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Gender-specific associations between functional autonomy and physical capacities in independent older adults: Results from the NuAge study

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ABSTRACT

Background: Even with healthy and active aging, many older adults will experience a decrease in physical capacities. This decrease might be associated with diminished functional autonomy. However, little is known about the physical capacities associated with functional autonomy in older women and men.
Objective: This study aimed to examine gender-specific associations between functional autonomy and physical capacities in independent older women and men.
Methods: Secondary analyses were carried out using cross-sectional data from 652 women and 613 men who participated in the NuAge longitudinal study. The "functional autonomy measurement system" (SMAF) was used to evaluate functional autonomy. The physical capacities measured (tests used) were: biceps and quadriceps strength (Microfet dynamometer), grip strength (Martin vigorimeter), unipodal balance, changing position & walking (timed up and go), normal & fast walking (four-meter walking speed) and changing position (chair stand). Correlation and multiple linear regression analyses adjusted for age, depressive symptoms and body composition were performed.
Results: On average, participants were aged 73 years and had mild to moderate functional autonomy loss. In women, after controlling for age, depressive symptoms and body composition, greater functional autonomy was best explained by faster changing position & walking skills and superior biceps strength ($R^2 = 0.46$; $p < 0.001$). After controlling for depressive symptoms, faster changing position & walking skills and better unipodal balance best explained greater functional autonomy in men ($R^2 = 0.21$; $p < 0.001$).
Conclusion: According to these results, physical capacities are moderately associated with functional autonomy among independent older adults, especially women.

1. Introduction

Aging of the population is a phenomenon with important individual and societal consequences. By 2031, older adults will make up about 25% of the population, a twofold increase over its current level (Statistics Canada: Population and Projections, 2005). Even when healthy and active, aging brings challenges. Many older adults will experience decreased functional autonomy, defined as "a clinical syndrome encompassing a group of non-specific symptoms involving physical, mental and functional dimensions" [translation] (Arcand and Hébert, 2007). Diminished physical capacities, in particular strength and mobility (changing position, walking and balance), are thought to play a major role in functional autonomy loss. This reduction stems from the consequences of a deficiency in an organic system and influences an individual's daily functioning. Despite its high incidence (11.9%) (Hébert, Brayne, & Spiegelhalter, 1997), functional autonomy loss is a dynamic process from which recovery is possible (Hardy & Gill, 2005). For example, a longitudinal study done with 572 participants aged 75 years and older demonstrated that over a one-year period about a third of older adults recovered their previous functional autonomy level (Arcand & Hébert, 2007).

Several instruments can be used to assess functional autonomy. In Quebec (Canada) and in France, the functional autonomy measurement system (SMAF) has been widely used to assess functional autonomy of older adults (Desrosiers, Bravo, Hébert, & Dubuc, 1995a,b; Centre d'expertise de santé de Sherbrooke, 2006–2009). This scale quantifies the level of performance in executing daily and instrumental activities and categorizes functional autonomy in five domains: daily activities, mobility,

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communication, mental functions and instrumental activities (Hébert et al., 2003).

