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brief report

## Measuring Slowness in Old Age: Times to Perform Moberg Picking-Up and Walking Speed Tests

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### A B S T R A C T

#### Keywords:

Frailty  
motor slowness  
timed tests  
performance

**Objectives:** Slowness is a marker of frailty captured by the Fried phenotype by a walking speed test which, for health or logistical reasons, is sometimes difficult to perform. The Moberg picking-up test (MPUT) is another timed functional test. It measures hand motor activity and might represent an alternative to assess slowness when the walking speed cannot be evaluated. This study aimed to evaluate the relationship between MPUT and walking speed.

**Design:** Cross-sectional.

**Setting and Participants:** In total, 2748 individuals aged 66 to 83 years who participated in the latest examination (2015–2017) of the population-based Lausanne cohort 65+ and completed both tests.

**Methods:** Walking speed (time to walk 20 meters at usual pace) and MPUT (time to pick up 12 objects) were compared using scatter graphs. Multivariate regression models further investigated the relationship between MPUT and walking times with adjustment for height, grip strength, body mass index, and Mini-Mental State Examination. All analyses were stratified by sex.

**Results:** MPUT and walking times were moderately, positively correlated in men ( $r = 0.38$ ,  $P < .001$ ) and in women ( $r = 0.38$ ,  $P < .001$ ). Higher grip strength and Mini-Mental State Examination performances were correlated to shorter MPUT and walking times. Men and women slower at the MPUT were also significantly slower at the walking speed test when adjusting for height ( $P < .001$ ) as well as in fully adjusted models ( $P < .001$ ).

**Conclusions and Implications:** These preliminary results point to a positive association between MPUT and walking speed independent of muscle strength and cognition. Further research is needed to investigate the capacity of MPUT to predict adverse health outcomes before considering this test as an alternative measure of slowness in the assessment of frailty.

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Population aging has a strong impact on health services. Several recent recommendations converge to evaluate frailty in older persons in various healthcare settings, as frailty is associated to a range of poor outcomes.<sup>1,2</sup> Since 2001, the Fried definition of frailty as a phenotype

with 5 dimensions (shrinking, weakness, exhaustion, slowness, and low physical activity) has become one of the most successful tools to evaluate frailty in populations of older adults.<sup>3</sup> Historically, Fried et al used data available in the Cardiovascular Health Study to operationalize these dimensions, including walking speed to assess slowness.

Further work has shown that walking speed was associated with mortality,<sup>4</sup> cognitive ability,<sup>5,6</sup> and lower limb muscle strength. Walking speed has also been proposed as a single tool to assess frailty<sup>7,8</sup> and is recognized as an essential measurement in geriatric assessment.<sup>9,10</sup> However, measuring walking speed in clinical settings or at home may be difficult because the test requires space in a quiet setting and some acute conditions (eg, fractures) limit its feasibility. In a recent study, only 30% of hospitalized older adults could complete a gait speed test whereas 95% successfully had a grip strength

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The authors declare no conflicts of interest.

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measurement.<sup>11</sup> Alternative measurements of slowness would, therefore, be useful.

The Moberg picking-up test (MPUT) is a timed test first used in neurorehabilitation to evaluate hand motor activity.<sup>12</sup> It does not require much strength, space, or expensive equipment. This study aimed to evaluate (1) the crude relationship between the time to perform a MPU and a walking speed test in a population of older adults; (2) the association of muscular strength and cognitive performance with the walking speed test and the MPU, respectively; and (3) the relationship between the time to perform the MPU and the walking speed test controlling for these 2 parameters.

## Methods

### Population and Study Sample

Participants were selected from the Lausanne cohort 65+ (Lc65+), an ongoing study of frailty conducted in Lausanne, Switzerland.<sup>13</sup> The Lc65+ enrolled 3 successive samples of community-dwelling adults aged 65 to 70 years living in Lausanne, randomly selected from the official population register. In 2004, the first cohort included 1564 persons born between 1934 and 1938; in 2009, the second cohort included 1489 persons born between 1939 and 1943; and in 2014, the third cohort included 1678 persons born between 1944 and 1948. After baseline assessment, participant follow-up assessment included in-person repeated performance tests performed at the study evaluation site every 3 years. The Lc65+ study protocol (No. 19/04) and periodic updates received approval from the Ethics Committee for Human Research of the Canton Vaud; participants provided their informed consent.

