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1 **Plantarflexor muscle-tendon properties are associated with mobility in**  
2 **healthy older adults**

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18 Running page headline: Muscle, tendon and mobility in old age

19

## 20 **Abstract**

21 **Background.** Muscle mass, strength and power are known determinants of mobility in older  
22 adults but there is limited knowledge on the influence of muscle architecture or tendon  
23 properties on mobility. The purpose of this study was to examine the relationship between  
24 mobility and plantarflexor muscle-tendon properties in healthy older adults.

25 **Methods.** A total of 52 subjects (age 70-81 years) were measured for six-minute walk test  
26 (6MWT), timed “up and go”-test (TUG), isometric plantarflexion strength, Achilles tendon  
27 stiffness, triceps surae muscle architecture, lower extremity lean mass, isometric leg extension  
28 strength and leg extension power. Partial correlations and multivariate regression models  
29 adjusted for sex, age, body mass and height were used to examine the relationship between  
30 mobility (6MWT and TUG) and lower limb muscle-tendon properties.

31 **Results.** Multivariate regression models revealed that Achilles tendon stiffness ( $p=0.020$ ),  
32 plantarflexion strength ( $p=0.022$ ) and medial gastrocnemius fascicle length ( $p=0.046$ ) were  
33 independently associated with 6MWT. Plantarflexion strength ( $p=0.037$ ) and soleus fascicle  
34 length ( $p=0.031$ ) were independently associated with TUG.

35 **Conclusions.** Plantarflexor muscle-tendon properties were associated with mobility in older  
36 adults independent of lower extremity lean mass, leg extension strength or power.  
37 Plantarflexion strength was a stronger predictor of mobility than leg extension strength or  
38 power. The novel finding of this study was that muscle architecture and tendon properties  
39 explained inter-individual differences in mobility. This study highlights the importance of the  
40 plantarflexors for mobility in older adults and provides understanding of possible mechanisms  
41 of age-related decline in mobility.

## 42 **Introduction**

43 Poor mobility in older age is linked to several adverse health outcomes such as increased risk of  
44 mortality, incidence of cardiovascular disease and mobility disability (1-3). In previous  
45 literature, lower extremity lean mass (4), leg extension strength (5) and power (6) have been  
46 proposed to be causal factors leading to a decline in mobility with aging. Muscle architecture  
47 (geometrical arrangement of muscle fibers) and tendon mechanical properties are factors that  
48 have received less attention in relation to mobility even though these factors are one of the  
49 main determinants of muscle function (7, 8). In addition, muscle architecture and tendon  
50 properties have been found to be significantly different between young and old adults (9, 10)  
51 making these factors potential contributors of age-related decline in mobility.

52 Muscle architecture and tendon mechanical properties have an effect on muscle fiber length  
53 and velocity hence affecting muscle's force and power production capacity according to force-  
54 length (11) and force-velocity (12) relationships. For example, a muscle with longer fibers can  
55 produce greater force and power with the same muscle shortening velocity due to lower  
56 sarcomere velocity. Longer fibers also reduce the amount of sarcomere shortening per muscle  
57 shortening enabling muscle to produce greater force and power throughout a certain joint  
58 rotation if operating around optimal length or at ascending limb of force-length relationship (8).

59 Pennation angle may also have an effect on muscle function. Pennation angle reduces the  
60 amount of force applied to a tendon (and to a bone) by a factor of cosine of the pennation  
61 angle (13). However, this negative effect is counterbalanced by a mechanism called muscle  
62 belly gearing. As muscle fibers shorten they also rotate, amplifying the shortening of the muscle  
63 by a factor of  $1/\cosine$  of the pennation angle (13) if constant muscle thickness is assumed. The  
64 result is a reduced shortening velocity of the individual fibers for a given whole-muscle

65 shortening velocity. Muscle belly gearing increases with increasing pennation angle and as a  
66 result, pennation angle has been shown to be related to maximal angular velocity of a limb (14).  
67 Finally, greater pennation angle of the muscle fibers allows a larger number of parallel  
68 sarcomeres to be arranged in a given muscle volume increasing physiological cross-sectional  
69 area of the muscle (8).

