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		ヒト	動物				
対象の内訳	対象	一般健常者	空白	地　域	欧米	研究の種類	縦断研究
	性別	男女混合	(　　　)		(　　　)		コホート研究
	年齢	(72歳)			(　　　)		(　　　)
	対象数	1000～5000			(　　　)		前向きコホート
					(　　　)		(　　　)
調査の方法	実測	(　　　)					
アウトカム	予　防	なし	なし	なし	なし	(死亡)	(　　　)
	維持・改善	な　し	な　し	な　し	なし	(	(　　　)

図　表

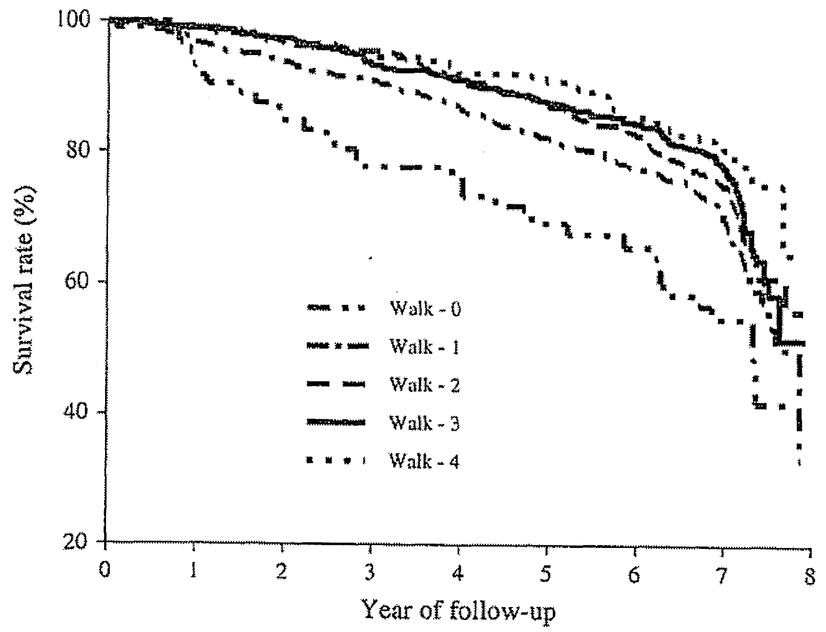

FIGURE 2. Survival curve of older Mexican Americans by walking speed category scores at baseline interview, Hispanic Established Population for the Epidemiologic Study of the Elderly, 1993–2000.

図表掲載箇所	
概　要 (800字まで)	<目的>歩行速度と死亡リスクとの関係を明らかにすること。<方法>コホート名：Hispanic Established Population for the Epidemiologic Study、対象者数：1304人、追跡期間：7年、因子評価方法詳細：通常歩行速度で8フィート歩くのにかかる時間、因子の単位：秒/8 feet (2.4384 m。歩行速度で以下の5分位に分けた。分位1：2-3.9秒/8 feet、分位2：4-5.9秒/8 feet、分位3：6-8.9秒/8 feet、分位4：9秒/8 feet以上、因子5：記録なしであった。歩行速度と死亡リスクとの関係は、分位1：1、分位2：2.01(1.42-2.83)、分位3：2.39(1.67-3.41)、分位4：4.12(2.85-5.97)、分位5：3.52(2.4-5.17)であった。
結　論 (200字まで)	高齢者で通常歩行速度が遅いほど死亡リスクが高いことが示唆された。
エキスパートによるコメント (200字まで)	通常歩行速度は簡易に測定可能な評価指標であり、健康関連体力指標として有用であることを示した点で意義のある研究である。

担当者　田中憲子

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MORTALITY

Physical performance measures as predictors of mortality in a cohort of community-dwelling older French women

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Abstract. This prospective cohort study evaluate the predictive value of physical performance measures for mortality in older French women, in particular those with a high health status. The subjects were 7,250 community-dwelling non-disabled French women aged 75 years or older, enrolled in the Epidémiologie de l'ostéoporose (EPIDOS) study. The short physical performance battery (SPPB), including walking speed, repeated chair stands, and balance tests, was administered and handgrip strength was measured. Anthropometric measurements, physical function, cognitive performance, sensory status, smoking, medical history, medication use, subjective self-assessment of health status, and physical activity level were assessed at the baseline visit. During a mean follow-up of 3.8 years, 754 (10.4%) participants died. Complementary analysis was performed on the 2,157 non-disabled healthiest participants (no disease at baseline). The SPPB and handgrip strength distinguished a gradient of risk for mortality from a low to high functional spectrum. Risk of death was 2.04-fold higher in poor (SPPB 0–6) than in good (SPPB 10–12) performers and 1.56-fold higher in participants with lower tertile grip strength. Walking speed alone also distinguished a gradient of mortality risk. After adjustment for confounders, low SPPB, grip strength score and slow walking speed remained significantly associated with death. In the non-disabled healthiest women, no physical performance measure predicted death. In community-dwelling elderly French women, physical performance measures significantly and independently predicted mortality. Increased risk of death was partly explained by baseline health status and was absent in the healthiest elderly.

Key words: Elderly, Mortality, Physical Performance, Walking speed, Women

Abbreviations: BMI = body mass index; CI = confidence interval; COPD = chronic obstructive pulmonary disease; DXA = dual-energy X-ray absorptiometry; EPESE = established populations for epidemiological studies in the elderly; EPIDOS = Epidémiologie de l'ostéoporose; HR = hazards ratios; IADL = instrumental activities of daily living; SD = standard deviations; SPPB = short physical performance battery

Introduction

Low results on standardised physical performance measures, such as the Established Populations for Epidemiological Studies in the Elderly (EPESE) short physical performance battery (SPPB) (based on walking speed, repeated chair stands, and balance tests) [1–6] and hand grip strength [7–10], independently predict adverse outcomes such as physical disability, hospitalisation and institutionalisation even in non-disabled older persons. Some prospective studies have also indicated these measures as predictors of mortality [3, 5, 7, 11–17]. It has therefore been suggested that physical performance measures should be implemented in clinical as well as research settings to improve the evaluation of older persons.

A major limitation to generalisation of the physical performance measures is that most studies have been conducted in United States populations and extremely limited prospective data are available for European populations. It is not known whether the predictive validity of physical performance tests may be applicable to populations who live in different environments and have different life-styles. Furthermore, evidence linking poor physical performance with mortality in older persons is limited and requires further investigation [5, 8]. This information may have important implications for enhancing the predictive validity of physical performance tests for major health-related events in different populations.

The aim of the present study was to evaluate the predictive value for mortality of the SPPB and hand grip strength. It was conducted as a secondary analysis of a large prospective epidemiological study, the Epidémiologie de l'ostéoporose (EPIDOS) study, which enrolled older women living in the community in France.

Materials and methods

Study population

From 1992 to 1994, 7,574 women aged 75 years and older were enrolled in the EPIDOS study [18]. EPIDOS is a prospective epidemiological study carried out in five French cities (Amiens, Lyon, Montpellier, Paris, and Toulouse) to investigate risk factors for hip fracture in healthy older persons. All participants provided written informed consent and the entire study protocol was approved by the local Ethical Committee of each city.