Data used in this study were collected in the last follow-up examination conducted in 2015 (third cohort), 2016 (second cohort), and 2017 (first cohort) by trained medical assistants. Eligible participants were those who completed both the walking speed test and the MPU. Participants with conditions that might alter the walking speed test (eg, sciatica, oxygen therapy) or the MPU (eg, joints deformation, fingers wound or fracture, long or absent nails, sensory impairment of the upper limb, low vision) were excluded. Finally, a few participants were excluded from multivariable analyses integrating grip strength measurements because of conditions compromising this test according to medical assistant discretion (eg, shoulder pain).

### Tests and Material

The MPU was assessed by the time in seconds to pick up (one at a time) with the dominant hand 12 small objects scattered on a table in front of seated participants and to place them into a box as fast as possible. The Figure 1 legend describes the standard protocol. Several studies showed that the MPU is a good test to evaluate the functional performance of upper limbs in rheumatology,<sup>14,15</sup> in patients with carpal tunnel syndrome,<sup>16</sup> and in absence of upper limb pathology.<sup>17,18</sup> Albeit stemming from small samples, reported internal consistency (test-retest) and inter-rater reliability of the MPU are good to excellent.<sup>16,17</sup> Walking speed was assessed by the time in seconds to walk a 20-meter distance at usual pace in a quiet, well-lit corridor. Muscular strength was measured by the grip strength assessed in pounds (1 pound = 0.4536 kg) using a JAMAR-type dynamometer with the right hand except in case of incapacity, following the standard protocol described by Mathiowetz.<sup>19</sup> The best of the 3 performances was recorded. Cognitive status was assessed using the Mini-Mental State Examination (MMSE)<sup>20</sup> stratified in 3 categories (0–23/24–27/28–30). MMSE score was imputed based on measured items for 6 participants who could not fully perform the test for noncognitive reasons (eg, visual impairment) but completed at least two-thirds of the test. A spontaneous, free-drawing Clock Drawing



**Fig. 1.** MPU in Lc65+ study. Standard protocol: The test uses a 60 × 30 cm plastic desk-blotter, a 13 × 8 × 5 cm plastic box, 12 small metallic objects (5 cm fine screw, 2.3 cm wide screw, 3.3 and 2.8 cm paper clips, 1.4 cm diameter ring, 3.8 cm safety pin, 2 small nuts, 1 wing nut, 2.8 cm and 2.2 cm diameter coins, 5.5 cm key) and a stopwatch. Marks delineate the corners of two 23 × 30 cm rectangles on the left and right sides of the desk-blotter (for left and right-handed persons, respectively) and the position of the box between them. The desk-blotter is placed lengthwise on a table. Individuals are seated in a chair facing it, their self-reported dominant hand resting on the table beside the desk-blotter. Ambidextrous individuals are asked to pick a small object on the table; the spontaneously chosen hand is considered as dominant. The box is placed on the desk-blotter and the 12 objects are dispersed randomly in the rectangle on the side of the dominant hand. Individuals are instructed to pick up each object one-by-one and place them in the box as quickly as possible, without sliding them. Time is recorded from the start order until the last object is dropped off.

Test (CDT) was added as a supplementary analysis as a cognitive screening test sensitive to impairment in executive functions. CDT was scored on a 10-point scale according to a standardized protocol<sup>21</sup> and stratified in 3 categories (<7/7–8/>8).

As height may influence walking speed and body mass index (BMI) may influence grip strength, they were measured at the study center. Participant education level was assessed as it may influence MMSE results and categorized as basic compulsory vs apprenticeship vs postcompulsory.

### Statistical Methods

Comparisons between men and women were tested using the Pearson  $\chi^2$  test for dummy variables and the Student *t*-test for continuous variables. As several significant differences were observed including in the walking speed, MPU, and grip strength performance (Supplementary Table 1), all analyses were stratified by sex.