70 Elastic tendon modulates muscle fiber behavior and may decouple length changes of the  
71 muscle-tendon unit from length changes of the muscle fibers (15). Recently, Farris and Sawicki  
72 showed that medial gastrocnemius force production capacity is impaired with increasing  
73 walking speed due to increasing shortening velocity of the muscle fascicles (surrogate of fiber  
74 behavior) at the instant of peak force production (16). In this study, Achilles tendon was  
75 elongating at the same time as gastrocnemius muscle fascicles were shortening and thus a  
76 stiffer (less extendable) Achilles tendon could decrease the amount and velocity of the muscle  
77 fascicle shortening. Another recent study by Panizzolo et al. showed that soleus muscle fascicle  
78 operating length shifted to a shorter length with increasing walking speed in older adults (17)  
79 who reportedly have lower Achilles tendon stiffness (9). This shift in operating length was due  
80 to greater Achilles tendon elongation since ankle joint dorsiflexion range of motion did not  
81 change. The shift in operating range could impair force production capacity since soleus may  
82 typically operate at the ascending limb of the force-length relationship (18). To conclude, with  
83 increasing walking speed, a stiffer Achilles tendon may decrease muscle fiber shortening  
84 velocity during the peak force production in gastrocnemius and preserve fiber operating length  
85 closer to optimal in soleus therefore enhancing force production potential.

86 The potential role of age-related alterations in muscle architecture and tendon properties on  
87 age-related impairments in mobility has received only a limited amount of research interest. It

88 is not known whether differences in muscle architecture or tendon stiffness can explain inter-  
89 individual differences in mobility in older adults and therefore possibly contribute to the age-  
90 related decline in mobility. To clarify this issue, the aim of the study was to examine the  
91 relationship between mobility and plantarflexor muscle-tendon properties in a sample of  
92 healthy older adults. Plantarflexors were chosen to be studied since the role of muscle  
93 architecture and tendon mechanical properties for mobility may be most notable in  
94 plantarflexors. It has been observed that during walking, age-related loss of joint moment and  
95 power occur at the ankle joint but not at the knee or hip joints in walking (19). In addition,  
96 triceps surae muscle group has a long elastic Achilles tendon attached to a relatively short  
97 muscle fascicles facilitating use of tendon elasticity during locomotion (7). This study also  
98 compares plantarflexor muscle-tendon properties to lower extremity lean mass, leg extension  
99 strength and power as predictors of mobility.

100 The hypothesis of this study was that plantarflexor muscle-tendon properties contribute to  
101 mobility in older adults and a relationship will exist between muscle-tendon properties and  
102 mobility. Better performance in mobility tests, i.e. faster movement speed, was assumed to  
103 require a greater force and power production from the plantarflexors and subsequently would  
104 be associated with greater plantarflexion strength, longer fascicle length and greater pennation  
105 angle in triceps surae muscles and greater Achilles tendon stiffness.

## 106 **Methods**

### 107 **Subjects**

108 This study was performed as part of a European wide cross-sectional study called MyoAge.  
109 Details of the recruitment of the subjects, inclusion and exclusion criteria have been reported

110 previously (20) and only a short description is given here. Twenty-six women and 26 men (70 to  
111 81 year old, 26) were measured for plantarflexor muscle-tendon properties (data collected in  
112 Finland). Mobility and other muscle related measurements were performed in total of 91  
113 women and 81 men (data collected in Finland, UK and France). Care was taken to standardize  
114 measurement protocols and devices between different measurement sites (20). All subjects  
115 were moderately socially active (participating in social or group activities to improve one's  
116 knowledge or skills two times or more in a month), free from major diseases and did not have  
117 mobility limitations, which would prevent them from walking 250 m without assistance. The  
118 local ethical committees of the respective institutions approved the study. Informed consent  
119 was obtained from all participants and permission for participation was obtained from a  
120 medical doctor. The study was conducted according to the standards set by the latest revision  
121 of the Declaration of Helsinki.