Participants were sampled from electoral lists. All women aged 75 years or older were invited by mail to participate in the EPIDOS study. Exclusion criteria included: (1) inability to walk independently; (2) institutionalisation; (3) previous history of hip fracture or bilateral hip replacement; (4) inability to understand or answer the study questionnaires.

Baseline examination was performed in each clinical research centre by a specially trained nurse. The methods used in the baseline survey have been described in detail previously [18]. During the follow-up, participants were contacted every 4 months by mail or telephone.

For the present analyses we excluded participants reporting (i) confinement to bed for at least 2 months or more during the last year and/or (ii) motor impairment such as stroke sequelae and/or (iii) one or more of the following comorbid diseases which have led to an overnight hospitalisation during the last year: stroke, hypertension, diabetes, coronary heart disease, cancer, Parkinson's disease. These exclusion criteria were aimed at excluding participants at higher risk of mortality and with characteristics known to influence their baseline physical performances. Three hundred twenty-four participants were then excluded from the initial 7,574 participants. Fifty-nine (18.2%) of those excluded died during follow-up. The sample population considered for the present analysis consisted of 7,250 participants.

Of these remaining 7,250 participants (1,400 from Amiens, 1,504 from Lyon, 1,482 from Montpellier, 1,458 from Paris, and 1,406 from Toulouse), 196 (2.7%) refused to perform the entire SPPB (27 refused the walk test (0.4%), 137 the repeated chair stand test (1.9%), 53 (0.7%) the balance test, and 95 (1.31%) the grip strength task). Amongst the 7,250 participants, 754 died (10.40%). At follow-up, among those not known to have died, complete information was not available for 30 participants (0.41%). There were no significant differences in mortality across the five cities.

In order to better understand the causal pathway leading from low physical performance to death, secondary analyses were carried out in a restricted sample. This was done because functional limitation, as an indicator of poor health status, may predict mortality. Indeed, neurological diseases affecting gait, such as Parkinson's disease, cerebrovascular diseases, skeletal muscular conditions and cardiovascular diseases, may influence functional performance as well as the risk of death. We excluded from this restricted analysis all subjects with documented disease at baseline or disability that could affect results of the physical performance measures. We also excluded participants with poor physical performance (defined as a SPPB score below 4). Therefore, restricted analysis was performed on 2,157 participants, defining the 'non-disabled healthiest participants' (death events: 123, 5.44%).

Physical performance measures

The following objective measures of physical performance were assessed at baseline:

Short physical performance battery
The SPPB is based on three timed tests: walking speed (performed on a 6-m course), repeated chair stands, and balance tests [1–6, 19]. The battery was administered by a different trained geriatric nurse in each city.

Walking speed: Participants were asked to walk at their usual pace over a 6-m course. Participants were instructed to stand with both feet touching the starting line and to start walking after a specific verbal command. Participants were allowed to use walking aids (cane, walker, or other walking aid) if necessary, but no assistance was provided by another person. Timing began when the command was given, and time in seconds needed to complete the entire distance was recorded. The faster of two walks was used for the present analysis.

Repeated chair stands test: This was performed using a straight-backed chair, placed with its back against a wall. Participants were first asked to stand from a sitting position without using their arms. If they were able to perform the task, they were then asked to stand up and sit down five times, as quickly as possible with arms folded across their chests. The time to complete five stands was recorded and used for the present analyses.

Balance test: Participants were asked to hold three increasingly challenging standing positions for 10 s each: (1) a side-by-side position; (2) semi-tandem position (the heel of one foot beside the big toe of the other foot); (3) tandem position (the heel of one foot in front of and touching the toes of the other foot).

Balance test score (in seconds) was given by the sum of seconds for which positions were held (range 0–30).

These three physical performance measures were used to calculate summary scores by using a quantile approach.

Quantile summary performance score: a score ranging from 0 to 4 was assigned to each of the three physical performance measures, where 4 indicated the best performers, and 0 the worst performers.

Four categories were computed for walking speed and repeated chair stands, according to cut points based on quartiles of the time to perform each task assessed in the SPPB [1]. The speed of the faster of two walks was scored as follows: ≤ 0.43 m/s = 1; 0.44 to 0.60 m/s = 2; 0.61 to 0.77 m/s = 3; ≥ 0.78 m/s = 4; a score of 0 was assigned to participants unable to perform the test. The time required to perform five chair stands was scored as follows: ≥ 16.7 s = 1; 13.7 to 16.6 s = 2; 11.2 to 13.6 s = 3; ≤ 11.1 = 4. A score of 0 was assigned to participants unable to perform the task. For the test of balance, participants were assigned a score of 1 if they could hold a side-by-side standing position for 10 s, but were unable to hold a semi-tandem position for 10 s; a score of 2 was assigned if they could hold a semi-tandem position for 10 s, but were unable to hold a full-tandem position for more than 2 s; a score of 3 was assigned if they could stand in a full-tandem position for 3–9 s; a score of 4 was assigned if they could stand in a full-tandem position for 10 s.

A summary score ranging from 0 (worst performers) to 12 (best performers) was calculated by adding walking speed, repeated chair stands and balance scores. This scale has proved its reliability [20] and validity for predicting institutionalisation, hospital admission and physical disability [1, 3–6]. Participants with a SPPB score between 10 and 12 were considered good performers, fair performers between 7 and 9 and poor performers between 0 and 6.

Handgrip strength

Handgrip strength was measured for the dominant hand with a hydraulic hand dynamometer (Martin Vigorimeter, Medizin Tecnik, Tuttlingen, Germany). The size of the grip was adjusted so that the participant felt comfortable. The participant stood upright with the arm vertical and the dynamometer close to the body. The maximal peak pressure expressed in Newton per square meter was recorded for a set of three contractions and used for the present analyses. Grip strength was analysed in tertiles (higher, middle, or lower tertile).

Health, disability, and physical function assessment at baseline

Potential confounders, commonly underlying death, were considered at baseline. Physical examination and a health status questionnaire were used to record comorbid diseases (hypertension, diabetes, dyslipidemia, coronary heart disease, chronic obstructive pulmonary disease (COPD), peripheral vascular disease, cancer, stroke, Parkinson's disease, depression), pain (pain of the back, hip, knee, ankle or feet) and history of fracture (other than hip fracture). Cognitive impairment was assessed with the Pfeiffer test [21]. Participants were asked to bring all their regular medication at the baseline clinic visit. Visual acuity was measured at a distance of 5 m with a Snellen letter test chart. Deafness was also assessed. Smoking (previous or current) and alcohol consumption were noted. Monthly income was divided into three groups: more than 1,300 euros, 900–1,300 euros, 450–900 euros and less than 450 euros. Highest level of education (illiterate, elementary, primary, high school, post-graduate degree) was noted.

Participants also self-reported in a structured questionnaire whether they regularly practiced recreational physical activities such as walking, gymnastics, cycling, swimming or gardening. Type, frequency and duration of each recreational physical activity were recorded. Participants were considered physically active if they had practiced at least one recreational physical activity for at least one hour a week for the past month or more. They were asked to note their subjective health self-assessment.