Correlations between performance tests were explored graphically. Bivariate correlations between MPU, walking speed, and grip strength were estimated with the Pearson correlation coefficient. A nonparametric test for trend was used to investigate the association between MPU, walking speed, and MMSE score levels.

Linear regressions were performed to evaluate the crude association between MPU and walking speed tests, adjusting only for height (model 1). Then, to account for the confounding potential of strength and cognition, multiple linear regressions were further carried out with additional adjustment for grip strength, BMI, MMSE, and education (model 2). Covariates with nonsignificant over effect were not included in the model. Walking speed test and MPU times were used as continuous variables and walking time was the dependent

variable in all analyses. Interactions tested between grip strength and BMI, as well as between MMSE and education were nonsignificant. Model assumptions of linearity, normality, and homoscedasticity were checked graphically. Multicollinearity was verified using the variance inflation factor (VIF). The limit was  $VIF > 5$ .

Influential outliers with a Cook distance greater than  $4/n$  and studentized residuals greater than 2 (in absolute value) in linear regression models were excluded.  $P$  values of  $< .05$  were considered as statistically significant. All analyses were performed using Stata v 15.1 software (StataCorp, College Station, TX).

A first sensitivity analysis assessed the impact of extreme points by including influential outliers in multivariate models. A second sensitivity analysis used the CDT as an adjustment variable (instead of MMSE first, and then in addition of it) in fully adjusted models.

## Results

Overall, 4731 persons were enrolled in the Lc65+ cohort and 3511 participated in the last examination (Supplementary Figure 1). Among these, 3073 accepted an appointment: 2897 had complete data for MPUT and walking speed tests, walking speed test was missing in 166 cases, MPUT in 3 cases, and both tests in 7 cases. We further excluded 59 participants because of conditions likely to compromise the interpretation of the MPUT (eg, joints deformation) ( $n = 27$ ) or walking speed (eg, sciatica) ( $n = 32$ ) tests. Outlier analysis resulted in further exclusion of 90 persons, leaving a total of 2748 participants in this study.

The study sample included a majority of women (58.2%, Supplementary Table 1). Mean age was 73.5 years and was similar in men and women ( $P = .216$ ). Figure 2 shows a significant positive correlation between MPUT and walking times ( $r = 0.38$ ,  $P < .001$  for men;  $r = 0.38$ ,  $P < .001$  for women), as well as significant negative correlations between grip strength and both tests (grip strength and MPUT time:  $r = -0.25$ ,  $P < .001$  for men and  $r = -0.28$ ,  $P < .001$  for women; grip strength and walking time:  $r = -0.32$ ,  $P < .001$  for men and  $r = -0.33$ ,  $P < .001$  for women). In both sexes, higher MMSE scores were significantly associated with faster execution of both the MPUT and the walking speed tasks (all tests  $P < .001$ ) (Figure 3).

Linear regression analyses (Supplementary Table 2) showed that participants with longer execution time for the MPUT had significantly longer execution time for the walking speed test, adjusting for height only. The association was slightly stronger in women ( $B = 0.39$ ,  $P < .001$ ) than in men ( $B = 0.31$ ,  $P < .001$ ) (model 1). Adjusted R-squared was 0.18 ( $P < .001$ ) in men and in women. After additional adjustment for strength and cognition (model 2), the relationship between MPUT and walking times remained significant but its strength decreased slightly ( $B = 0.23$ ,  $P < .001$  for men;  $B = 0.24$ ,  $P < .001$  for women). As covariates, higher grip strength was independently associated with a shorter walking time in men ( $B = -0.03$ ,  $P < .001$ ) and in women ( $B = -0.05$ ,  $P < .001$ ) and worse cognitive performance at the MMSE was significantly associated with a longer walking time only in women. Adjusted R-squared of model 2 was 0.27 in men and 0.35 in women ( $P < .001$ ).

The first sensitivity analysis showed that, for both sexes, the magnitude of the relationship between MPUT and walking speed was slightly stronger when influential outliers were taken into account, suggesting that exclusion of these participants produced more conservative results. The second sensitivity analysis showed a nonsignificant specific contribution of the CDT in multivariable models.