While physical capacities, and strength and mobility in particular, have been studied frequently, few studies investigated their associations with functional autonomy. Specifically, studies reported that greater grip strength was associated with greater functional autonomy. One of these studies was done with 598 very old women and men and used the Katz index of activities of daily living (Jeune et al., 2006). Another study with 102 women aged 75 years and over did not confirm the association between grip strength and functional autonomy using the Barthel index (Tietjen-Smith et al., 2006). Moreover, according to den Ouden, Schuurmans, Arts, & van der Schouw, 2013a,b, greater grip strength and leg strength as well as level of physical activity are associated with a lower risk of losing functional autonomy. Another study carried out with 37 older men demonstrated that greater grip strength was associated with a reduced length of stay in a rehabilitation hospital (Roberts, Syddall, Cooper, & Aihie Sayer, 2012). Among studies that included muscle strength (Tietjen-Smith et al., 2006; Clemencon, Hautier, Rahmani, Cornu, & Bonnefoy, 2008; Marsh, Miller, Rejeski, Hutton, & Kritchevsky, 2009), one demonstrated that greater functional autonomy in very old (75–84) and oldest (>85) women is associated with greater overall body (back pull-down, back row, chest press, knee extension and flexion, and shoulder press) strength (Tietjen-Smith et al., 2006). Greater functional autonomy was also associated with greater lower body strength, especially of the quadriceps (leg extensors) (Clemencon et al., 2008; Marsh et al., 2009; Samuel, Rowe, Hood, & Nicol, 2012). Another study showed that measures of lower extremity function were associated with functional autonomy (den Ouden et al., 2013a,b). Some studies examined the associations between functional autonomy and mobility capacities, in particular changing position & walking skills as measured by the chair stand test or the timed up and go (TUG). One study found that faster walking speed explained 55.0% ($p < 0.01$) of greater functional autonomy (physical performance test) in 83 community-dwelling veterans aged 60 and over (Brach & VanSwearingen, 2002). Moreover, one study that followed young and older adults after a rehabilitation program found that increased functional autonomy is predicted by improved changing position & walking skills (Gosselin et al., 2008). Another study done with middle-aged and older men found that faster changing position & walking and greater leg strength were associated with better functional autonomy in daily activities (den Ouden et al., 2013a,b). Finally, one review indicated that greater functional autonomy in older adults is associated with better balance (Patterson et al., 2007; Prata & Scheicher, 2012).

In summary, previous studies have mostly shown significant associations between functional autonomy and physical capacities, in particular grip strength, muscle strength especially of the quadriceps, changing position & walking, and balance. To our knowledge, no study investigated all these physical capacities together or their association with functional autonomy as assessed using an objective measure such as the SMAF, a widely used instrument in Quebec, Canada, and France. Moreover, studies using large representative samples of older men and women, as well as gender-specific analyses, are needed. To maximize functional autonomy recovery, it is important to target physical capacities that are mostly associated with functional autonomy. This study thus aimed to examine associations between functional autonomy and physical capacities in independent older adults. The specific objectives were, for women and men separately, to verify if: (1) muscle (biceps and quadriceps) and grip strength and (2) mobility capacities (changing position, walking and balance) are associated with functional autonomy (total score) or functional autonomy in daily activities, mobility and instrumental activities (subscores). A third objective was to find a set of variables that best explain functional autonomy in older women and men.

2. Materials and methods

2.1. Participants

This cross-sectional secondary study was carried out using data from the NuAge study (Nutrition as a determinant of successful aging: The Quebec longitudinal study) (Gaudreau et al., 2007; Payette et al., 2010). The NuAge longitudinal study is a 5-year observational study of 1793 older adults (940 women) aged 68–82 years in good general health at recruitment. A random sample, stratified by age and sex, from a population-wide health insurance list (Quebec Medicare database (RAMQ)), was used to identify participants. In addition, 11.5% of the sample was recruited as volunteers. Community-dwelling men and women living in the areas of Montreal, Laval, and Sherbrooke in Quebec, Canada, were included if they spoke French or English, were independent in daily activities, were without cognitive impairment [Modified Mini-Mental State (3MS) >79], able to walk one block and climb one floor without rest, and willing to commit to a 5-year study period. Those who had heart failure $\geq$ class II, chronic obstructive pulmonary disease requiring oxygen therapy or oral steroids, inflammatory digestive diseases or cancer treated by radiation therapy, chemotherapy or surgery in the past 5 years were excluded. The numbers of women (W) and men (M) recruited in each age stratum were as follows: 70 ± 2 years: 337 W, 329 M; 75 ± 2 years: 305 W, 289 M; 80 ± 2 years: 298 W, 235 M. Computer-assisted interviews were carried out by trained research dieticians and nurses following rigorous standardized procedures. Data were collected at baseline between January 2004 and April 2005 and have been followed annually.