## 122 **Measurements**

123 Detailed information about the measurements can be found from the supplementary material.

124 Subjects' height and body mass was measured and body mass index (BMI) was calculated.  
125 Habitual physical activity level was assessed using the Voorrips physical activity questionnaire  
126 (21). Mobility was assessed using the 6-minute walk test (6MWT) (22) and timed "up and go"-  
127 test (TUG) (23). Maximal voluntary isometric plantarflexion strength was measured with a  
128 custom-built dynamometer. Muscle fascicle length and pennation angle were measured at rest  
129 using ultrasonography from medial gastrocnemius and soleus. Muscle thickness was assessed  
130 from the same ultrasound images as a measure of muscle size. In order to account for  
131 differences in subject's leg length, fascicle lengths were normalized dividing fascicle length by  
132 tibia length. Achilles tendon stiffness was measured from several isometric plantarflexions

133 using a method that combines ultrasonography, motion analysis and force measurement (9).  
134 Lower extremity lean mass (excluding bone mass) was measured using dual-energy X-ray  
135 absorptiometry. Leg extension strength was measured by performing an isometric maximal  
136 voluntary contraction with knee extensors in a dynamometer. Leg extension power was  
137 measured from a countermovement jump performed on a force plate. Instantaneous power  
138 was calculated and peak value during concentric phase was considered to represent leg  
139 extension power (24).

#### 140 **Statistical analysis**

141 Data was first carefully checked for coding and measurement errors. Descriptive statistics were  
142 checked to verify normality of distributions. Differences between men and women were tested  
143 using Student's two-tailed independent samples t-test.

144 Possible covariates for mobility (anthropometrics, age, sex and habitual physical activity level)  
145 were tested using bivariate correlations. Factors correlating with mobility (age, sex, body mass  
146 and height) were used as adjusting factors in subsequent partial correlations and multivariate  
147 regression models.

148 Partial correlations were performed to examine the association between mobility (6MWT and  
149 TUG) and lower limb muscle-tendon properties adjusted for age, sex, body mass and height.  
150 Squared partial correlation coefficients are reposted (table 2) and represent the proportion of  
151 the variance in mobility test explained by a given muscle-tendon property adjusted for age, sex,  
152 body mass and height.

153 The muscle-tendon properties having a significant partial correlation with mobility were  
154 included in the subsequent multivariate models to determine their independent effect. From



155 the multivariate models, a squared semipartial correlations are reported (tables 3 and 4) which  
156 represent the proportion of the variance in mobility tests that was uniquely associated with a  
157 given muscle-tendon property in the model.

158 Consistency of the relationships found between mobility and lower extremity lean mass and leg  
159 extension strength and power in the primary analysis (n=52) was tested with a larger sample  
160 size using data available from the MyoAge-project (n=172).

161 The Level of statistical significance was set at  $\alpha=0.05$ . Statistical tests were performed using  
162 IBM SPSS Statistics (version 20.0.0).

## 163 **Results**

164 Subject characteristics and mean values of the measured variables are summarized in table 1.  
165 There was no difference in age or level of physical activity between men and women, but men  
166 were taller, heavier, had greater lower extremity lean mass, leg extension strength and power  
167 and Achilles tendon stiffness, had larger soleus pennation angle, walked a longer distance  
168 during the 6MWT and performed TUG in shorter time. Women had longer normalized soleus  
169 fascicle length ( $p<0.05$  for all sex differences). 6MWT performance ranged from 420 to 749 m,  
170 which is equivalent to an average walking speed of 1.2 to 2.1 m/s. TUG time ranged from 4.53  
171 to 9.29 s.

## 172 **Partial correlations**

173 Partial correlations between mobility tests and lower limb muscle-tendon properties, adjusted  
174 for age, sex, body mass and height, are reported in table 2. Longer distance walked in 6MWT  
175 was significantly associated with greater plantarflexion strength, Achilles tendon stiffness,

176 soleus pennation angle, leg extension strength and power and shorter medial gastrocnemius  
177 and soleus fascicle lengths ( $p < 0.05$ , table 2).

178 Shorter TUG time was significantly associated with greater plantarflexion strength, Achilles  
179 tendon stiffness, soleus pennation angle and leg extension power and shorter soleus fascicle  
180 length ( $p < 0.05$ ). Lower extremity lean mass or muscle thicknesses of medial gastrocnemius or  
181 soleus were not significantly associated with either mobility test.