## Discussion

In spite of the widespread use of walking speed tests, the proportion of noncompleters in older populations or in representative patient groups is not much discussed. Recent US population-based

studies reported 11% missing walking speed tests at age 65+ years in the Health and Retirement Study (HRS)<sup>22</sup> and proportions increasing from 7% at age 65 to 75 years to more than 20% at age 85 to 94 years in the National Health and Nutrition Examination Survey.<sup>23</sup> A Swedish study reported 24% noncompletion in the 85+ years of age population.<sup>24</sup> Increasing proportions of missing walking tests with age suggest that they are not randomly distributed and noncompleters are likely to be more frail.<sup>22</sup> In clinical settings such as hospitals, non-completion may be even more frequent.<sup>11</sup>

In this study, missing information was markedly more frequent on walking tests than on MPUT, and the latter test was performed in most cases when walking speed was missing. Results recorded when both tests were available support our initial hypothesis that participants with faster gait speed would also complete the MPUT faster. Although the correlation was moderate, it remained significant after adjusting for muscular strength and cognition. The magnitude of the association between walking speed and MPUT was close in men and in women.

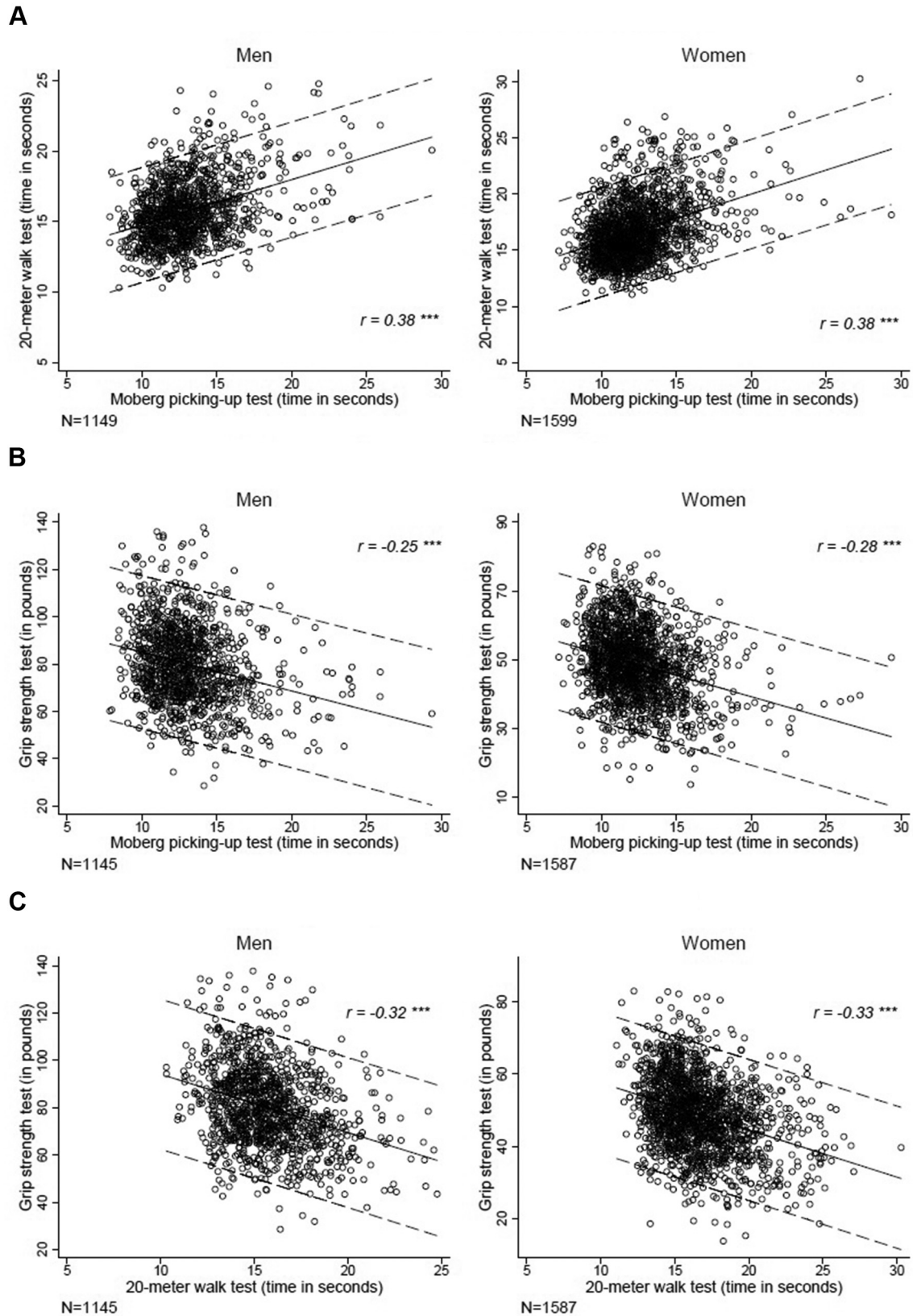
We did not identify other studies that addressed the relationship between MPUT and walking speed tests. However, previous studies pointed to correlations between walking speed and grip strength, particularly in case of sarcopenia,<sup>25</sup> and between walking speed and cognition.<sup>5,6</sup> Our results confirmed these correlations with walking speed and they extend the previous knowledge in showing similar relationships between the MPUT performance and both grip strength and cognitive performance (MMSE). Walking and picking up small objects are complex activities influenced, probably to varying degrees, by many parameters. Some of them, such as strength and balance, are likely to have more influence on the walking speed than on the MPUT. For this reason, a perfect correlation between the 2 tests was not expected. In both sexes, grip strength had a slightly stronger correlation with walking speed than with the MPUT, suggesting more impact of sarcopenia on gait than on hand motor activity.