Anthropometrics measurements were performed by a trained technician using standardised techniques [22] in a research laboratory. Weight was measured with a beam balance scale and height with a height gauge. Body mass index (BMI) was calculated as weight/height^2. Obesity was defined as a BMI above 30 kg/m^2. Hip circumference was determined using a tape measure at the level of the maximum posterior protrusion of the buttocks. Waist circumference was measured one centimetre above the iliac crests. Calf circumference was measured with the patient supine, with left knee raised and calf at right angles to the thigh. The tape measure was placed around the calf and moved to obtain the maximal circumference. Subcutaneous tissues were not compressed. Osteoporosis was assessed for all participants by dual-energy X-ray absorptiometry (DXA, Hologic QDR 4500 W). Osteoporosis was defined as a *T*-scores of 2.5 or less on lumbar spine and/or femoral neck [23].

Subjects answered a questionnaire about their ability to perform instrumental activities of daily living (IADL) without assistance [24].

Follow-up

Participants were contacted every 4 months by mail or telephone. Mortality was ascertained through the end of 1998 by telephone call to proxies and primary-care physicians.

Statistical methods

There was no difference according to age in the distribution of the SPPB between the participants in the five cities. Analysis was therefore carried out on pooled data. Quantitative variables were expressed as means ± standard deviations (SD). Preliminary analysis was done to describe baseline participant disabilities according to their performance measures. The relationship between risk of death and baseline physical performance measures (SPPB and hand grip strength) was examined using age-adjusted Cox proportional hazard analysis in which the time scale was the age of the subjects with delayed entry to take into account the left truncation process. Thus, age was not entered as an explanatory variable in the model.

The first model (model 1) included each physical performance measurement. In the second model (model 2) we added all confounding variables which were independently associated with death in a prior multivariate Cox survival analysis performed without taking into account physical performance (IADL, diabetes, cancer, Pfeiffer cognitive test, smoking, subjective health self assessment, obesity, inability to walk outdoors and hospitalisation during the year). This model was constructed with the aim of performing all subsequent analysis with the same sample. Each component of the SPPB (walking speed, repeated chair stands and balance test) and handgrip strength was analysed separately. Restricted analysis was performed in the 2,157 non-disabled healthiest participants (model 3).

For all tests, sample size provided > 80% power to detect significant differences. A *P*-value lower than 0.05 was considered significant. Proportionality in Cox analysis was tested using Schoenfeld residuals and log–log plot. Data analysis was performed using Stata 7.0 software.

Results

Baseline characteristics of the study populations (all sample and non-disabled healthiest women) are reported in Table 1. In the all sample, average age at baseline was 80.5 years (SD 3.76). Most of the participants (68.22%) had no IADL disability at baseline. Average mean follow-up was 3.8 years (SD 0.9), corresponding to 28,142.7 participant-years of follow-up with the first entry time occurring at 75 years and the last observed exit at 103.3 years. Table 2 shows the mean physical performance scores for the whole sample according to the number of IADL disabilities. Most of the participants were high-functioning subjects, with 42.4% good, 38.5% fair and only 19.1% poor performers as defined by the SPPB score. Lower scores in all physical performance measures were associated with a stepwise increase in IADL disabilities (*P* for trend <10–4).

The mean scores for walking speed, repeated chair stands, balance test, SPPB score and handgrip strength are given in Table 2.

Table 3 shows the hazard ratios of death associated with the physical performance measures separately and the SPPB score (model 1) and for all confounders (model 2). We found a significant association between physical performance measure and risk of death (model 1). There was a risk gradient for death associated with all physical performance measures (*P* for trend < 10–4). Poor performers had almost a two-fold increased risk of death compared with good performers (HR, 1.81[1.44–2.27], $P < 0.05$). Risk of death was 1.47 (CI 1.18–1.83, $P < 0.05$) higher in participants with lower tertile than in those with higher tertile grip strength. Grip strength was significantly associated all components of the SPPB and the SPPB score ($P < 0.0001$ for all). When grip strength was included in the models, walking speed (between 0.44 and 0.60 m/s) remained the only physical performance measure independently associated with the risk of death. Figure 1 shows Kaplan–Meier survival estimates according to performers (good, fair or poor) for SPPB score or by tertiles (higher, middle or lower) for handgrip strength.

After adjustment for all confounders (model 2), a significant risk gradient for death was associated with SPPB score (*P* for trend = 0.02), grip strength (*P* for trend = 0.01) and walking speed ($P = 0.001$). Repeated chair stand and balance tests were not significant predictors of mortality ($P > 0.1$).

In restricted analysis performed on non-disabled healthiest participants, physical performance scores (walking speed, 0.99 m/s, SD 0.19; repeated chair stands, 14.75 s, SD 6.55; balance test, 26.30 s, SD 5.01; SPPB score, 9.62, SD 1.85; handgrip strength, 54.80 N/m2, SD 13.28) were higher than in the sample as a whole. None of the physical performance measures remained significantly associated with risk of death after adjustment for other confounders (Table 4). In this final model (model 3), hospitalisation during the years was the only variable which remained associated with death (HR = 5.12[2.30–11.1] $P < 10–4$).

Discussion

This study evaluates the predictive value of physical performance measures for mortality in a large sample of high-functioning community-dwelling older women in France. The age-adjusted results confirmed the previously reported association between the SPPB [5], walking speed [12, 17, 25], handgrip strength [8, 14, 26] and mortality among a European population of elderly women. This large prospective study confirms the predictive validity of physical performance measures in a large non-US population. Moreover, it

Table 1. Baseline characteristics[a] of the study populations.

	All sample n = 7,250	All sample less the non-disabled healthiest women n = 5,093	Non-disabled healthiest women n = 2,157	p
Age (mean, SD), y	80.50 (3.76)	80.90 (3.89)	79.56 (3.26)	<0.001
Education level				
Illiterate	2.1	2.7	0.6	<0.001
Elementary	18.9	21.2	13.5	
Primary	36.3	37.4	33.6	
High school	27.2	25.2	32.1	
Post-graduate degree	15.5	13.5	20.2	
IADL[b]				
0	68.2	54.8	100	–
1	15.1	21.4	–	
2	7.2	10.2	–	
3 or more	8.5	13.6	–	
Income (euros)				
>1,300	9.8	9.8	9.8	<0.001
900–1,300	9.5	10.8	6.2	
450–900	36.5	38.9	30.9	
<450	44.2	40.5	53.1	
Anthropometric measures (mean, SD)				
Weight (kg)	59.48 (9.93)	60.21 (10.16)	57.79 (9.17)	<0.001
BMI[c] (kg/m^2)	25.27 (3.97)	25.66 (4.08)	24.34 (3.53)	<0.001
Osteoporosis[d]	13.8	14.4	12.5	0.04
Obese	42.2	45.2	35.6	<0.001
Lifestyle habits				
Physical activity[e]	48.5	46.8	59.5	<0.001
Smoking (previous or actual)	13.9	2.9	4.5	0.001
Co-morbidities				
Hypertension	47.3	67.3	–	–
Diabetes	5.8	8.3	–	
Coronary heart	18.2	25.9	–	
Cancer	4.2	5.9	–	
Stroke	2.9	4.1	–	
Parkinson's disease	2.2	3.2	–	
Depression	14.5	15.8	11.4	<0.001
History of fracture[f]	44.76	44.84	44.56	0.83
Number of medication				
0	68.0	61.5	83.3	<0.001
1	12.4	13.5	9.9	
2	6.6	8.1	3.2	
3 or more	13.0	16.9	3.6	
Cognitive impairment[g]	4.3	5.2	2.0	<0.001
Subjective health self assessment				
Very good	6.4	4.8	10.2	<0.001
Good	78.5	77.0	82.1	
Bad	14.5	17.4	7.5	
Very bad	0.6	0.8	0.2	

[a]All values are expressed as percentage unless indicated.
[b]IADL 8 items, Instrumental Activity of Daily Living (food preparation, housekeeping, shopping for groceries, doing laundry, handling money, using the telephone, taking medications, using public transport).
[c]BMI = weight/height^2, Obesity was defined by a BMI >30.
[d]T-scores of 2.5 or less on lumbar spine and/or femoral neck.
[e]Participation in a recreational physical activity (hiking, gymnastics, cycling, swimming or gardening), regularly (at least one hour a week) since one month at least.
[f]Other than hip fracture.
[g]Pfeiffer score <8.

