

LOWER EXTREMITY STRENGTH REQUIREMENTS IN YOUNG AND OLDER FEMALE ADULTS DURING LOCOMOTOR ACTIVITIES OF DAILY LIVING

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INTRODUCTION

A comparison of joint moments with measured strength has demonstrated the relative difficulty of sit-to-stand (STS) tasks for older adults (Alexander et al., 1997). Such an analysis remains to be performed for various other locomotor activities of daily living (LADLs). Thus, the purpose of the present study was to compare maximum measured dynamometric strength with the calculated 3D lower extremity joint moments required to perform overground walking (OGW), sit-to-stand (STS), stair ascent (SA), and stair descent (SD) in healthy young and older adults.

METHODS

Eleven young [age: 24.2 (2.6) yrs, body mass (BM): 63.4 (7.2) kg, height: 165.0 (2.9) cm: mean (st. dev.)] and 10 active healthy older females [age: 73.5 (2.6) yrs, BM: 65.6 (10.8) kg, height: 158.3 (4.6) cm] were studied. VICON 370 (Oxford Metrics, U.K.) was used to collect 3D kinematics of the left lower extremity. Five trials of SA and SD were collected at 0.65 m/s on a 7-step staircase instrumented with a portable force platform (type 9286, Kistler Instrument Corp, NY). Five trials of OGW (1.35 m/s) and STS (rise time: 1.8s, chair height: 43 cm) were collected on a 10m runway equipped with a Kistler force platform (type 9287A). Net joint moments were calculated using the MARey package (Cavanagh et al., 2001). Maximum voluntary contractions (MVC) in the sagittal plane were assessed for the hip, knee, and

ankle and for hip ab/adduction with a Biodex dynamometer (System 2, Biodex Med Sys, NY). The muscle contraction modes tested were isometric, 30°/s and 90°/s concentric, and 60°/s eccentric. All strength tests demonstrated good repeatability. For each subject in each activity, the strength requirement (%MVC) was expressed as the ratio of peak calculated joint moments to peak measured dynamometric torques (at the most appropriate contraction mode and joint angular velocity). Analysis of variance with Bonferroni corrections compared the differences in strength requirements between activities, and t-tests compared differences between age groups for each activity (Minitab 12, Minitab Inc, PA).

RESULTS

Older adults required a significantly higher fraction of measured MVC in the lower extremity musculature than young subjects to perform the majority of the LADLs studied (Table 1, Figure 1). The most significant age differences were found in the hip abductors (ABD) during all LADLs. The most demanding LADL was not the same for each muscle group. SA was most demanding for knee EXT and ankle PF whereas the hip EXT group was challenged the most during OGW. There were no significant differences in the demands placed upon the hip ABD during these LADLs, with the exception that SD was more demanding than OGW for the young.

DISCUSSION

Although STS is commonly used to assess the functional level in older adults, at the chair height used here it was one of the least challenging of the LADLs studied for the lower extremity musculature. Stair ascent required a substantial portion of the maximum available strength for both young and older adults, and should be considered in future analyses of strength and functional ability in older individuals. Similarly, the striking age differences in hip abductor requirements for all LADLs suggest that this muscle group should be considered in a functional assessment of older adults. The difficulties in comparing maximum measured strength and calculated joint moments are demonstrated by the finding that several LADLs were predicted to require more than 100% of the MVC at the ankle joint. Some requirements also seem unreasonably large at other joints. This is clearly an artifact of the different approaches to estimation of the two quantities and deserves further study.

Table 1. Required strength [mean (st. dev) in %MVC] for young and older adults

LADL	Ankle		Hip	
	PF	EXT	EXT	ABD
Young				
SD	78.3 ^{b†} (26.7)	55.0 [†] (26.5)	22.6 ^{†‡} (12.0)	74.7 ^{a†} (15.8)
SA	179.1 ^{†‡} (56.0)	78.5 ^{b†‡} (16.1)	59.0 [†] (22.1)	65.8 ^a (17.8)
STS	29.2 ^{b†} (10.0)	38.8 ^{a‡} (6.9)	45.6 ^{b‡} (10.1)	-
OGW	114.2 ^{b‡} (29.4)	18.0 ^{b†‡} (8.6)	83.5 ^{†‡} (16.9)	57.1 ^{a†} (18.1)
Older				
SD	132.8 ^{b†} (53.9)	68.8 [†] (21.8)	32.5 [†] (16.7)	100.3 ^a (17.3)
SA	232.4 [†] (79.0)	88.1 ^{b†‡} (16.7)	87.5 ^{†‡} (27.5)	86.1 ^a (13.9)
STS	43.8 ^{b†‡} (17.7)	52.1 ^{a‡} (8.5)	57.9 ^{b‡} (14.0)	-
OGW	176.4 ^{b‡} (71.8)	29.6 ^{b†‡} (10.6)	105.1 ^{†‡} (31.3)	92.5 ^a (23.0)

Age difference within an activity ^a p<0.01, ^b p<0.05;
Activity difference within an age group ^{†‡‡} p<0.01

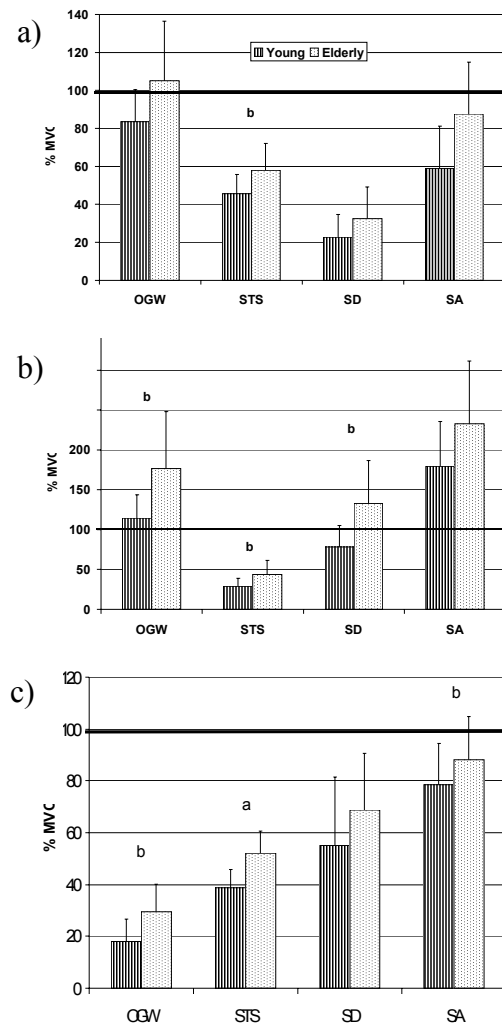


Figure 1. Required strength (%MVC) during LADLs in young and older adults for a) Hip EXT, (b) Ankle PF, and (c) Knee EXT. Solid line is 100% MVC.

REFERENCES

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