Data were collected on many aspects, in particular height, weight, nutrition, physical capacities, cognitive status, quality of life and daily activities. For the present secondary study, data from participants ($n = 1265$; 652 women) still in the cohort at the third follow-up were used. The NuAge protocol was approved by the Ethics Committees of the University Institutes of Geriatrics of Sherbrooke and Montréal. All participants signed an informed consent form.

2.2. Sociodemographic and clinical characteristics

The following sociodemographic characteristics were assessed using a series of self-reported questions: gender, age, marital status, housing situation, living arrangement (if the participant lived alone or not), schooling, health problems, income and satisfaction with their income (Table 1). Data were collected by means of interviewer-administered questionnaire. Depressive symptoms were estimated using the geriatric depression scale (GDS) (Brink et al., 1982). Body composition was represented by body mass index [weight (kg)/height (m)^2]. In line with previous studies on physical capacities and functional autonomy (Brink et al., 1982; Lalancette et al., 2010), age, depressive symptoms and body composition were used as potential confounding variables.

2.3. Measurement instruments

2.3.1. Functional autonomy (dependent variable)

Functional autonomy was measured with the SMAF (Hébert et al., 1988), an instrument widely used in the geriatric community (Desrosiers et al., 1995a,b). This instrument can be administered by various health professionals and evaluates 29 activities in five domains (number of items): daily activities (7), mobility (6), communication (3), cognitive functions (5) and instrumental

Table 1
Participant characteristics and raw scores on the main variables.

Continuous variables	Women (n = 652)	Men (n = 613)	Difference
	mean ± SE	mean ± SE	P-value[a]
Sociodemographic and clinical			
Age	73.9 ± 0.09	73.2 ± 0.09	*<0.001*
Depressive symptoms (GDS;/30)	5.2 ± 0.3	4.3 ± 0.26	*0.03*
Body composition (BMI)	27.4 ± 0.32	27.6 ± 0.27	0.76
Schooling	12.7 ± 0.24	13.7 ± 0.33	*0.02*
Functional autonomy (SMAF)			
Total score (/87)	5.4 ± 0.25	6.5 ± 0.25	*0.001*
Daily activities (/21)	1.5 ± 0.1	0.8 ± 0.07	*<0.001*
Mobility (/18)	0.6 ± 0.06	0.3 ± 0.04	*<0.001*
Communication (/9)	0.5 ± 0.04	0.5 ± 0.04	0.55
Cognitive functions (/15)	0.3 ± 0.04	0.4 ± 0.04	0.31
Instrumental activities (/24)	2.4 ± 0.12	4.5 ± 0.2	*<0.001*
Physical capacities tests			
Strength: Grip	51.6 ± 0.94	69.9 ± 1.23	*<0.001*
Biceps	25.17 ± 0.4	46.6 ± 0.70	*<0.001*
Quadriceps	36.9 ± 0.74	58.6 ± 1.17	*<0.001*
Walking: Normal	1.1 ± 0.01	1.2 ± 0.02	*<0.001*
Fast	1.5 ± 0.02	1.7 ± 0.02	*<0.001*
Unipodal balance	12.5 ± 1.11	16.2 ± 1.25	*0.03*
Changing position (Chair Stand)	12.0 ± 0.24	10.8 ± 0.22	*<0.001*
Changing position & walking (TUG)	11.1 ± 0.14	10.5 ± 0.13	*<0.001*
Categorical variables	**%**	**%**	**P-value[b]**
Marital status:			
Single	19.7	9.5	*<0.001*
Widowed	34.9	12.2	
Married/common law	36.6	69.0	
Divorced	8.9	9.3	
Living arrangement (alone)	48.4	23	*<0.001*
Housing situation:			0.36
Owner	89.5	92.8	
Tenant with services	4.8	2.8	
In religious community	5.7	4.4	
Income < low-income cutoff (yes)	23.8	12.3	*<0.001*