Table 2. Mean (SD) physical performance score according to the number of disabilities on the instrumental activity of daily living scale (IADL)[a]

		Number of IADL disabilities[a]					
		0	1	2	3	4 and more	P for trend
N	7250	4934	1089	521	283	406	
Repeated chair stands (s)	17.15 (8.1)	15.4 (6.9)	18.3 (8.3)	20.9 (9.0)	23.3 (9.5)	26.0 (9.7)	10^{-4}
Walking speed (m/s)	0.89 (0.2)	1.0 (0.2)	0.8 (0.2)	0.7 (0.2)	0.7 (0.2)	0.6 (0.2)	10^{-4}
Balance test (s)	24.52 (6.5)	25.8 (5.4)	23.5 (6.6)	22.2 (7.2)	20.9 (7.9)	17.3 (9.4)	10^{-4}
SPPB score	8.66 (2.4)	9.3 (2.0)	8.1 (2.3)	7.2 (2.5)	6.4 (2.4)	5.2 (2.8)	10^{-4}
Handgrip strength (N/m^2)	52.76 (13.1)	54.5 (12.9)	51.1 (12.3)	48.7 (11.8)	48.0 (12.9)	44.3 (13.0)	10^{-4}

[a]Participants answered a questionnaire about their ability to perform IADL without assistance (18). The IADL scale was composed of 8 items: food preparation, housekeeping, shopping for groceries, doing laundry, handling money, using the telephone, taking medications and using public transport.

Table 3. Mortality rate (for 1000 women) and hazard ratios for death (HR, 95% confidence interval) for SPPB, each SPPB variable considered individually and hand grip strength

		Unadjusted (model 1)			Adjusted for confounders[a] (model 2)		
	Mortality rate/1000 (CI 95%)	HR	95% CI	*P* for trend	HR	95% CI	*P* for trend
Walking speed							
4 to ≥0.78 m/s	19.4 [17.56–21.42]	1		10^{-4}	1		0.001
3 to 0.61–0.77 m/s	33.17 [28.65–38.40]	1.29	[1.05–1.59]		1.11	0.89–1.38	
2 to 0.44–0.60 m/s	61.67 [51.29–74.16]	2.07	[1.60–2.67]		1.52	1.13–2.03	
1 to ≤ 0.43 m/s	75.65 [56.48–101.32]	2.47	[1.67–3.67]		1.50	0.97–2.33	
0	151.3 [85.93–266.42]	6.01	[2.81–12.83]		4.15	1.87–9.19	
Repeated chair stands							
4 to ≤ 11.1 s	17.65 [14.53–21.42]	1		10^{-4}	1		0.321
3 to 11.2–13.6 s	22.31 [18.94–26.28]	1.12	[0.85–1.47]		1.10	0.84–1.45	
2 to 13.7–16.6 s	25.36 [21.54–29.86]	1.23	[0.93–1.61]		1.15	0.87–1.51	
1 to ≥ 16.7 s	22.18 [24.48–32.44]	1.24	[0.96–1.61]		1.04	0.79–1.37	
0	54.96 [47.03–64.24]	1.65	[1.23–2.21]		1.27	0.93–1.73	
Balance test							
4	18.72 [16.48–21.26]	1		10^{-4}	1		0.17
3	22.3 [18.57–26.77]	1.07	[0.883–1.37]		1.08	0.84–1.38	
2	33.15 [29.14–37.71]	1.29	[1.04–1.59]		1.18	0.95–1.46	
1	44.56 [37.18–53.41]	1.39	[1.07–1.81]		1.21	0.85–1.48	
0	73.70 [54.26–100.09]	1.68	[1.04–2.69]		1.28	0.78–2.08	
Performers[b]							
Good (10–12)	16.75 [14.60–19.23]	1		10^{-4}	1		0.02
Fair (7–9)	26.31 [23.38– 29.60]	1.35	[1.10–1.65]		1.24	1.01–1.53	
Poor (0–6)	49.84 [43.96–56.50]	1.81	[1.44–2.27]		1.34	1.04–1.73	
Handgrip strength (N/m2) in tertiles							
Higher	17.74 [15.16–20.76]	1			1		0.01
Middle	24.99 [21.94–28.46]	1.22	[0.97–1.54]		1.22	0.97–1.54	
Lower	36.14 [32.59–40.09]	1.47	[1.18–1.83]		1.34	1.07–1.68	

[a]IADL, diabetes, cancer, Pfeiffer cognitive test, smoking, self-reported assessment of health, obesity, inability to walk outdoors and hospitalisation during the year.
[b]According to SPPB score: Good (10–12), Fair (7–9), Poor (0–6).

suggests that the value of physical performance measures is independent of life-styles and environments. This report provides valuable information on using physical performance measures as screening tests for people with specific levels of disability (Table 2) and at increased risk of mortality in a variety of populations (Table 3).

Most studies have focused on the effect of a single physical performance score on risk of death, but little information is available as to whether one or more physical performance measures have the same predictive value for death. Because one physical performance is easier and takes less time to measure than a whole battery, it is useful to discuss whether a single

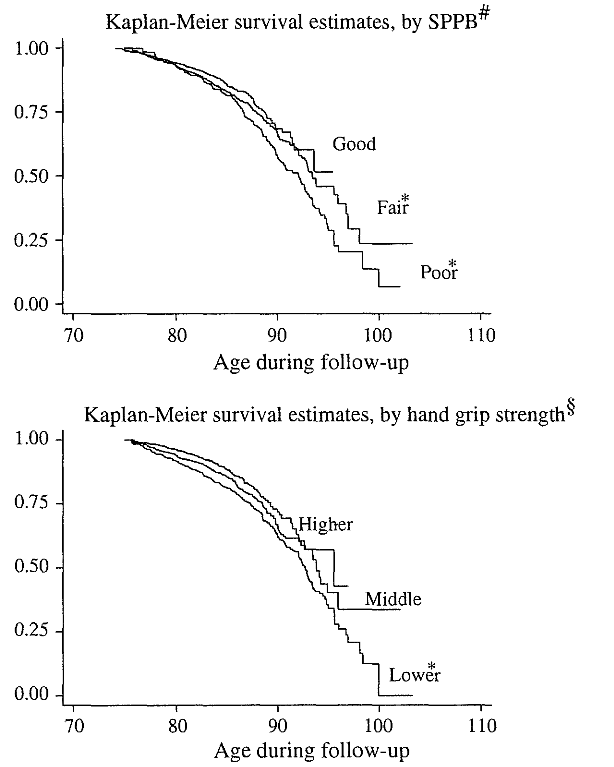

Figure 1. Kaplan–Meier survival estimates for the whole sample, by performers (Good [10–12], Fair [7–9] or Poor [0–6]) for SPPB score or by tertiles (higher, middle or lower) for handgrip strength.

test could contain the predictive information of the SPPB.