This study has several strengths. It was based on the observation of a large sample of the community-dwelling population. Information recorded with standardized performance tests allowed excluding participants unable to perform the tests validly for physical reasons. Available time-independent tests of muscular strength and cognition (MMSE) allowed controlling for these 2 dimensions without over-adjustment. Finally, separate analyses for men and women produced similar results, suggesting consistency of the correlation between our 2 timed tests.

Limitations of the current study include its cross-sectional design and the extent of adjustment, particularly for muscular strength. The relationship between walking speed and MPUT was controlled in this study for grip strength as a measure of strength. However, we could not further adjust for lower limb muscular strength. An additional limitation is that the MPUT makes use of small objects from everyday life that may be difficult to grab. Using larger, easy-to-grab standard objects would probably have improved the test as a measure of slowness rather than tactile perception, and thus increased its specificity. MPUT is essentially used to document patients' progress in a context of rehabilitation and population-based normal values are not available. Finally, the ability of the MPUT to predict adverse outcomes in older persons, as the walking speed does, remains unknown.

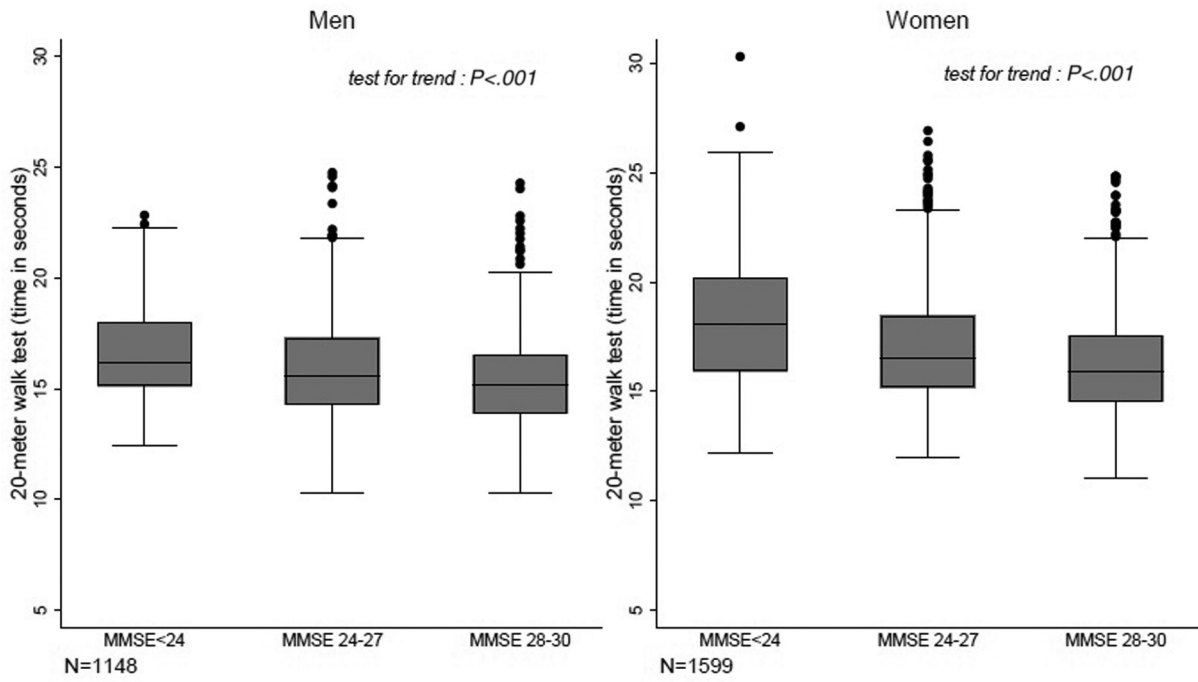
## Conclusions

The moderate but significant and robust correlation between the MPUT and walking speed suggests that MPUT could be an alternative for assessing slowness in both men and women when measuring walking speed is not feasible. However, our results are preliminary. Further research should document the distribution of MPUT values in population groups and investigate the longitudinal relationship between the MPUT and adverse outcomes. Comparative studies of