## 182 **Multivariate models**

183 Adjusted multivariate regression models include the lower limb muscle-tendon properties that  
184 had significant partial correlation with mobility tests (tables 3 and 4).

185 The multivariate model predicted 73% of the variance in 6MWT distance (table 3).  
186 Plantarflexion strength, Achilles tendon stiffness and medial gastrocnemius fascicle length were  
187 independent predictors in this model (figure 1).

188 The multivariate model predicted 61% of the variance in TUG time (table 4). Plantarflexion  
189 strength and soleus fascicle length were independent predictors in this model.

## 190 **Consistency of the results**

191 The larger sample size ( $n=172$ ) gave comparable results to the ones obtained from the primary  
192 analysis. Longer distance walked in 6MWT was significantly associated with greater leg  
193 extension strength (partial  $r^2=3\%$ ,  $p=0.034$ ) and leg extension power (partial  $r^2=16\%$ ,  $p < 0.001$ ).  
194 Shorter time in TUG was significantly associated with greater leg extension power (partial  
195  $r^2=15\%$ ,  $p < 0.001$ ). However, in this larger sample greater lower extremity lean mass was  
196 significantly associated with both mobility test (6MWT: partial  $r^2=6\%$ ,  $p=0.002$  and TUG: partial

197  $r^2=3\%$ ,  $p=0.033$ ). Leg extension power was the only significant independent predictor of 6MWT  
198 distance and TUG time in the adjusted multivariate regression models ( $p<0.05$ ).

## 199 **Discussion**

200 This study examined the relationship between mobility and plantarflexor muscle-tendon  
201 properties in healthy older adults. The novel finding was that triceps surae muscle architecture  
202 and Achilles tendon stiffness were associated with mobility. In addition it was found that  
203 plantarflexion strength explained a greater proportion of the variance in the mobility tests  
204 compared to lower extremity lean mass, leg extension strength or power. The current study  
205 provides evidence that muscle architecture and tendon properties are important factors in  
206 mobility in healthy older adults.

207 The plantarflexors have a crucial role in age-related decline in mobility. Plantarflexors produce  
208 most of the positive mechanical work in walking (25) and there is an age-related reduction at  
209 ankle but not at knee or hip joint moment and power in walking and running in older adults  
210 compared to young (19). It has been estimated that among older adults plantarflexors are used  
211 near their maximal force production capacity in walking (26). In the current study, it was found  
212 that plantarflexion strength explained a higher proportion of variance in mobility (19-23 %)   
213 compared to lower extremity lean mass (2%), leg extension strength (8-13 %) or leg extension  
214 power (18-20 %). Furthermore, plantarflexion strength was significantly associated with  
215 mobility when controlling for other measured muscle-tendon properties including leg extension  
216 strength and power. Our results emphasize the important role of plantarflexors for mobility and  
217 support the previous findings of a strong relationship between mobility and plantarflexor  
218 muscle function (27, 28). Plantarflexion strength may be a limiting factor for walking speed in

219 healthy older adults. This has been proposed by previous studies among populations, such as  
220 stroke (29) and heart failure patients (30). However, plantarflexion weakness can be  
221 compensated, at least to some extent by redistributing the work from the ankles to the hips  
222 (25).

223 Supporting our hypothesis, it was found that better performance in the mobility tests was  
224 associated with greater pennation angle in the soleus muscle and greater Achilles tendon  
225 stiffness. Interestingly, shorter fascicle length in the triceps surae muscles was associated with  
226 better mobility. In the following paragraphs possible mechanism explaining the observed  
227 relationships between mobility and muscle architecture and tendon properties are discussed.

228 In the soleus muscle a greater pennation angle was associated with better walking performance  
229 but when controlling for the other muscle-tendon properties in the multivariate regression  
230 models this association was not significant. This result may indicate that the greater pennation  
231 angle was associated with better performance in mobility tests due to its effect on increasing  
232 muscle physiological cross-sectional area (31) and this effect is taken into account by the  
233 plantarflexion strength in the model.