Although, we did not compare predictive abilities between tests (e.g., using ROC curves), our results suggest that in this population a simple performance test alone can perform almost as well as the full battery in predicting incident mortality. Among the different measures, walking speed appeared pertinent because it significantly distinguished a gradient of risk for mortality between the low and the high end of the functional spectrum. Walking speed assessment may be an efficient tool in screening older persons with higher risk of mortality and may easily identify large high-risk groups in the community. None of the other simple performance tests used in our study (balance, repeated chair stands, hand grip strength) was able to distinguish a gradient of risk for mortality over the whole functional spectrum, especially at the high end. For balance, repeated chair stands and the handgrip strength test, our results suggested that a low threshold of performance might be reached to predict death (Table 4).

These findings are consistent with those of previous studies in which walking speed was an underlying factor of dependence and a predictive factor of death. Laukkanen and colleagues reported an increased risk of death with decreased walking speed in a similar population adjusted by age and sex [17]. In a prospective study, Woo and colleagues reported that walking speed was a strong predictor of death in a population of 2032 elderly Chinese [12]. Studenski and colleagues also found an association between low-walking speed and adverse events one year later, including death [27]. In their prospective study, walking speed remained a significant factor of adverse events, but not the SPPB. Walking speed alone has also been found to be as efficient as the whole SPPB [1, 4] in detecting incident disability, itself a strong predictor of death [5].

Poor physical performance may be a predictor of death for several reasons. Age and comorbidity contribute to decreased performance. Poor physical performance, like slow walking speed, is a reliable marker of death in patients with congestive heart failure [26, 28] or lung disease [29].

On the other hand, poor physical performance may also predict incident diseases. This hypothesis is supported by authors reporting significantly higher risk of death in non-disabled older persons with low

Table 4. Mortality rate (for 1000 women) and hazard ratios for death (HR, 95% confidence interval) for death adjusted for age, and all other confounders for SPPB Score and handgrip strength for non-disabled healthiest women

	Mortality rate (95% CI)	Unadjusted			Adjusted for confounders†		
		HR	95% CI	*P* for trend	HR	95% CI	*P* for trend
Performers[a]							
Good (10–12)	12.28 [9.58–15.76]	1		0.23	1		0.31
Fair (7–9)	14.76 [10.87–20.05]	1.16	[0.76–1.77]		1.16	[0.75–1.79]	
Weak (4–6)	25.58 [15.67–41.75]	1.44	[0.75–2.78]		1.40	[0.70–2.80]	
Hand grip strength (N/m^2) in tertiles							
Higher	10.73 [7.67–15.02]	1		0.70	1		0.65
Middle	16.64 [12.43–22.29]	1.11	[0.67–1.83]		1.13	[0.68–1.90]	
Lower	16.72 [12.45–22.48]	1.31	[0.81–2.13]		1.36	[0.83–2.22]	

[a]According to SPPB score: good (10–12), fair (7–9), weak (4–6).
†Pfeiffer cognitive test, smoking, subjective health self assessment, obesity, inability to walk outdoors and hospitalisation during the year

performance even after adjustment for baseline comorbidity or blood tests [3]. In a non-disabled older population who performed poorly in lower extremity functional tests, Ferrucci and colleagues reported a higher rate of hospitalisation three years later [2]. They also found that hip fracture and diabetes were independently associated with poor performance. Even in patients without manifest disease, low physical performance could be a risk factor of disease.

Various hypotheses have been proposed to explain the predictive value of physical performance for death. Walking speed, handgrip strength or other physical performance measures have a substantial component of genetic variance [30] and may also reflect an underlying genetic vulnerability to disease or faster physiological aging.

Other mechanisms could explain the association between poor physical performance and death. Factors such as strength, balance, visual sense and coordination, as well as many other components difficult to assess such as motivation, mood or fear of falling, may be impaired during the pre-clinical stage of disease. Low physical performance could reflect a state of frailty, with low mobility reserve in case of bed rest. A minimum threshold of physical performance may be needed to avoid the consequences of the deconditioning effect of immobilisation. Without a sufficient level of fitness at baseline, immobilisation may be difficult to overcome without disability. Our adjusted results suggested that the SPPB, the walking speed test and the handgrip strength test may identify this frailty.

After adjustment for multiple potential confounding factors, good results on the SPPB and handgrip strength as well as walking speed reduced the risk of death but remained significantly associated with an increased risk (Table 4). On the other hand, the repeated chair stands and balance tests did not significantly predict death. A limited number of studies have investigated the association between handgrip strength or walking speed and mortality. Most [8, 12, 14, 25], but not all [13], have found that poorer handgrip strength performance or slow walking speed were significant predictors of mortality in women. One limitation of these studies is that the association between physical performances and mortality is potentially confounded by many factors such as undernutrition, treatment, acute or chronic diseases, inactivity, osteoporosis, depression or old age. Our study attempted to take into account many co-factors which could explain the mechanism underlying the association between functional limitation and mortality. This approach reinforced the association between these physical performances and the risk of death. On the other hand, our adjusted results suggest that the predictive value of repeated chair stands and balance performance for death was explained by comorbidity.

This study also improves our understanding of the pathway between physical performance and mortality. In analysis restricted to the subgroup of non-disabled healthiest participants, none of the performance tests reached a significant level of association with death. For all these tests, sample size provided sufficient power to detect significant differences. These results suggest that a threshold of frailty is required in an elderly population to interpret poor physical performance as a predictor of death. One could argue that in a young or an adult population, physical performance would not carry the same information.

Our study presented several limitations. The subjects were all volunteers living at home, with no difficulties in walking alone and no history of hip fracture or hip replacement. Functional measures may reflect motivation in this group of volunteers, which may in itself affect survival. Moreover, some physical performance tests such as walking speed may have a specific cultural pattern like an indicator of socioeconomic status. Then, this selection of a healthy French population is probably not representative of the general population of the same age. Moreover, reliability and reproducibility of the SPPB and Grip Strength measurements has not been specially addressed in this specific cohort of community-dwelling older French women. Another limitation of our work is that we had no data for men. Influence of sex and hormones may be important. Finally, self-reported assessment of disability may not always be accurate.

This study confirms the potential clinical and research importance of physical performance measures. Walking speed [31] appears to be a simple, reliable screening tool to predict death in large populations. This test alone could identify even high-risk groups. The relationship between physical performance and death was, in part, related to comorbidity. Our results also suggested that a threshold of frailty is needed to interpret physical performance as a predictor of death. Whether improving physical performance has an impact on mortality is currently an open question. Previous studies have demonstrated better walking ability, balance and strength after physical activity programs. Physical performance can be improved at any age. Interventional programs are required to investigate whether simply improving physical performance reduces the risk of mortality.

