Title: Measuring physical performance in highly active older adults: Associations with age and gender?

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Word count manuscript text: 3556

Abstract:

Background: Higher age is associated with reduced physical capability in the general population. The role of age and gender for physical performance in older adults who exercises regularly is however not clear, and there is also a lack of recommendations for outcomes to address physical performance for this population.

Aims: To explore the associations between physical performance, age and gender, and to examine the suitability and feasibility of clinical field tests for physical performance in active older adults.

Methods: In this cross-sectional study we included 105 persons, 70–90 years of age, who had exercised regularly for ≥ 12 months. The field tests were Short Physical Performance Battery (SPPB), Timed Up and Go and gait speed for mobility; One-leg standing (OLS) test and Mini-BESTest for balance; Stair test for endurance, 30 s sit-to-stand, and grip strength for muscle strength.

Results: We found associations between age and physical performance, and the associations were slightly stronger for women. Men performed better on tests of muscle strength, balance and endurance, while no gender differences were found in mobility. Grip strength was not associated with mobility tests for men. All tests were feasible, while SPPB and OLS had ceiling and floor effects that limit their suitability in this population.

Conclusions: Both age and gender were associated with physical performance. We recommend using the gait speed, Mini-BESTest, 30s sit-to-stand, grip strength and stair tests to assess physical performance in physically active older adults.

Keywords: Aging, exercise, outcome measures, performance-based, feasibility

INTRODUCTION

Most people in the world today can expect to live into their 60s and beyond. The population of older adults will increase both in numbers and proportion in the coming years [1]. Despite this development, there is an ongoing discussion about whether a longer life can also be a life with maintained health status and quality of life [2,3]. Higher age is associated with reduced physical capability in terms of muscle strength, balance, and gait [4]. It is, however, important to recognize that several older adults have a well-preserved functional level [5]. In general, older men perform better than older women on most physical performance measures, and the differences are most pronounced on measures of muscle strength [4,6]. Differences in gait speed are also reported; however, these differences have largely been attenuated after adjustments for body height [4,7,6].

The influence of aging on physical capability might also be enforced by physical inactivity. The World Health Organization (WHO) recommends adults aged 65 years and above to do at least 150 min of moderate-intensity aerobic or 75 min of vigorous-intensity aerobic physical activity per week to improve their health status [8]. However, a low number of older adults obtain the recommended levels of physical activity [9,10]. While there is much research on specific diagnostic groups or frail or sedentary groups of older adults, there is a dearth of studies on gender differences among older adults who are exercising regularly.

Assessment of physical capability can be useful for several purposes. The assessments can be used to monitor the effect of exercise, identify a decline in physical capability, and provide both specific information regarding physical domains (i.e., strength, balance) or more overall general functioning (i.e., mobility). Field tests based on timed performances or standardized observer-rated observations are important tools to evaluate physical performance in clinical practice and research studies. To be feasible and provide valuable information about physical capability, the tests should lack ceiling and floor effects in the relevant population as well as require limited space, time, and equipment. Most tests of physical capability are developed for frail older adults or screening purposes, and we wanted to explore how suitable such tests are for a population of active older adults who exercise regularly.

The first aim of this paper is to describe the associations between physical performance and age and gender in older adults who have exercised regularly over time. The second aim is to describe the strengths and limitations of a set of clinical field tests for physical function in this study sample.

METHODS

Design and Participants: This cross-sectional study is part of FYSIOPRIM, a research program studying physical therapy practice in primary health care in Norway. We included a convenience sample of 105 participants from four training facilities located in physical therapy practices and from two traditional membership-based training centers. Contact persons at each facility invited participants into the study. These inclusion sites were located in both rural and urban surroundings. The inclusion period lasted from June 2016 through March 2017. Inclusion criteria were age 70 years or older, been exercising more than once a week for at least one year, and able to accomplish the physical testing without the use of walking devices. The exercise had to take place either in a gym, an organized group setting or in a physical therapy setting.

Procedure: The two authors collected all data; HSR assisted the participants in filling out questionnaires about demographics, health information and exercise habits, and GGT conducted all of the field tests. Half of the participants answered the questionnaires first, while the other half completed the field tests first (order randomly assigned). All data were collected electronically using a tablet (Infopad). The Infopad system automatically recorded the time to complete each of the tests. We manually recorded the time used for the entire session of testing for each participant. To examine the ceiling and floor effect of the tests with scoring systems, we have provided the proportion who obtained maximum and minimum score.