Significant results are in *italics*. SE, Standard error; GDS, Geriatric depression scale; BMI, Body mass index; SMAF, Functional autonomy measurement system; TUG, Timed up and go.
[a] P value of the t tests for independent samples.
[b] P value of the one-way ANOVA.

activities (8) (Desrosiers et al., 1995a,b). Subscores for the five domains and the total score represent the sum of each activity rated on a 5-level scale (0, independent; 0.5, with difficulty; 1, needs supervision; 2, needs help; 3, dependent). The total score ranges from 0 to 87, and a higher score indicates a greater decline in functional autonomy, with scores above 15 representing a moderate to severe loss of functional autonomy (Hébert, Brayne, & Spiegelhalter, 1999). A difference of 5 points in the total score is considered clinically significant. The SMAF has excellent psychometric properties [intraclass correlation coefficients of 0.95 for test-retest and 0.96 for interrater (Hébert, Guilbault, Desrosiers, & Dubuc, 2001)] and is highly correlated with the functional independence measure (r = 0.90, p = 0.001), a well-known functional autonomy tool (Desrosiers et al., 2003).

2.3.2. Physical capacities (independent variables)

Six tests measuring various physical capacities were used, including biceps, quadriceps and grip strength, and mobility capacities, i.e. changing position, walking speed and balance. Results presented are the mean of three trials using the dominant side.

2.3.2.1. Strength. Biceps, quadriceps and grip strength were evaluated by applying resistance using the device against the movement executed by the participant. The Microfet dynamometer was used to assess biceps and quadriceps strength in newtons, and has excellent intraclass correlation coefficients [0.93–0.98 for test-retest and 0.93–0.98 for interrater (Roma, Chiarello, Barker, & Brenneman, 2001)]. For grip strength, to reduce the stress on joints and soft tissues of the hand by providing an ergonomic grip (Desrosiers et al., 1995a,b), the Martin vigorimeter was used instead of the Jamar dynamometer with which it is highly correlated (0.89–0.90). The Martin vigorimeter measures grip strength in kilo pascals.

2.3.2.2. Mobility capacities. Balance, changing position & walking skills were evaluated with four physical capacity tests measured in seconds. The unipodal balance test, which has good interrater reliability (0.75) (Giorgetti, Harris, & Jette, 1998), measures the time the participant can maintain his/her balance on one foot up to a maximum of 60 s. The timed up and go (TUG) includes changing position and walking by recording the time the participant takes to get up from a chair, walk three meters, go around a cone, walk back and sit on the chair. The participant was asked to walk at a comfortable, safe speed and could use her/his walking aid. The TUG has excellent intraclass coefficients [0.99 for test-retest and interrater (Podsiadlo & Richardson, 1991)]. The four-meter walking speed test rates the average time to walk four meters at a normal or fast but safe speed. The participant can use her/his technical aid (Guralnik et al., 1994). The chair stand test involves lower body strength and balance while changing position and measures the time taken to stand up five times from a chair with arms crossed on the chest (Guralnik et al., 1994).

2.4. Statistical analyses

All analyses were done separately for women and men using SAS survey procedures (SAS Institute and Inc., 2013) and taking into account the stratified random sampling strategy. To describe our participants, mean, standard error and percentage were used. For the categorical variables, T-tests and chi-square tests were performed to identify gender differences comparing characteristics of women and men. Pearson's correlation test was used to examine bivariate associations between physical capacities and functional autonomy (total score) and subscores (daily activities, mobility and instrumental activities), except for the communication and cognitive function subscores, which were thought to be less affected by physical capacities. Independent variables whose bivariate test results had a P value lower than 0.05 were retained for the regression analyses. The all-possible-regression procedure (Kleinbaum, Kupper, Nizam, & Muller, 2008) was performed in two steps: (1) examining the associations between all physical capacities and functional autonomy, and (2) where relevant, controlling for potential confounding variables (age, depressive symptoms and body composition). Assumption of normality of variables was visually verified with histograms and statistically with the Kolmogorov–Smirnov test. No collinearity problem between variables was observed, and a residual analysis was done to verify basic assumptions.