234 The Achilles tendon is responsible for most of the length changes in triceps surae muscle-  
235 tendon unit during the stance phase of walking (15) and thus long muscle fascicles may not  
236 provide further advantage for force or power production. Instead, shorter fascicles may reduce  
237 the energy cost of a given force production due to lower activated muscle mass compared to a  
238 similar muscle with longer fascicles (37). This may permit force production to be carried out in  
239 prolonged walking with relatively less metabolic load and fatigue. Short fascicles may also help  
240 to minimize muscle mass and thus overall energy requirements of swinging the lower leg during

241 walking. Tendon stiffness dictates tendon length changes under loading and thus affects muscle  
242 fascicle behavior. A modeling study by Lichtwark and Wilson (32) showed that the Achilles  
243 tendon stiffness value measured from young men (180 N/mm) (33) provides an efficient muscle  
244 fascicle behavior in walking and the efficiency was decreased markedly with lower stiffness  
245 values. Older adults have been shown to have lower Achilles tendon stiffness compared to  
246 young adults (9, 34) and in the current study the average Achilles tendon stiffness was 140  
247 N/mm. This may explain why our data suggest that greater Achilles tendon stiffness is  
248 associated with better mobility performance especially in constant fast speed walking such as  
249 that required in the 6MWT.

250 A strength of this study is that two distinct functional tasks were used to describe mobility, one  
251 that required fast-paced walking for a very short time (around 7 sec) and another that required  
252 prolonged walking for 6 min. 6MWT that requires sustained high workloads may benefit from  
253 Achilles tendon stiffness that is well tuned for efficient force production and elastic energy  
254 utilization. TUG on the other hand is more complex test that sets high demand on balance and  
255 may challenge for example hip abductor muscles that were not examined in this study. A  
256 sample of older adults with varying levels of physical activity but free from comorbidities were  
257 recruited allowing us to generalize the results to the healthy older population. In addition,  
258 insights into the muscle-tendon properties were provided by the measurements of muscle  
259 architecture and tendon stiffness. The limitation of this study is its inability to reveal cause-  
260 effect relationships due to the cross-sectional study design and by not measuring muscle-  
261 tendon interaction during locomotion.

262 In conclusion, this study increases our understanding of the age-related loss of mobility.  
263 Plantarflexion strength was shown to be an important factor determining mobility in the elderly

264 population. In addition, muscle architectural features and tendon mechanical properties were  
265 found to explain inter-individual differences in mobility to a high degree. More research is  
266 needed to examine the role of age-related changes in muscle architecture and tendon  
267 properties regarding the etiology of age-related loss of muscle function and physical  
268 functioning. The important role of plantarflexors warrants attention when planning  
269 interventions for improving or maintaining mobility in the elderly.

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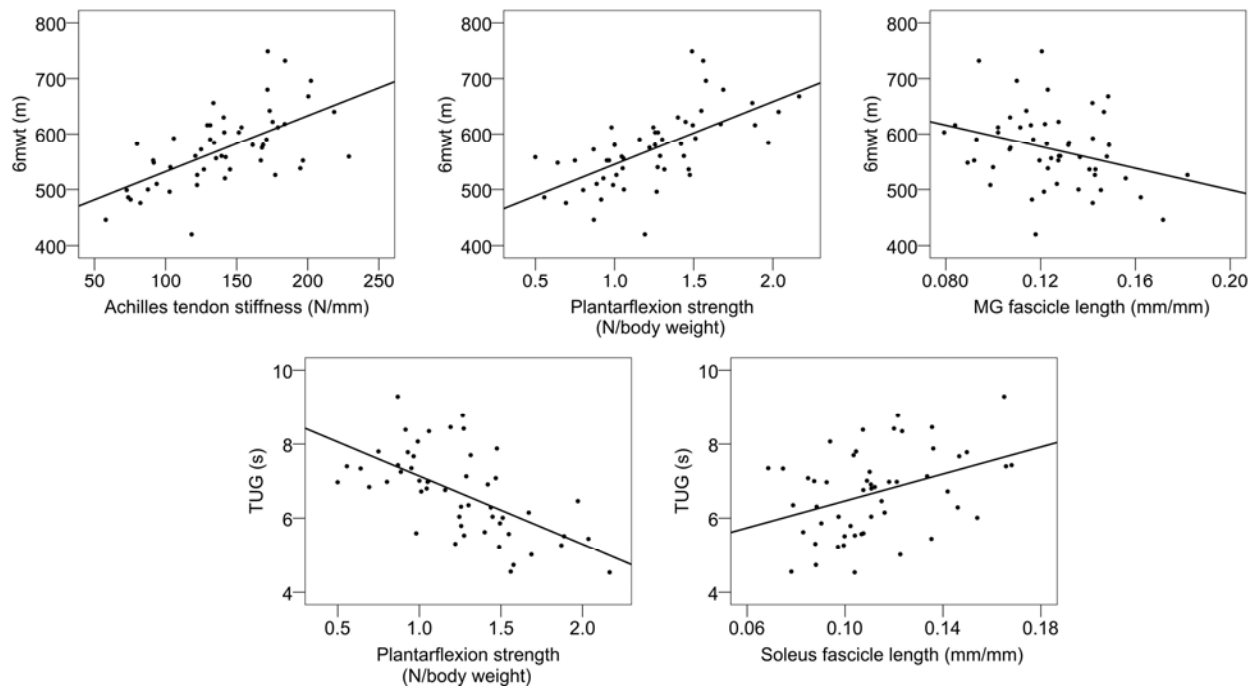
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349 **Figure caption**