Clinical field tests

Short Physical Performance Battery (SPPB) is a screening test for physical function developed for use in older adults [11]. SPPB consists of three subtests; standing balance, walking, and rising from a chair. Each subtest is scored on a scale of 0–4 points and the total score is 0–12 points. A higher score indicates better performance. The balance assessment has three different standing positions with increasing levels of difficulty; feet positioned side-by-side, semi-tandem, and tandem positions. Each position should be held for up to 10 s, and if a participant fails to hold a position for 10 s, the more advanced position(s) is scored as zero. The gait speed protocol in the SPPB is a 4-m walk, at a comfortable pace, from a static start. The walk is repeated twice, and time is recorded in seconds with one decimal. Points in SPPB are based on the fastest of the two walks. Also, we used the mean time (reported in m/s) of the two walks as an independent, continuous variable (referred to as gait speed throughout the manuscript). Lower limb strength is assessed with a timed chair stand test, where the participants are asked to perform sit-to-stand (five times) as quickly as possible without the use of arms. In addition to the total score, we also report results from the SPPB with cut off ≤ 10 points. In a previous study with 3-year follow-up, this cut off predicted the loss of ability to walk 400 m [12].

Mini Balance Evaluation Systems Test (mini-BESTest) includes test items that cover several domains of balance control, with emphasis on dynamic balance [13,14]. Based on 14 items and four subscales, the total score ranges from 0–28 points. A higher score indicates a better balance. The mini-BESTest is also included in the core outcome set for assessment of standing balance in adults [15].

One-leg standing (OLS) is one of the most commonly used screening tests for standing balance, and a variety of different protocols exists [16]. We conducted the OLS test first with eyes open and then with eyes closed. The participants were instructed to stand on one leg for up to 30 s. Each participant had two attempts, and we report the best result.

30 s sit to stand test (30sSTS): This test is a proxy test for lower limb strength [17]. We asked the participants to fold their arms over their chest and to stand up from a chair (seat height approximately 45 cm) as many times as possible within 30 s. The outcome is the number of full stands.

Timed up and Go (TUG): TUG is a screening test for mobility in older persons [18]. In this study, TUG was conducted as part of the Mini-BESTest (item 14) but is also reported as an independent test. The participants are instructed to rise from a chair, walk 3 m at a comfortable pace, turn around and sit down again. The performance was timed.

Stair test: The stair test is a proxy measure for submaximal endurance [19]. We asked the participants to walk or run as fast as they could three times up and down 18 steps in a stair [20]. The participants could hold the handrail but were not allowed to skip any steps. We used the available stair at each inclusion site, and all the stairs included a platform. The outcome is the time (measured in s) to complete the run.

Grip strength is a basic measure of muscle strength [21]. We used a Baseline dynamometer (Fabrications Enterprises, New York). The participant was sitting in a chair, with the upper arm along the side of the trunk and with approximately 90° flexion in the elbow. The dynamometer had five handle positions, and we used the second position for all participants unless they asked for another position (two men with large hands). The participants were instructed to squeeze as hard as possible, and the assessor gave standardized verbal encouragement during this task. We repeated the test three times for the dominant hand, and then three times for the non-dominant hand. The results are reported in kilograms, and we used the best results of the three attempts for each hand.

The field tests represents overlapping abilities, but we have categorized the SPPB, TUG and gait speed as measures of general mobility, OLS and Mini-BESTest as balance measures, 30sSTS and grip strength as measures of muscle strength and the stair test as an endurance measure.

Exercise habits: We used the three questions from the Nord-Trøndelag Health (HUNT) Study to register the amount and intensity of exercise habits [22]. First, we asked "How often do you exercise (on average)? There were five mutually exclusive answers; Never, <1, 1, 2–3 and more than four times per week. The second question was "For how long do you usually exercise (on average)"? The four possible answers were <15 min, 15–30 min, 31–-60 min and more than 60 min each time. Finally, we asked "How hard do you exercise (on average)". The three possible answers were: Easy (without breaking a sweat or losing breath), moderate (lose breath and break into a sweat), and hard (near exhaustion). Also, we asked open questions regarding the types of activities. These answers were later categorized into four types of exercise: strength, endurance, balance and flexibility.