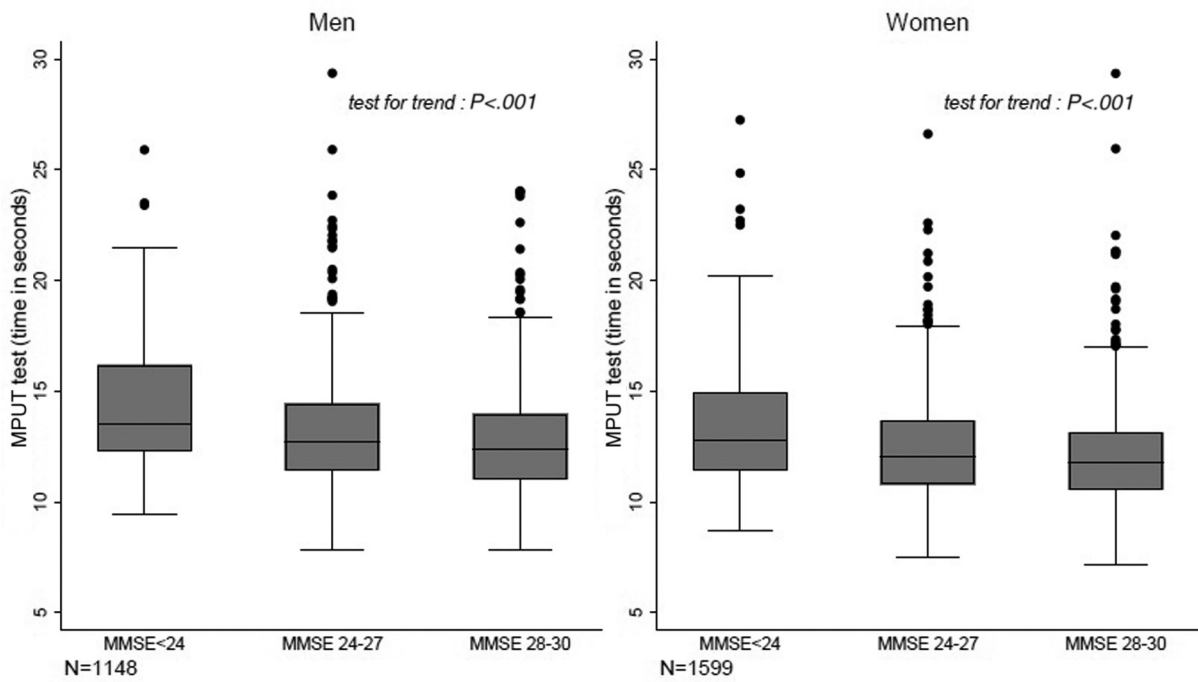


**Fig. 2.** Correlation between physical performance tests by sex. (A) 20-meter walk test and Moberg picking-up test. (B) Grip strength test and Moberg picking-up test. (C) Grip strength test and 20-meter walk test. *r*, correlation coefficient, \*\*\**P* < .001.