3. Results

On average, participants were approximately 73 years old, had about 13 years of schooling (Table 1) and 1.5% of women and 7.5% of men had moderate to severe depressive symptoms (data not shown), estimated using the GDS. Compared to men, more women were widowed, lived alone and had a low income. The majority of the participants had mild loss of functional autonomy and, compared to women, men had greater decline in instrumental activities, which was the only clinically significant gender difference in functional autonomy (Table 1). For physical capacities

Table 2
Correlations between physical capacities and functional autonomy of women ($n = 652$) and men ($n = 613$).

Dependent variables	SMAF Total score		Daily activities		Mobility		Instrumental activities	
Independent variables	Women	Men	Women	Men	Women	Men	Women	Men
Normal speed walking	*−0.47 (<0.001)*[a]	*−0.26 (<0.001)*	*−0.39 (<0.001)*	*−0.34 (<0.001)*	*−0.35 (<0.001)*	*−0.32 (<0.001)*	*−0.37 (<0.001)*	−0.09 (0.10)
Fast speed walking	*−0.41 (<0.001)*	*−0.29 (<0.001)*	*−0.35 (<0.001)*	*−0.32 (<0.001)*	*−0.35 (<0.001)*	*−0.35 (<0.001)*	*−0.32 (<0.001)*	−0.11 (0.06)
Changing position	*0.41 (<0.001)*	*0.24 (0.001)*	*0.33 (<0.001)*	*0.32 (<0.001)*	*0.48 (<0.001)*	*0.35 (0.0001)*	*0.29 (<0.001)*	0.04 (0.51)
Changing position & walking	*0.51 (<0.001)*	*0.32 (<0.001)*	*0.41 (<0.001)*	*0.36 (<0.001)*	*0.46 (<0.001)*	*0.41 (<0.001)*	*0.42 (<0.001)*	*0.14 (0.01)*
Unipodal balance	*−0.32 (<0.001)*	*−0.30 (<0.001)*	*−0.31 (<0.001)*	*−0.29 (<0.001)*	*−0.21 (<0.001)*	*−0.18 (<0.001)*	*−0.24 (<0.001)*	*−0.18 (<0.01)*
Biceps strength	*−0.32 (<0.001)*	*−0.23 (<0.001)*	*−0.26 (<0.001)*	*−0.24 (<0.001)*	*−0.17 (0.006)*	*−0.22 (0.001)*	*−0.27 (<0.001)*	*−0.12 (0.05)*
Quadriceps strength	*−0.26 (<0.001)*	*−0.15 (0.02)*	*−0.22 (<0.001)*	*−0.23 (<0.001)*	*−0.15 (0.02)*	*−0.21 (<0.001)*	*−0.25 (<0.001)*	−0.02 (0.65)
Grip strength	*−0.28 (<0.001)*	*−0.22 (<0.01)*	*−0.24 (<0.001)*	*−0.26 (<0.001)*	*−0.23 (<0.001)*	*−0.26 (<0.001)*	*−0.21 (<0.01)*	−0.08 (0.20)

Significant results are in *italics*.
[a] Pearson's correlation coefficients (P value).

tests, men had superior strength, better unipodal balance, and faster changing position & walking skills, but women walked faster (normal and fast speed).

Four independent variables [walking (normal & fast speed), changing position, and changing position & walking] mostly showed moderate ($r \geq 0.3$) correlations with the functional autonomy total score or subscores (Table 2). Strength and balance presented generally small correlations. Higher correlations were mainly observed for women and involved changing position & walking. For men, except for changing position & walking and balance, no correlation was found between physical capacities and functional autonomy in instrumental activities (Table 2). Nevertheless, functional autonomy in daily activities and mobility of men presented moderate correlations with walking (normal and fast speed), changing position, and changing position & walking.