Statistical Analysis

The associations between the different tests, age, and gender were examined using Spearman's correlation coefficient. Grip strength is the only measure involving upper-extremity function, and we, therefore, expected low to moderate correlations (0.30–0.50) between grip strength and the other tests. We expected moderate correlations (0.50–0.70) between each of the other tests because they reflect related aspects of mobility [23].

To analyze if there were gender differences in the field tests, we conducted regression analysis and controlled for age. The distribution of the scores from SPPB and the OLS were skewed, and the assumptions for linear regression was not met. We, therefore, dichotomized the SPPB into 10 points versus lower score, the OLS open task into 30 s versus 0–29.9 s, and the OLS closed task into 2 s versus 2.1–30 s. For these three variables, we used logistic regression, while for the other variables we used linear regression.

We evaluated the presence of ceiling and floor effects based on the percentage of the participants achieving the highest or lowest possible score respectively. No ceiling or floor effects are considered as excellent, ≤ 20 % scoring highest or lowest respectively as adequate and > 20 % as poor [24]. This only applies for the tests with a maximum score; such as the SPPB and the Mini-BESTest. For the OLS, where timing ranged from 0-30 s, we considered ceiling effects based on how many had obtained 30 s, while floor effects were based on how many who obtained ≤ 2 s. All statistical analyses were conducted in IBM SPSS Statistics (SPSS Inc., Chicago, IL) version 23, and we used a 5 % level of significance.

RESULTS

We included 105 participants, of whom 48 (45.7 %) were women (Table 1). The men were significantly older than the women and had more neurological disorders. Heart disease and musculoskeletal disorders were the most frequently reported medical conditions. None of the participants used walking aids indoors; two (1.9 %) participants used walking aids outdoors. None received home nursing or food delivery, while two persons had formal help with domestic chores. Two participants had paid work as the main occupation, one had a disability pension, and all the other participants were retired. None of the participants smoked.

Strength and endurance training were the most common forms of exercise. The strength training was in general performed using weights, focusing on large muscle groups, targeting both muscle size (5–6 repetitions) and muscle endurance (10–15 repetitions). The endurance training was conducted using treadmills, stationary bikes or by participating in aerobics classes. There were no gender differences in exercise habits regarding amount or intensity (Table 1). Based on the self-reported amount of exercise, 102 (97%) of the participants achieved the recommended 75 min of vigorous activity or 150 min of moderate activity.

When we controlled for age in the analyses, men performed significantly better than women on 30sSTS, Mini-BESTest, Stair test, and grip strength, while there were no differences on the SPPB, gait speed, OLS tests and TUG (Table 2).

For women, higher age was associated with worse results on all tests except for the SPPB (Table 3). For men, higher age was associated with worse results on the Mini-BESTest, the stair test, gait speed, and grip strength. Grip strength was not associated with any of the other tests for men. For women, all tests except SPPB and OLS with closed eyes were positively associated with grip strength (r_s between 0.34 and -0.66). All correlation coefficients between the tests were below 0.7, except for the correlation between stairs and STS among men (r_s = 0.71).

The SPPB and the OLS with eyes open were the only tests with a substantial ceiling effect, 55.2% of the participants obtained the highest score on SPPB and 46.7% could stand on one leg for 30 s (Table 4). One participant was unable to perform the sit to stand task without help; all other items and tests had valid scores. We had no missing data. No adverse events occurred during testing.

DISCUSSION

In this study, including older adults exercising regularly over time, we found that age and gender were associated with performance on clinical field tests of physical function. However, we observed no gender differences in gait speed and general mobility. The mobility tests were moderately associated with each other for both men and women, while grip strength showed no associations with the mobility tests for men. The SPPB and the OLS had pronounced ceiling effects in our sample of active older adults.