**A**



**B**



**Fig. 3.** Distribution of performance times, by level of MMSE and by sex. (A) 20-meter walk time. (B) MPUJ time. MMSE, Mini-Mental State Examination; MPUJ, Moberg picking-up test.

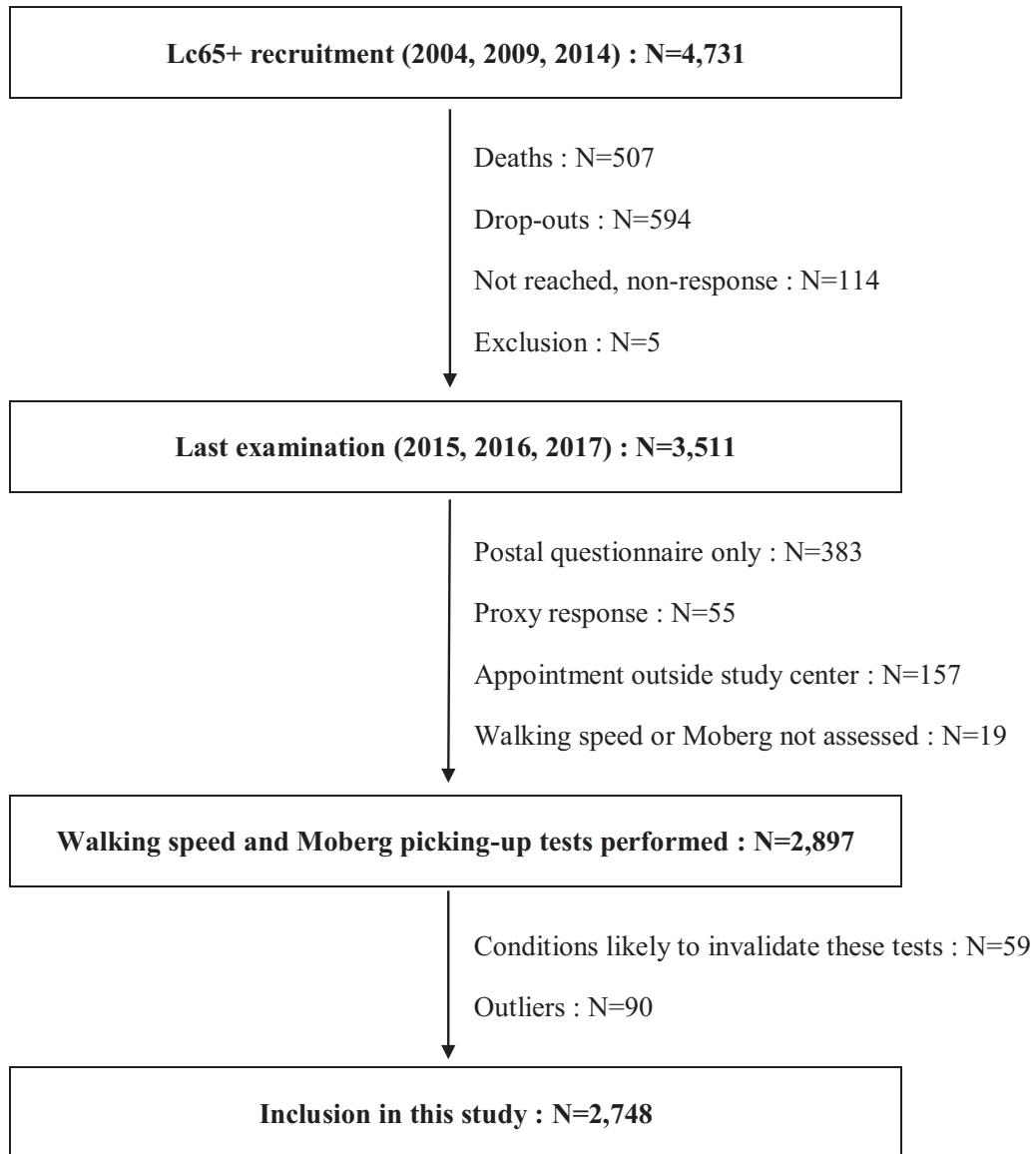
walking speed and MPUT tests' association with mortality and functional decline are needed.