350 Figure 1. Scatter plots showing the relationship between mobility and the independent  
351 predictors from the adjusted multivariate regression models. For illustrative purposes  
352 plantarflexion strength was normalized to body mass. Body mass was treated as covariate in  
353 the regression models. Fascicle length values were normalized to tibia length.



354

355 Table 1. Subject characteristics (mean  $\pm$  standard deviation).

	Women (n=26)	Men (n=26)	Total (n=52)
Age (years)	74.5 $\pm$ 3.1	75.2 $\pm$ 3.6	74.8 $\pm$ 3.3
Height (cm)	158 $\pm$ 5	174 $\pm$ 5*	166 $\pm$ 9
Body mass (kg)	61.8 $\pm$ 8.5	76.3 $\pm$ 7.3*	69.0 $\pm$ 10.7
BMI (kg/m <sup>2</sup> )	24.6 $\pm$ 3.0	25.3 $\pm$ 2.3	24.9 $\pm$ 2.7
Physical activity score (points)	9.8 $\pm$ 6.4	11.6 $\pm$ 5.9	10.7 $\pm$ 6.2
<b>Mobility</b>			
6MWT (m)	547 $\pm$ 50	599 $\pm$ 73*	573 $\pm$ 67
TUG (s)	7.19 $\pm$ 0.98	6.18 $\pm$ 1.10*	6.69 $\pm$ 1.15
<b>Plantarflexor muscle-tendon properties</b>			
Plantarflexion strength (N)	669 $\pm$ 226	1021 $\pm$ 237*	845 $\pm$ 290
Achilles tendon stiffness (N/mm)	120 $\pm$ 38	160 $\pm$ 33*	140 $\pm$ 41
MG fascicle length (mm/mm)	0.130 $\pm$ 0.022	0.118 $\pm$ 0.021	0.124 $\pm$ 0.022
MG pennation angle (°)	23.4 $\pm$ 3.4	23.8 $\pm$ 4.1	23.6 $\pm$ 3.7
MG thickness (mm)	16.8 $\pm$ 2.0	17.7 $\pm$ 3.5	17.3 $\pm$ 2.8
Soleus fascicle length (mm/mm)	0.122 $\pm$ 0.025	0.103 $\pm$ 0.020*	0.112 $\pm$ 0.024
Soleus pennation angle (°)	16.8 $\pm$ 3.3	21.1 $\pm$ 4.0*	18.9 $\pm$ 4.3
Soleus thickness (mm)	11.7 $\pm$ 2.9	13.3 $\pm$ 2.7	12.5 $\pm$ 2.9
<b>Lower limb muscle properties</b>			
Lower extremity lean mass (kg)	11.8 $\pm$ 1.3	16.7 $\pm$ 1.4*	14.2 $\pm$ 2.8
Leg extension strength (Nm)	85 $\pm$ 19	140 $\pm$ 26*	112 $\pm$ 36
Leg extension power (W)	1206 $\pm$ 209	1960 $\pm$ 385*	1583 $\pm$ 489

356 BMI: body mass index, 6MWT: 6-minute walk test, TUG: timed “up and go” –test, MG: medial  
357 gastrocnemius. \*Significantly different from women.