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対象の内訳		ヒト	動物	地 域	欧米	研究の種類	縦断研究
	対象	一般健常者	空白		( )		コホート研究
	性別	女性	( )		( )		( )
	年齢	80.50(±3.76)歳	[redacted]		( )		前向き研究
	対象数	5000～10000			( )		( )
調査の方法	実測	( )					
アウトカム	予 防	な し	な し	な し	な し	死亡	( )
	維持・改善	な し	な し	な し	な し	( )	( )

図 表

Table 3. Mortality rate (for 1000 women) and hazard ratios for death (HR, 95% confidence interval) for SPPB, each SPPB variable considered individually and hand grip strength

		Unadjusted (model 1)			Adjusted for confounders[a] (model 2)		
	Mortality rate/1000 (CI 95%)	HR	95% CI	*P* for trend	HR	95% CI	*P* for trend
Walking speed							
4 to ≥0.78 m/s	19.4 [17.56–21.42]	1		10^{-4}	1		0.001
3 to 0.61–0.77 m/s	33.17 [28.65–38.40]	1.29	[1.05–1.59]		1.11	0.89–1.38	
2 to 0.44–0.60 m/s	61.67 [51.29–74.16]	2.07	[1.60–2.67]		1.52	1.13–2.03	
1 to ≤0.43 m/s	75.65 [56.48–101.32]	2.47	[1.67–3.67]		1.50	0.97–2.33	
0	151.3 [85.93–266.42]	6.01	[2.81–12.83]		4.15	1.87–9.19	
Repeated chair stands							
4 to ≤11.1 s	17.65 [14.53–21.42]	1		10^{-4}	1		0.321
3 to 11.2–13.6 s	22.31 [18.94–26.28]	1.12	[0.85–1.47]		1.10	0.84–1.45	
2 to 13.7–16.6 s	25.36 [21.54–29.86]	1.23	[0.93–1.61]		1.15	0.87–1.51	
1 to ≥16.7 s	22.18 [24.48–32.44]	1.24	[0.96–1.61]		1.04	0.79–1.37	
0	54.96 [47.03–64.24]	1.65	[1.23–2.21]		1.27	0.93–1.73	
Balance test							
4	18.72 [16.48–21.26]	1		10^{-4}	1		0.17
3	22.3 [18.57–26.77]	1.07	[0.883–1.37]		1.08	0.84–1.38	
2	33.15 [29.14–37.71]	1.29	[1.04–1.59]		1.18	0.95–1.46	
1	44.56 [37.18–53.41]	1.39	[1.07–1.81]		1.21	0.85–1.48	
0	73.70 [54.26–100.09]	1.68	[1.04–2.69]		1.28	0.78–2.08	
Performers[b]							
Good (10–12)	16.75 [14.60–19.23]	1		10^{-4}	1		0.02
Fair (7–9)	26.31 [23.38–29.60]	1.35	[1.10–1.65]		1.24	1.01–1.53	
Poor (0–6)	49.84 [43.96–56.50]	1.81	[1.44–2.27]		1.34	1.04–1.73	
Handgrip strength (N/m2) in tertiles							
Higher	17.74 [15.16–20.76]	1			1		0.01
Middle	24.99 [21.94–28.46]	1.22	[0.97–1.54]		1.22	0.97–1.54	
Lower	36.14 [32.59–40.09]	1.47	[1.18–1.83]		1.34	1.07–1.68	

[a]IADL, diabetes, cancer, Pfeiffer cognitive test, smoking, self-reported assessment of health, obesity, inability to walk outdoors and hospitalisation during the year.
[b]According to SPPB score: Good (10–12), Fair (7–9), Poor (0–6).

図表掲載箇所	P118, Table3
概 要 (800字まで)	本研究は、フランスのThe Epidemiologie de l'osteoporose Studyに参加した高齢女性7,250名を対象に平均3.8年間の追跡調査を行い、身体能力と全死因死亡リスクとの関連を検討したものである。身体能力テストは、6m歩行、椅子座り立ち連続5回、10秒×3回のバランステスト、握力を行った。歩行速度が0.78m/s以上の集団と比較すると、0.44-0.60m/sの集団で死亡リスクが1.52(95%信頼区間:1.13-2.03)と有意に上昇し、歩行テストを完了できなかった集団では、死亡リスクは4.15(1.87-9.19)と上昇した。握力を高い順に3分位に分類し、最も高い集団と比較すると、最も低い集団で死亡リスクが1.34(1.07-1.68)と有意に上昇した。座り立ちテストおよびバランステストでは有意な関連はみられなかった。
結 論 (200字まで)	本研究の高齢女性コホートにおいて、歩行速度と握力の測定が死亡リスクの独立予測因子となり得ることが示唆された。
エキスパートによるコメント (200字まで)	身体活動基準の策定に用いられた研究の1つである。全身持久力以外の体力が低いことが、高い死亡リスクと関係することを示し、特に歩行速度やイス座り立ちテストのような簡便な体力測定で、この関係を明らかにした点に意義がある。

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Walking speed as a good predictor for the onset of functional dependence in a Japanese rural community population

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Abstract

Objective: to investigate and compare the predictive values of four physical performance measures for the onset of functional dependence in older Japanese people living at home.
Design: a population-based prospective cohort study.
Setting: Nangai village, Akita Prefecture, Japan.
Methods: out of the population aged 65 years and older living in Nangai ($n = 940$) in 1992, we measured hand grip-strength, one-leg standing, and usual and maximum walking speeds in 736 subjects who were independent in the five basic activities of daily living. Their functional status was assessed each year for the subsequent 6 years. The outcome event was the onset of functional dependence, defined as a new disability in one or more of the five basic activities of daily living, or death of a subject who had shown no disability at the previous follow-up.
Results: even after controlling for age, sex and a number of chronic conditions, lower scores on each baseline performance measure showed increased risk for the onset of functional dependence. Maximum walking speed was most sensitive in predicting future dependence for those aged 65–74 years, while usual walking speed was most sensitive for people aged ≥75 years.
Conclusion: walking speed was the best physical performance measure for predicting the onset of functional dependence in a Japanese rural older population.

Keywords: *cohort study, functional dependence, older adults, physical performance measure, walking speed*

Introduction

Performance-based measures of physical function can predict future incidence of disability, dependence in activities of daily living (ADLs), institutionalization and death in initially non-disabled older people [1–9]. Objective measures of lower-extremity function, such as walking speed, standing balance and repeated rising from a chair, are highly predictive of subsequent disability in various ethnic older populations [2, 3]. In addition, hand grip-strength is an important predictor for disability and mortality in older people [5–7].

However, previous studies have not examined whether the predictive value of such performance measures in an older population is affected by age. The Tokyo Metropolitan Institute of Gerontology launched a prospective cohort study on ageing in 1990. As part of the baseline survey of this study, several physical performance tests were conducted on a rural Japanese older population [10]. The functional status of these subjects was followed-up annually until 1998. We have used these data to investigate and compare the predictive values of different baseline physical performance measures for the onset of functional dependence in people aged either 65–74 years or 75 years and older.

Methods

Study area and subjects

We obtained the data in this study from the Tokyo Metropolitan Institute of Gerontology Longitudinal Interdisciplinary Study on Ageing. Details of this project have been described elsewhere [10]. The study area was Nangai village, Akita Prefecture, Japan. In 1992, 940 people aged 65 years and older were registered as residents in the village. Of these, 88 were living in institutions, bed-ridden at home or long-term absent. The remaining 852 were invited to participate in the baseline survey held at community halls. After signing informed consent forms, which had been approved by the ethics committee of the Institute, 748 took part in the survey (88% response).