In women, after controlling for age, depressive symptoms and body composition, greater functional autonomy was best explained by faster changing position & walking skills, and superior biceps strength ($R^2 = 0.46$; $p < 0.001$; Table 3). After controlling for depressive symptoms and body composition, faster changing position & walking skills (also including changing position only), better unipodal balance and superior biceps strength best explained greater functional autonomy in daily activities of women ($R^2 = 0.37$; $p < 0.001$). Again for women, after controlling for depressive symptoms and body composition, greater mobility in functional autonomy was best explained by changing position & walking skills (also including changing position only; $R^2 = 0.37$; $p < 0.001$; Table 3). Finally, after controlling for age and body composition, faster changing position & walking skills and superior biceps strength best explained greater functional autonomy in instrumental activities of women ($R^2 = 0.25$; $p < 0.001$).

In men, after controlling for depressive symptoms, faster changing position & walking skills and better unipodal balance best explained greater functional autonomy ($R^2 = 0.21$; $p < 0.001$; Table 4). After controlling for depressive symptoms and body composition, greater functional autonomy in daily activities of men was best explained by faster changing position & walking skills, faster normal speed walking, superior grip strength and better unipodal balance ($R^2 = 0.28$; $p < 0.001$). Again for men, after controlling for age, depressive symptoms and body composition, faster changing position & walking skills best explained greater mobility in functional autonomy ($R^2 = 0.23$; $p < 0.001$; Table 4). Finally, but only without controlling, greater functional autonomy in instrumental activities of men was best explained by better unipodal balance ($R^2 = 0.03$; $p < 0.01$).

Thus, better unipodal balance was the only physical capacity common to women and men that best explained greater functional autonomy. Better unipodal balance was also the only physical capacity common to women and men that best explained greater functional autonomy in daily activities, and faster walking at fast speed was the only common physical capacity for greater mobility in functional autonomy. Finally, no common physical capacity was found that explained functional autonomy in instrumental activities of women and men. For older women and men the percentage of functional autonomy (totally or, based on subscores, partially) explained by physical capacities thus varied between 4 and 43 percent.

4. Discussion

This study aimed to examine the associations between physical capacities and functional autonomy in older women and men. Results show that greater functional autonomy was best explained by faster changing position & walking skills (also including changing position for women only), for both women and men, and superior biceps strength for women and better unipodal balance for men. Overall, the results of this study indicate that changing position or changing position & walking skills influence the functional autonomy (total score and subscores) of older women and men, with the exception of functional autonomy (total score) and instrumental activities of men. According to these results, physical capacities only moderately or even modestly explain functional autonomy, especially for men. Nevertheless, these results are consistent with previous studies which demonstrated that functional autonomy is associated with changing position & walking (Brach & VanSwearingen, 2002; den Ouden et al., 2013a,b; Wang, Sheu, & Protas, 2006; Gosselin et al., 2008; Fraga, Cader, Ferreira, Giani, & Dantas, 2011) and balance (Patterson et al., 2007; Prata & Scheicher, 2012), and not associated with grip strength (Tietjen-Smith et al., 2006; den Ouden et al., 2013a,b). Therefore, more complex physical capacities such as changing position & walking seem to best explain functional autonomy. Surprisingly, and contrary to other studies, muscle strength, especially of the quadriceps (Clemencon et al., 2008; Marsh et al., 2009), was not among its best correlates and presents only small associations with functional autonomy.