Table 2. Partial correlations between mobility and lower limb muscle-tendon properties.

	6MWT (m)			TUG (s)		
	Partial r	Partial r <sup>2</sup> (%)	P-value	Partial r	Partial r <sup>2</sup> (%)	P-value
Plantarflexion strength (N)	<b>0.482</b>	<b>23.2</b>	<b>0.001</b>	<b>-0.434</b>	<b>18.8</b>	<b>0.002</b>
Achilles tendon stiffness (N/mm)	<b>0.519</b>	<b>26.9</b>	<b>&lt;0.001</b>	<b>-0.381</b>	<b>14.5</b>	<b>0.007</b>
MG fascicle length (mm/mm)	<b>-0.287</b>	<b>8.2</b>	<b>0.048</b>	0.093	0.9	0.528
MG pennation angle (°)	0.188	3.5	0.603	0.049	0.2	0.742
MG thickness (mm)	-0.077	0.6	0.603	0.013	0.0	0.931
Soleus fascicle length (mm/mm)	<b>-0.302</b>	<b>9.1</b>	<b>0.037</b>	<b>0.291</b>	<b>8.5</b>	<b>0.045</b>
Soleus pennation angle (°)	<b>0.422</b>	<b>17.8</b>	<b>0.003</b>	<b>-0.298</b>	<b>8.9</b>	<b>0.040</b>
Soleus thickness (mm)	0.073	0.5	0.622	-0.053	0.3	0.719
Lower extremity lean mass (kg)	0.155	2.4	0.292	-0.125	1.6	0.396
Leg extension strength (Nm)	<b>0.360</b>	<b>13.0</b>	<b>0.012</b>	-0.282	8.0	0.053
Leg extension power (W)	<b>0.443</b>	<b>19.6</b>	<b>0.002</b>	<b>-0.419</b>	<b>17.6</b>	<b>0.003</b>

Adjusted for age, sex, body mass and height. 6MWT: 6-minute walk test, TUG: timed “up and go” –test, MG: medial gastrocnemius.

Table 3. Adjusted multivariate regression model with 6-minute walk test as dependent variable and lower limb muscle-tendon properties as independent variables.

	R <sup>2</sup>	Adjusted R <sup>2</sup>	Standardized coefficient	β- Semipartial r <sup>2</sup> (%)	P-value
<b>6MWT</b>	0.727	0.651			
Plantarflexion strength (N)			0.340	3.9	0.022
Achilles tendon stiffness (N/mm)			0.272	4.0	0.020
MG fascicle length (mm/mm)			-0.208	2.9	0.046
Soleus fascicle length (mm/mm)			-0.121	0.9	0.269
Soleus pennation angle (°)			0.110	0.6	0.358
Leg extension strength (Nm)			0.038	0.0	0.831
Leg extension power (W)			0.321	2.0	0.098

Adjusted for age, sex, body mass and height. P-value for the model <0.001. 6MWT: 6-minute walk test, MG: medial gastrocnemius.

Table 4. Adjusted multivariate regression model with timed “up and go” -test as dependent variable and lower limb muscle-tendon properties as independent variables.

	R <sup>2</sup>	Adjusted R <sup>2</sup>	Standardized coefficient	β- Semipartial r <sup>2</sup> (%)	P-value
<b>TUG</b>	0.613	0.530			
Plantarflexion strength (N)			-0.335	4.3	0.037
Achilles tendon stiffness (N/mm)			-0.169	1.6	0.193
Soleus fascicle length (mm/mm)			0.245	4.6	0.031
Soleus pennation angle (°)			-0.027	0.0	0.841
Leg extension power (W)			-0.363	2.7	0.096

Adjusted for age, sex, body mass and height. P-value for the model <0.001. TUG: timed “up and go”-test, MG: medial gastrocnemius.