Baseline survey

We asked the subjects about their dependence in five basic ADLs: bathing, dressing, walking, eating and continence [1, 11, 12]. Dependence in an ADL was defined as the subject needing help from someone else or being unable to perform the activity. We ascertained the presence of chronic conditions (defined as a history of heart disease, stroke or diabetes mellitus) from the subjects' reports. In addition, we defined arthritis as persistent pain in any joint in arms or legs (knee, hip, etc.) and included it among the group of chronic conditions.

The participants then underwent tests of hand grip-strength, length of time standing on one leg, and usual and maximum walking speed. We evaluated hand grip-strength by a mechanical dynamometer in the dominant hand and used the higher of two trials in the analysis. For the one-leg standing test, we asked subjects to look straight ahead at a dot 1 m in front of them. We then asked them to stand on the preferred leg with their eyes open and hands down alongside the trunk. The time until balance was lost (or maximum 60 s) was recorded. We used the better of two trials in the analysis. To test walking speed, we asked subjects to walk on a straight walkway 11 m in length on a flat floor once at their usual speed and then, twice, at their maximum speed. Walking speed was measured over a 5 m distance between marks 3 and 8 m from the start of the walkway. For maximum walking speed, we used the faster result in the analysis. The good reproducibility of these walking tests has been reported previously [13].

Follow-up survey

Of the 748 participants in the baseline survey, the 736 who had no disability in their basic ADLs were followed up annually for the next 6 years. Each July their levels of basic ADLs were assessed as in the

Table 1. Quartiles of the physical performance measures at baseline by sex and by age group

			Walking speed (m/s)							
			Maximum		Usual		Hand-grip strength		One-leg standing[b]	
Sex	Age (years)	Quartile[a]	Level	n	Level	n	Level (kg)	n	Time (s)	n
Men	65-74	1	≤1.81	50	≤1.08	52	≤27	49	≤18	51
		2	1.82-2.10	50	1.09-1.25	52	28-32	50	19-59	43
		3	2.11-2.36	50	1.26-1.38	52	33-36	53	≥60	114
		4	≥2.37	50	≥1.39	52	≥37	56	-	-
	≥75	1	≤1.34	17	≤0.82	18	≤20	18	≤5	19
		2	1.35-1.64	18	0.83-1.02	20	21-25	20	6-12	19
		3	1.65-1.99	18	1.03-1.20	19	26-29	18	13-49	19
		4	≥2.00	17	≥1.21	19	≥30	21	≥50	19
Women	65-74	1	≤1.45	72	≤0.9	76	≤16	73	≤7	73
		2	1.46-1.70	73	0.91-1.07	77	17-19	73	8-24	79
		3	1.71-1.98	73	1.08-1.25	76	20-21	88	25-59	52
		4	≥1.97	72	≥1.26	76	≥22	71	≥60	101
	≥75	1	≤1.08	29	≤0.69	29	≤12	30	≤1.9	17
		2	1.09-1.34	31	0.70-0.87	31	13-15	29	2-6	40
		3	1.35-1.62	29	0.88-1.04	29	16-19	32	7-15	33
		4	≤1.63	30	≥1.05	30	≥20	30	≥16	31

[a]Performance scores from 1 (lowest) to 4 (highest) were allocated according to quartile.
[b]Distribution of data on one-leg standing was skewed in subject groups aged 65-74 years because the maximum was set at 60 s.

baseline survey. Death was ascertained from death certificates. The outcome event in this study was the onset of functional dependence—defined as a new disability in one or more of the five basic ADLs—or death of person who had shown no disability at the follow-up in the previous year.

Statistical analysis

Within each age group we divided men and women into quartiles according to their baseline performance in each test, and allocated a performance score (1-4) according to the quartile: 1 indicating the lowest performance and 4 indicating the highest (Table 1). We created a summary performance score by adding the scores for the tests of hand grip-strength, one-leg standing and walking speed (maximum walking speed for subjects aged 65-74 years and usual walking speed for those aged ≥75 years), and grouped subjects into quartiles of summary performance score (3-5, 6-7, 8-9 and 10-12).

We analysed functional dependence over 6 years according to baseline scores on the individual tests and summary performance scores. We used the Cox proportional hazard model to assess the independent association of the individual test scores and summary performance score with the onset of functional dependence during follow-up period, controlling for age, sex, and number of chronic conditions.

Results

During the 6-year follow-up period, 251 outcome events (disability in 183, death in 68) occurred within the cohort of 736 subjects who had been initially independent in the five basic ADLs.

Tables 2 and 3 show the number of events according to the baseline score for each of the four performance measures for subjects in each of the age groups. As seen in their hazard ratios, lower performance levels for each measure had significantly increased risks of onset of functional dependence compared with the highest performance levels, even after controlling for age, sex and number of chronic conditions. Among the four performance measures, maximum walking speed was the most sensitive for predicting the onset of functional dependence among subjects aged 65-74 years, while usual walking speed was the most sensitive predictor among those aged 75

Table 2. Adjusted hazard ratios for baseline performance score against the onset of functional dependence during the 6-year follow-up period among subjects aged 65-74 years

		No. of subjects		
	Score[a]	At baseline	With functional dependence at 6 years[b]	Hazard ratio (95% CI)[c]
Maximum walking speed	1	122	61 (16)	5.15 (2.71-9.77)
	2	123	33 (13)	2.52 (1.29-4.90)
	3	123	21 (4)	1.65 (0.81-3.36)
	4	122	12 (4)	1.0
Usual walking speed	1	128	56 (14)	2.43 (1.42-4.17)
	2	129	40 (12)	1.76 (1.02-3.04)
	3	128	21 (8)	0.93 (0.50-1.72)
	4	128	20 (5)	1.0
One-leg standing	1	124	63 (13)	2.53 (1.40-4.55)
	2	122	30 (8)	1.12 (0.06-2.09)
	3	166	26 (14)	0.75 (0.39-1.46)
	4	101	18 (4)	1.0
Hand grip-strength	1	122	53 (12)	2.51 (1.50-4.20)
	2	123	34 (8)	1.50 (0.87-2.61)
	3	141	29 (12)	1.18 (0.67-2.08)
	4	127	21 (7)	1.0

[a]Higher number indicates better performance.
[b]Including deaths (numbers in parentheses).
[c]Adjusted for age, sex and number of chronic conditions (stroke, heart diseases, diabetes and arthritis).

Table 3. Adjusted hazard ratios for baseline performance score against the onset of functional dependence during the 6-year follow-up period among subjects aged ≥75 years

	Score[a]	No. of subjects At baseline	With functional dependence at 6 years[b]	Hazard ratio (95% CI)[c]
Maximum walking speed	1	43	35 (11)	3.45 (1.81-6.56)
	2	45	24 (6)	1.64 (0.86-3.14)
	3	45	12 (2)	0.67 (0.32-1.43)
	4	43	16 (3)	1.0
Usual walking speed	1	47	41 (11)	6.18 (3.16-12.1)
	2	51	29 (9)	2.56 (1.32-4.98)
	3	48	19 (2)	1.71 (0.84-3.48)
	4	49	13 (3)	1.0
One-leg standing	1	36	28 (6)	3.69 (1.87-7.26)
	2	59	37 (8)	2.62 (1.39-4.93)
	3	52	25 (8)	1.73 (0.89-3.35)
	4	50	14 (3)	1.0
Hand grip-strength	1	48	35 (11)	2.21 (1.23-3.97)
	2	49	28 (5)	1.31 (0.73-2.37)
	3	50	20 (4)	0.89 (0.48-1.65)
	4	51	22 (6)	1.0

[a]Higher number indicates better performance.
[b]Including deaths (numbers in parentheses).
[c]Adjusted for age, sex and number of chronic conditions (stroke, heart diseases, diabetes and arthritis).

years and older. Of interest is that the one-leg standing test showed the second highest predictive value after the maximum walking speed test for subjects aged 75 years and older.