The participants in this study had all been exercising for 1 year or more, and almost all achieved the level of physical activity recommended by the WHO [8]. There were almost equal numbers of men and women included, and we observed no gender differences in exercise habits. Previous studies have reported that more men than women participate in leisure time physical activity [25]. In the present study, we did not consciously seek to include equal numbers of men and women, and we have not cooperated with gender-specific exercise settings. Hence, the equal number of men and women is incidental. The reported gender differences in the amount of physical activity are less pronounced in studies where objective measures are used (such as accelerometers) than in studies using self-reported information [25], so these differences might occur partly because men and women report physical activity in different ways.

Age was associated with performance on the field tests for both men and women, and this association was more consistent across the entire test battery for women than for men. The tests related to mobility and lower-extremity function showed moderate correlations with each other. However, the correlation coefficients were with one exception below 0.7. This indicates that the tests represent related but not overlapping aspects of physical function. In our study, grip strength showed the lowest association with all the other tests. This is in line with our hypothesis, which was based on the notion that these other tests target mobility and lower-limb functions, while grip strength is the only upper-limb test. Reduced grip strength is well-acknowledged as a prognostic factor for the future decline in cognitive function, mobility, functional status, and for mortality in older community-dwelling persons [26]. Contrary to what we expected, grip strength was not significantly correlated with any of the other tests among men in our sample. The low correlation between grip strength and mobility outcomes in this high functioning sample of older adults might indicate that, although grip strength is an important indicator for incident frailty in population-based studies, it might not provide exact information about other aspects of physical performance. Therefore, we recommend that for screening purposes, grip strength should be complemented with a mobility measure to describe overall functioning.

In line with results from population-based studies, we found that men performed better than women on measures of muscle strength (grip strength, 30sSTS), balance (Mini-BESTest), and endurance (Stairs) [4,27]. However, there were no differences in measures of mobility, such as gait speed or TUG, when controlling for age. This finding is also in concordance with the meta-analysis of data from eight cohort studies [4]. However, in a Norwegian population-based study with 1005 participants (mean age 76.6 years), men were significantly faster than women on the TUG [28]. If we compare the results on TUG between participants in our study versus results from this population-based study, we see that our exercising older adults performed a lot better: mean results on TUG, 8.5 versus 11.7 s for men and 7.8 versus 13.2 s for women. Such differences are also observed for grip strength. The mean grip strength of men (with a median age of 75 years) in our study was comparable to normative data on the mean grip strength of 70-year-old men. Likewise, the mean grip strength of women in our study (median age 73 years) was comparable to normative data for 65-year-old women [27]. Although it is difficult to draw conclusions based on comparisons of different study populations, we believe that these superior performances of our participants compared to the population-based sample indicate that the decline in function observed with aging, may be attenuated with exercise. It is important to keep in mind that most of our participants had one or more medical diseases, with cardiovascular diseases and musculoskeletal disorders as the most frequent conditions, so they should be regarded as active older adults but not necessarily as healthy older adults.

Regarding the feasibility of the field tests in clinical practice, 80% of the participants completed the entire test battery in 25 min or less. Very few participants needed to rest between the tests, and this contributed to the quick completion of the test battery. For clinical use, one should consider that several tasks are overlapping and as such it is not recommended to use the entire set. As expected, the most time-consuming test was the Mini-BESTest, which also requires more equipment and space than the other tests. However, given the ceiling (Eyes open) and floor (Eyes closed) effect of the two OLS tests, we still recommend the use of Mini-BESTest to assess balance performance in this population. The SPPB is highly recommended for use in community-dwelling older adults aged 60 years and older by a systematic review paper from 2012 [29]. Using the previously mentioned cut-off of 10 points on the SPPB, approximately 25% of our sample is at risk of losing their ability to walk 400 m in the next 3-years [12]. While this is very useful information, the scale itself does not work well in our highly active older adults. In our sample as many as 55% achieved the top score of 12 points, indicating a substantial ceiling effect. Our findings are in line with the conclusion from a recent systematic review investigating performance-based clinical tests in young seniors (i.e., 60–70 years) [30]. The chair stand (lower limb strength) and gait speed tasks in

SPPB are relevant tasks for evaluation of mobility, and the problem seems to be related to the scoring system. To obtain a top score for gait speed on the SPPB, a gait speed faster than 0.83 m/s is required. However, a gait speed of 1.0 m/s is often referred to as a threshold for an independent living [31,32]. We, therefore, argue that the scoring system of the SPPB does not work well in community-dwelling independent older adults, and that gait speed as a continuous outcome (in m/s) and the 30sSTS test can provide more useful information. Besides SPPB and OLS, the other tests did not have issues regarding ceiling effect, and the continuous outcomes were, in general, normally distributed, which also indicates that these tests have room for measuring changes in a positive as well as negative direction.