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Supplementary Figure 1. Flow chart.

**Supplementary Table 1**

Characteristics of Study Participants (N = 2748) and Their Comparisons Across Sexes

	N	All	Men (n = 1149)	Women (n = 1599)	P Value
Age, mean (SD)	2748	73.5 (4.9)	73.4 (5.0)	73.6 (4.9)	.216
20-m walk time (s), mean (SD)	2748	16.3 (2.6)	15.7 (2.2)	16.7 (2.7)	<.001
MPUT (s), mean (SD)	2748	12.6 (2.5)	13.1 (2.6)	12.3 (2.4)	<.001
Grip strength (lbs), mean (SD)	2732	61.9 (20.6)	80.0 (17.1)	48.8 (10.6)	<.001
Height, mean (SD)	2748	165.4 (9.0)	172.8 (6.8)	160.0 (6.2)	<.001
BMI, mean (SD)	2747	26.7 (4.6)	27.4 (4.0)	26.3 (5.0)	<.001
MMSE, n (%)	2747				<.001
<24		254 (9.3)	99 (8.6)	155 (9.7)	
24–27		1111 (40.4)	515 (44.9)	596 (37.3)	
28–30		1382 (50.3)	534 (46.5)	848 (53.0)	
Education level, n (%)	2744				<.001
Basic compulsory		404 (14.7)	117 (10.2)	287 (18.0)	
Apprenticeship		1058 (38.6)	422 (36.8)	636 (39.8)	
Postcompulsory		1282 (46.7)	609 (53.0)	673 (42.2)	

SD, standard deviation.

**Supplementary Table 2**

Results of Linear Regression Models of the Relationship Between Times to the MPUT and to the 20-Meter Walking Test by Sexes

Men	Model 1 (n = 1149)			Model 2 (n = 1144)		
	B Coefficient	CI 95%	P Value	B Coefficient	CI 95%	P Value
MPUT	0.31	[0.27; 0.36]	<.001	0.23	[0.18; 0.27]	<.001
Height	−0.06	[−0.08; −0.05]	<.001	−0.02	[−0.04; −0.01]	.011
Age				0.06	[0.04; 0.09]	<.001
Grip strength test				−0.03	[−0.03; −0.02]	<.001
BMI				0.12	[0.09; 0.15]	<.001
MMSE						
<24				0.26	[−0.16; 0.69]	.227
24–27				0.15	[−0.09; 0.39]	.216
28–30				ref.		
Women	Model 1 (n = 1599)			Model 2 (n = 1586)		
	B coefficient	CI 95%	P Value	B coefficient	CI 95%	P Value
MPUT	0.39	[0.34; 0.44]	<.001	0.24	[0.19; 0.29]	<.001
Height	−0.09	[−0.10; −0.07]	<.001	−0.02	[−0.04; −0.00]	.013
Age				0.10	[0.07; 0.12]	<.001
Grip strength test				−0.05	[−0.06; −0.04]	<.001
BMI				0.17	[0.14; 0.19]	<.001
MMSE						
<24				1.04	[0.65; 1.42]	<.001
24–27				0.29	[0.05; 0.52]	.016
28–30				ref.		

B, unstandardized coefficient; CI, confidence interval.

Model 1: adjusted only for height.

Model 2: adjusted for height, grip strength, BMI, and MMSE.