Table 4 presents the adjusted hazard ratios for each category of summary performance score against the onset of functional dependence. This score identified the subgroups within the cohort at lowest or highest risk of the onset of functional dependence. The predictive value of this score for older subjects was superior to that for younger subjects.

Table 4. Adjusted hazard ratios for each summary performance score against the onset of functional dependence during the 6-year follow-up period among subjects aged 65-74 years and ≥75 years at baseline

	65-74 years at baseline			≥75 years at baseline		
	No. of subjects			No. of subjects		
Summary performance score[a]	Total	With functional dependence at 6 years[b]	Hazard ratio (95% CI)[c]	Total	With functional dependence at 6 years[b]	Hazard ratio (95% CI)[c]
3-5	110	59 (13)	4.07 (2.28-7.27)	46	39 (13)	6.05 (3.09-11.9)
6-7	118	34 (13)	2.07 (1.14-3.75)	49	29 (4)	2.85 (1.50-5.44)
8-9	133	17 (4)	0.90 (0.46-1.76)	45	19 (5)	1.60 (0.81-3.18)
10-12	129	17 (7)	1.0	55	15 (3)	1.0

[a]Calculated by adding scores for walking speed (maximum in younger group, usual in older group), one-leg standing and hand grip-strength; higher scores indicate better performance.
[b]Including deaths (numbers in parentheses).
[c]Adjusted for age, sex and number of chronic conditions (stroke, heart diseases, diabetes and arthritis).

Discussion

Muscle strength, standing balance and walking ability are key components of physical performance in older people [14-16]. Thus, in this study we adopted the hand grip-strength, one-leg standing and walking speed tests for assessments of the physical performance of subjects living at home. These tests do not require special equipment and are not time-consuming, and thus hold advantages for a large-scale population survey.

Among these physical performance measures, maximum walking speed was the most sensitive in predicting the onset of functional dependence for younger people, while usual walking speed was most sensitive for older people. To date, several reports have shown that walking speed is highly predictive of future disability and mortality in non-disabled older people [2, 3, 5, 8]. However, it has remained unclear whether maximum and usual walking speeds differ in terms of predictive value. The present study is the first to show that the two walking speed indices differ in predictive value depending on the age group being investigated.

The reason for this is unclear. Perhaps, as a person ages, leg function decreases to an extent which limits usual walking speed. In other words, the usual walking speed in older people may represent functional capacity of the leg. Usual walking speed can be measured without difficulty for almost all older people who are independent in ADLs. By contrast, it is difficult for some older people to perform a maximum walk test. For example, in this study, 4.5% of younger and 9.7% of older people who completed the usual walking test could not complete the maximum walk test, mainly because of pain. Taken together, we recommend the test of usual walking speed rather than the test of maximum walking speed for examinations of walking ability for subjects aged 75 years and older.

The one-leg standing and hand grip-strength tests were also shown to be useful for detecting older people at increased risk of future functional dependence. This result largely confirmed previous reports [5, 6]. Using the Tokyo Metropolitan Institute of Gerontology Index of Competence [17], we had demonstrated that lower performance in these two physical tests was independently associated with decline in the higher-order levels of functional capacity (instrumental self-maintenance, intellectual activity and social role) in a rural older population [18]. The mechanisms underlying the association, however, remain unclear and need further study.

Furthermore, separate analysis by age group showed that physical performance measures are as much or even more valuable for predicting future dependence in older people than in younger people, as seen in the summary performance score. This result may imply that at advanced ages, physical performance level becomes more critical for maintaining an independent life than at younger ages, and stresses the importance of functional evaluation even at advanced ages in a clinical setting.

In summary, the four physical performance measures can be used for predicting the onset of functional dependence in community-dwelling older people. The walking speed—maximum for younger subjects and usual for older subjects—is the best physical performance measure in terms of predictive value for the onset of functional dependence.

Key points

- Hand grip-strength, one-leg standing and walking speed are predictive of the onset of functional dependence in older people living at home.
- Maximum and usual walking speeds are the best predictors in younger (65-74-years) and older (≥75 years) people, respectively.
- Baseline summary performance score is more useful for older people than for younger people in predicting future dependence.

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	性別	男女混合	( )		( )		( )
	年齢	65歳以上	[redacted]		( )		前向き研究
	対象数	500～1000			( )		( )
調査の方法	実測	( )					
アウトカム	予 防	な し	な し	な し	介護予防	死亡	( )
	維持・改善	な し	な し	な し	な し	( )	( )
図 表							
図表掲載箇所	P443, Table2, P444,Table3						
概 要 (800字まで)	本研究は、日本のThe Tokyo Metropolitan Institute of Gerontology Longitudinal Interdisciplinary Study on Ageingに参加した農村地方の65歳以上の高齢男女736名を対象に6年間の追跡調査を行い、身体能力と介護依存リスクとの関連を検討したものである。身体能力は、握力、片足立ち、日常歩行速度、最大歩行速度の4項目を測定した。介護依存については、入浴、着替え、歩行、食事、随意調節の5項目より判定した。全ての測定項目に関して、性年齢別に調整後、低い順に4群(低1-2-3-4高)に分類した。65-74歳の集団において、測定結果の最も良い4の集団と比較すると、最大歩行速度が2の集団、最も悪い1の集団でそれぞれ介護依存リスクが2.52(95%信頼区間:1.29-4.90)、5.15(2.71-9.77)と有意に上昇し、日常歩行速度も2の集団、1の集団でそれぞれ1.76(1.02-3.04)、2.43(1.42-4.17)と上昇した。片足立ち、握力では1の集団でのみそれぞれ2.53(1.40-4.55)、2.51(1.50-4.20)とリスクが上昇した。75歳以上の集団においては、日常歩行速度が2の集団、1の集団でそれぞれ2.56(1.32-4.98)、6.18(3.16-12.1)と有意に上昇し、片足立ちが2の集団、1の集団でそれぞれ2.62(1.39-4.93)、3.69(1.87-7.26)とリスクが上昇した。最大歩行速度、握力では1の集団でのみそれぞれ3.45(1.81-6.56)、2.21(1.23-.97)と有意に上昇した。						
結 論 (200字まで)	高齢日本人コホートにおいて、本研究で行われた全ての身体能力測定と介護依存リスクとの間に有意な関連がみられた。特に、65-74歳では最大歩行速度測定が、75歳以上では日常歩行速度測定が最も強力なリスク予測因子であることが示唆された。						
エキスパートによるコメント (200字まで)	高齢社会の日本において、介護依存を減少させることは非常に重要である。介護依存のリスクと関連のある測定項目に関して、継続的に評価することにより介護依存のリスクの高い個人を特定し、支援を強化することで、より効果的・効率的に要介護者減少につながることを期待したい。						

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