One limitation of the present study is that we have a relatively low proportion of older adults who participate in sports competitions, so our findings might not be generalizable to this group of exercising older adults. Further, we used a convenience sample, although we strived to recruit participants from both rural and urban settings, as well as from areas with a different sociodemographic profile. Since participation was based on an invitation from local physical therapists or staff at training centers, we have no information about who declined participation. The estimates of the amount of physical activity are likely low because we did not use activity monitoring nor did we ask specifically about outdoor exercises such as brisk walking, running, or skiing, which are popular activities for Norwegian older adults [33]. Strengths of this study include the equal gender distribution and complete performance-based tests and demographic data.

In conclusion, age and gender were associated with performance-based tests of physical function. SPPB and OLS had pronounced ceiling effects and should not be used as measures of physical performance in high-functioning older adults. We recommend using the gait speed test for general mobility; the Mini-BESTest for balance; the 30sSTS and grip strength for muscle strength; and the stair test for endurance in active older adults.

ACKNOWLEDGEMENTS

The authors would like to thank all the participants for the time and effort they put into the participation in this study. We will also thank all the personnel at the inclusion sites who invited their clients into the study.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

Source of Funding: The Norwegian Fund for Post-Graduate Training in Physiotherapy supported this study through the FYSIOPRIM program.

Ethical approval: The study is approved by the Regional Committee for Medical and Health Research Ethics South East Norway (nr. 2013/2030).
Informed consent: Written consent is obtained from all participants.

Previous presentation: Parts of the results from this study have been presented as oral presentations on the Norwegian physiotherapy congress 2018, the Norwegian sports medicine congress 2017, and on the 24th Nordic Congress of Gerontology.

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Table 1 Participant characteristics and exercise habits (n=105)

	All (n=105)	Men (n=57)	Women (n=48)	*p*
Age, years, median (IQR)	74.0 (5)	75.0 (6)	73.0 (4)	0.040[a]
Min-max	70-90	70-90	70-88	
Married, n (%)	72 (68.6 %)	43 (75.4 %)	29 (60.4 %)	0.139[b]
Education level, years n (%)				0.059[c]
≤ 9	8 (7.6 %)	5 (8.8 %)	3 (6.3 %)	
10-12	29 (27.6 %)	10 (17.5 %)	19 (39.6 %)	
13-15	26 (24.8 %)	14 (24.6 %)	12 (25.0 %)	
≥ 16	42 (40.0 %)	28 (49.1 %)	14 (29.2%)	
Living alone, n (%)	32 (30.5 %)	13 (22.8 %)	19 (39.6 %)	0.063[b]
Body mass index, mean (SD)	24.6 (3.1)	24.4 (2.8)	24.7 (3.4)	0.554[d]
Number of medications (n, %)				0.146[b]
None	19 (18.1 %)	11 (19.3 %)	8 (16.7%)	
1-3	56 (53.3 %)	25 (43.9 %)	31 (64.6 %)	
4-5	18 (17.1 %)	12 (21.1 %)	6 (12.5 %)	
> 5	12 (11.4 %)	9 (15.8 %)	3 (6.3 %)	
Medical conditions, n (%)				
Cardiovascular diseases	69 (65.7 %)	40 (70.2 %)	29 (60.4 %)	0.310[b]
Neurologic disorders	10 (9.5 %)	9 (15.8 %)	1 (2.1 %)	0.020[c]
Diabetes mellitus	4 (3.8 %)	4 (7.0 %)	0	0.123[c]
Cancer	13 (12.4 %)	7 (12.3 %)	6 (12.5 %)	1.000[b]
Lung diseases	14 (13.3 %)	9 (15.8 %)	5 (10.4 %)	0.567[b]
Musculoskeletal disorders	67 (63.8 %)	36 (63.2 %)	31 (64.6 %)	1.000[b]
Frequency of exercise, n (%)				0.844[b]
2-3 times per week	57 (54.3 %)	30 (52.6 %)	27 (56.3 %)	
Almost every day	48 (45.7 %)	27 (47.4 %)	21 (43.8 %)	
Duration of exercise, n (%)				0.777[c]
Up to 30 minutes	2 (1.9 %)	1 (1.8 %)	1 (2.1 %)	
30 min – 1 hour	50 (47.6 %)	29 (50.9 %)	21 (43.8 %)	
More than 1 hour	53 (50.5 %)	27 (47.4 %)	26 (54.2 %)	
Intensity, n (%)				0.497[c]
Easy, no hard breathing or sweat	12 (11.4 %)	6 (10.5 %)	6 (12.5 %)	
Lose breath and break into sweats	85 (81.0 %)	45 (78.9 %)	40 (83.3 %)	
Almost to exhaustion	8 (7.6 %)	6 (10.5 %)	2 (4.2 %)	