At least two explanations for small associations between physical capacities and functional autonomy are plausible. First, functional autonomy is explained by many factors other than physical capacities, such as living arrangement (Heinonen et al., 2012), cognitive (Rajan et al., 2012), pulmonary, visual or auditory impairments (Hébert et al., 1997), positive affect (Franke, Margrett, Heinz, & Martin, 2012), motivation, and previous habits in daily and instrumental activities. A second explanation for these moderate or modest results could be that the participants recruited for the NuAge study were independent, i.e. their functional autonomy level was relatively high at T1 of the study and still high at T3 (less statistical variation in functional autonomy reduces the probability of finding associations).

Table 3
Unstandardized regression coefficients (β) in the multivariate models estimating the association between physical capacities and functional autonomy in women ($n = 652$).

Variable	Model 1- SMAF Total score				Model 2- Daily activities				Model 3- Mobility				Model 4- Instrumental activities			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.
Constant	0.74 (1.91)	0.70	−11.6 (3.96)	<0.01	2.01 (1.09)	0.06	−1.60 (1.06)	0.13	−1.38 (0.34)	<0.001	−2.53 (0.45)	<0.001	0.65 (0.93)	0.49	−6.07 (2.18)	<0.01
Normal speed walking					−1.00 (0.47)	0.03	−0.39 (0.44)	0.37								
Changing position	0.14 (0.07)	0.04	0.15 (0.07)	0.02					0.07 (0.02)	<0.001	0.07 (0.02)	<0.001				
Changing position & walking	0.56 (0.13)	<0.001	0.43 (0.12)	<0.001	0.15 (0.06)	0.02	0.13 (0.05)	0.01	0.10 (0.03)	<0.001	0.08 (0.03)	<0.01	0.29 (0.07)	<0.001	0.25 (0.07)	<0.001
Unipodal balance	−0.04 (0.01)	<0.001	−0.02 (0.01)	0.123	−0.02 (0.004)	<0.001	−0.01 (0.004)	<0.01					−0.01 (0.01)	0.02	−0.005 (0.001)	0.45
Biceps strength	−0.11 (0.03)	<0.001	−0.11 (0.03)	<0.001	−0.03 (0.01)	0.02	−0.04 (0.01)	<0.001					−0.05 (0.02)	<0.01	−0.05 (0.02)	<0.01
Depressive symptoms (GDS)			0.19 (0.05)	<0.001			0.05 (0.02)	<0.01			0.03 (0.01)	0.03				
Age			0.08 (0.05)	0.08											0.07 (0.03)	<0.01
Body composition (BMI)			0.23 (0.04)	<0.001			0.11 (0.01)	<0.001			0.05 (0.01)	<0.001			0.06 (0.03)	0.03
R^2	0.34	0.46	0.23	0.37	0.28	0.37	0.21	0.25								
F	F(4643) = 24.06	F(7643) = 24.62	F(4643) = 21.61	F(6643) = 32.73	F(2643) = 16.46	F(4643) = 12.94	F(3643) = 17.95	F(5643) = 14.98								
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001								

SMAF, Functional autonomy measurement system; SE, Standard error; GDS, Geriatric depression scale; BMI, Body mass index.

Table 4
Unstandardized regression coefficients (β) in the multivariate models estimating the association between physical capacities and functional autonomy in men ($n=613$).

