two to three blocks (9). The Korean version of the FRAIL scale used a question regarding difficulty walking 300 m (4), but the authors suggest that another question, "Difficulty walking one lap of a 400 m track," may be better for community-dwelling older adults. A validation study using a prospective cohort is needed.

Conclusion

"Difficulty in walking around one lap of a 400-m track without help" may be the best question for evaluating slow gait speed in community-dwelling elderly. The question performed the best in subgroup analysis regarding age, gender, residence, marital status, MMSE score, and GDS score.

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Ethics statement: The research plan was approved by the Institutional Review Board of Kyung Hee University, and written consent was obtained from each subject prior to commencement of the study (approved NO. KHUH 2019-02-016).

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