Type of exercise, n (%)				
Strength	104 (99.0 %)	57 (100 %)	47 (97.9 %)	0.457[c]
Endurance	102 (97.1 %)	56 (98.2 %)	46 (95.8 %)	0.591[c]
Balance	52 (49.5 %)	32 (56.1 %)	20 (41.7 %)	0.172[b]
Flexibility	59 (56.2 %)	30 (52.6 %)	29 (60.4 %)	0.438[b]
Participates in competitions, n (%)	10 (9.5 %)	4 (7.0 %)	6 (12.5 %)	0.507[c]
[a]Mann-Whitney U test, [b]Chi square test, [c]Fisher exact test, [d]t-test				

Table 2 Results on performance-based tests of physical function.

Test	All (n=105)	Men (n=57)	Women (n=48)	B[a] / OR[b] (95 % CI)	P
General mobility:					
SPPB (0-12)					
Median (IQR)	12 (2)	12 (1)	12 (2)		
Min-max	4-12	6-12	4-12		
> 10 points, n (%)	79 (75)	44 (77)	35 (73)	1.8 (0.7, 4.9)[a]	0.227[c]
Gait speed, m/s, mean (SD)	1.14 (0.2)	1.11 (0.2)	1.18 (0.2)	-0.4 (-1.1, 0.04)[b]	0.292[d]
TUG, s, mean (SD)	8.2 (1.5)	8.5 (1.5)	7.8 (1.5)	0.5 (-0.1, 1.0)[b]	0.075[d]
Balance					
OLS-EO, s median (IQR)	24.7 (20.2)	24.7 (20.6)	26.5 (19.8)		
Min-max	2.2-30.0	3.0-30.0	2.2-30.0		
30 s, n (%)	49 (46.7)	25 (43.9)	24 (50)	1.1 (0.5, 2.6)[a]	0.839[c]
OLS-EC, median (IQR)	3.0 (3.4)	3.0 (3.6)	3.0 (3.3)		
Min-max	0.7-30.0	0.7-30.0	1.1-14.5		
< 2 s, n (%)	78 (74.3)	43 (75.4)	35 (72.9)	1.6 (0.6, 4.1)[a]	0.346[c]
Mini-BESTest (0-28)					
Median (IQR)	24.0 (4.0)	25.0 (4)	23.6 (3.2)	1.4 (0.4, 2.3)[b]	0.009[d]
Min-max	14-28	15-28	14-28		
Muscle strength					
30sSTS, mean (SD)	16.9 (5.1)	17.6 (5.1)	16.2 (5.0)	2.1 (0.3, 4.0)[b]	0.026[d]
Grip strength, kg, mean (SD)					
Dominant hand	32.7 (9.5)	39.1 (7.6)	25.1 (4.6)	15.1 (12.8, 17.3)[b]	<0.001[d]
Non-dominant hand	32.0 (9.7)	38.9 (6.9)	23.7 (4.8)	16.0 (13.7, 18.2)[b]	<0.001[d]
Endurance					
Stair test, s, median (IQR)	51.3 (16.1)	50.8 (14.7)	51.5 (20.6)	-9.3 (1.7, 2.9)[b]	0.002[d]
Min-max	33.9-125.9	33.9-103.1	37.9-125.9		

Abbreviations: OR, odds ratio; SPPB, Short physical performance battery; OLS-EO, One leg standing – eyes open; OLS-EC, One leg standing – eyes closed; 30sSTS, 30-seconds sit-to-stand test; Mini-BESTest, Mini Balance Evaluations Systems Test; TUG, Timed Up and Go.