Variable	Model 1- SMAF Total score				Model 2- Daily activities				Model 3- Mobility				Model 4- Instrumental activities			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	β (SE)	sig.	B (SE)	sig.
Constant	5.14 (1.91)	<0.01	3.57 (1.86)	0.06	1.70 (0.81)	0.04	−0.26 (0.80)	0.74	−058 (0.33)	0.08	−1.74 (0.73)	0.02	4.98 (0.26)	<0.001	–	–
Normal speed walking					−0.85 (0.36)	0.02	−0.63 (0.31)	0.04								
Changing position									0.03 (0.01)	0.03	0.03 (0.01)	0.07				
Changing position & walking	0.42 (0.12)	<0.001	0.41 (0.12)	<0.001	0.09 (0.04)	0.03	0.09 (0.04)	0.03	0.08 (0.03)	<0.01	0.08 (0.03)	<0.01				
Unipodal balance	−0.05 (0.01)	<0.001	−0.04 (0.01)	<0.01	−0.01 (0.003)	<0.001	−0.01 (0.003)	<0.01					−0.03 (0.01)	<0.01	–	–
Biceps strength	−0.05 (0.02)	0.03	−0.04 (0.02)	0.09												
Grip strength					−0.01 (0.003)	<0.01	−0.01 (0.004)	<0.01	−0.004 (0.002)	0.02	−0.003 (0.002)	0.06				
Depressive symptoms (GDS)			0.24 (0.06)	<0.001			0.07 (0.02)	<0.01			0.02 (0.01)	0.08				
Age											0.01 (0.01)	0.13				
Body composition (BMI)							0.05 (0.02)	<0.01								
R^2	0.16	0.21	0.20	0.28	0.21	0.23	0.03									
F	F(3604) =14.46	F(4604) =16.15	F(4604) =16.65	F(6604) =13.39	F(3604) =8.9	F(5604) =6.99	F(1604) =8.11	–								
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	–								

SMAF, Functional autonomy measurement system; SE, Standard error; GDS, Geriatric depression scale; BMI, Body mass index.

Compared to men, superior associations between physical capacities and functional autonomy were found for women, especially for instrumental activities. Such associations were also observed in Heinonen et al. (2012). These differences might be because many men of that generation are not used to doing instrumental activities (e.g. housework). Moreover, compared to women, more men who participated in the present study were married or living common law and therefore had someone who could do those activities for them.

5. Clinical implications

The results of this study suggest approaches to take in clinical interventions. First, changing position or changing position & walking skills should be considered in interventions aimed at maintaining or improving older adults' functional autonomy. Second, specific physical capacities might be targeted in interventions aimed at maintaining or improving one particular domain of activities. For example, improving daily activities and mobility of women might be specifically achieved by increasing walking at normal speed. Increasing functional autonomy of women and men may be achieved by increasing walking at fast speed. These physical activities may be positively modified and thus warrant special attention in rehabilitation interventions. Other studies are needed to confirm these findings and suggested intervention strategies.

6. Study limitations and strengths

As mentioned, one limitation of this study was that the participants had a high level of functional autonomy at baseline, and this level remained almost unchanged two years later. Moreover, since this study used data collected previously (secondary analysis), it was not possible to consider other variables that might have further explained functional autonomy. As this study was cross-sectional, it was not possible to establish the direction of the observed relationships and identify best predictors of functional autonomy.

Nevertheless, this study is a first step in understanding physical capacities that explain functional autonomy of older women and men. Based on a rigorous methodology, it included a high number of participants representative of independent older adults having good cognitive function. Furthermore, the study simultaneously considered many types of physical capacities targeted by health interventions and used a wide variety of validated tools. Finally, gender-specific analyses were provided, pointing up interesting differences between women and men.

7. Conclusion

This study found gender-specific associations between functional autonomy and physical capacities for older women and men having successful aging. For women, after controlling for age, depressive symptoms and body composition, higher functional autonomy was best explained by faster changing position & walking skills and superior biceps strength. After controlling for depressive symptoms, faster changing position & walking skills and better unipodal balance best explained higher functional autonomy of men. According to these results, physical capacities only moderately estimate functional autonomy, especially for men.

Future studies replicating and extending these findings are warranted. Specifically, it is important to better understand why associations between functional autonomy and physical capacities were higher for women than men. Moreover, other studies might consider additional physical capacities such as general balance, triceps strength and range of motion of upper and lower limbs. As mentioned, other types of variables might help better explain functional autonomy, i.e. cognitive impairments, motivation and previous habits in daily and instrumental activities. Finally, future studies could include a wider range of functional autonomy measures and use a longitudinal design in order to identify best predictors of functional autonomy.

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