[a]OR, [b]Unstandardized coefficient, [c]Logistic regression, using dichotomized variable as dependent variable, with age as covariate, [d]linear regression analysis with age as covariate.

Table 3 Correlation coefficients between the physical performance tests and age in men and women

		Men (n=57)									
		SPPB	**OLS-EO**	**OLS-EC**	**30sSTS**	**Mini-BESTest**	**TUG**	**STAIRS**	**GAIT SPEED**	**GRIP**	**AGE**
Women (n=48)	**SPPB**		0.47**	0.27*	0.53**	0.41**	-0.38**	-0.48**	0.36**	-0.09	-0.11
	OLS-EO	0.21		0.50**	0.20	0.60**	-0.19	-0.38**	0.32*	0.01	-0.26
	OLS-EC	0.11	0.33		0.44**	0.47**	-0.24	-0.43**	0.16	-0.01	-0.24
	30sSTS	0.63**	0.35	0.04		0.41**	-0.46**	-0.71**	0.37*	0.15	-0.25
	Mini-BESTest	0.40**	0.47**	0.24	0.51**		-0.42**	-0.57**	0.53**	0.07	-0.42**
	TUG	-0.40**	-0.28	-0.11	-0.50**	-0.50**		0.59**	-0.63**	0.02	0.19
	STAIRS	-0.37*	-0.49**	-0.21	-0.63**	-0.66**	0.64**		-0.52**	-0.24	0.42**
	GAIT SPEED	0.12	0.37**	0.26	0.29*	0.39**	-0.57**	-0.55**		0.12	-0.27*
	GRIP	0.06	0.34*	0.20	0.35*	0.50**	-0.39**	-0.66**	0.52**		-0.44**
	AGE	-0.27	-0.38**	-0.33*	-0.35*	-0.55**	0.48**	0.49**	-0.40**	-0.32*	

The values are Spearman correlation coefficients, women are in the lower triangle and men are in the upper triangle. * P <0.05, ** P <0.01

SPPB: Short physical performance battery, OLS-EO: one leg standing – eyes open, OLS-EC: One leg standing – eyes closed, 30sSTS: 30 seconds sit to stand, MINI-BESTest: Mini Balance evaluation systems test, TUG: Timed up and Go. For grip strength (dominant hand) and gait speed, mean values are used.

Table 4 Description of the performance-based tests according to feasibility

	Duration (min:s), mean (SD)	Equipment and space	Ceiling effect	Floor effect
SPPB	2:50 (0:34)	Stop watch Chair, appr. 45 cm height ~ 5m walkway, 4 m marked	55.2 %	0
OLS-EO OLS-EC	1:43 (0:37)	Stop watch	46.7 % 1 %	0 % 25.7 %*
Mini-BESTest	10:26 (1:40)	Stop watch Chair, appr. 45 cm height Tape mark, 3 m in front of chair 60 x 60 cm block of foam (10 cm thick) – i.e. balance pillow Incline ramp of 10° slope Box, 23 cm height 7 m walkway	7.6 % Negatively skewed	0%
30sSTS	01:22 (0:16)	Stop watch Chair, appr. 45 cm height	Normally distributed	
Stairs	3:06 (0:54)	Stop watch Stair with 18 steps and handrail	Positively skewed	
Grip strength	02:41 (0:52)	Chair Hand held dynamometer	Normally distributed	
TUG	Part of Mini-BESTest	Stop watch Chair, appr. 45 cm height Tape mark, 3 meters in front of chair	Normally distributed	
Gait speed	Part of SPPB	Stop watch ~ 5 m walkway, 4m marked	Normally distributed	
Total time	23:30 (3:48)			

Abbreviations: SPPB, Short physical performance battery; OLS-EO, One leg standing – eyes open; OLS-EC, One leg standing – eyes closed; 30sSTS, 30-seconds sit-to-stand test; Mini-BESTest, Mini Balance Evaluations Systems Test; TUG, Timed Up and Go; Appr, approximately. *< 2 seconds.