

ASSOCIATIONS BETWEEN FORCE STEADINESS AND TESTS OF HAND FUNCTION ACROSS THE ADULT LIFE SPAN

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INTRODUCTION

As older adults are usually weaker [1, 3, 4] and less steady than young adults [1, 2, 5], measures of strength and steadiness are frequently used as indices of motor function. However, there are relatively few studies about the associations between these indices and performance on functional hand tests. The aim of the study was to evaluate the relations among measures of isometric hand strength, force steadiness, and hand function.

METHODS

Seventy-five healthy men and women (30 men; 19 - 89 yrs) were assigned to one of three groups; young (19-36 yrs), middle-aged (41- 59 yrs), and old (66-89 yrs). Each subject performed 3 strength measures, 2 force steadiness tasks, and 4 functional hand tests with the dominant and non-dominant hands. The strength measures comprised maximal voluntary contractions during index finger abduction, precision pinch, and handgrip. The steadiness measures involved isometric contractions during which hand muscles exerted an abduction force with the index finger and a precision pinch with the index finger and thumb (Figures 1A and B). The target force for the steadiness tasks was 5% of maximum and the contraction was held for 60 s. Subjects received intermittent visual feedback during each 60-s trial (5 s with, 5 s without). The functional tests included manipulating small metal pegs into a board with holes cut out (Grooved Pegboard Test), removing small plastic pieces from a game board using tweezers (OperationTM), a scissor task (Star Cutout), and tracing a 4-revolution spiral with a pen (Archimedes Spirals) (Figures 1C- F).

RESULTS AND DISCUSSION

Significant differences were observed between young and old adults for all strength, steadiness and functional tests (Table 1). Middle-aged and old

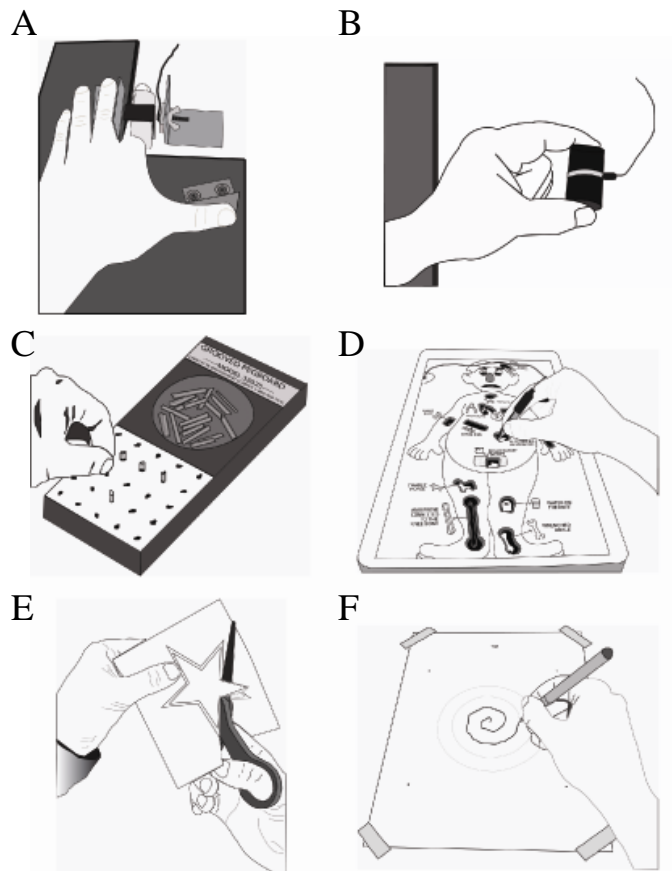


Figure 1. Experimental set-ups for hand steadiness and function. Steadiness; index finger abduction (A) and precision pinch (B). Function; Grooved Pegboard (C), OperationTM (D), Star cutout (E), and Archimedes Spirals (F).

adults differed for grip strength, both steadiness measures with feedback provided, and all functional tests except the errors in matching the Archimedes Spirals. Middle-aged and young adults only differed significantly for grip strength, pinch steadiness, and Grooved Pegboard ($p < 0.05$).

Multiple regression models and partial correlations were calculated using strength and steadiness measures to predict functional performance (Table 2). The strongest associations were found between steadiness and performance on both the Grooved Pegboard test and the game OperationTM. Signifi-

cant regression models for the Grooved Pegboard showed performance time could be predicted by index finger steadiness and grip strength ($R^2= 0.36$; $p < 0.001$). Performance on the game Operation™ was significantly predicted by pinch steadiness, grip strength, and index finger steadiness ($R^2= 0.40$; $p < 0.001$).

CONCLUSIONS

These findings indicate that the physiological mechanisms responsible for differences in performance on some tests of hand function are related to the steadiness of submaximal isometric contractions. However, only about 36% of the variability in performance on the Grooved Pegboard and 40% of the variability in performance in the game of Operation™ were related to measures of hand strength and steadiness.

REFERENCES

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Table 1. Descriptive statistics for the measures of strength, steadiness, and function for the three groups of subjects.

	<u>Young</u>	<u>Middle-aged</u>	<u>Old</u>
Age (yrs)	25.8 ± 4.3	50.6 ± 5.5	74.5 ± 6.2
Grip strength (N)	350 ± 90	297 ± 98	*244 ± 73
Pinch strength (N)	49.5 ± 12.3	43.5 ± 16.3	*40.6 ± 11.4
FDI strength (N)	32.4 ± 9.6	30.1 ± 10.5	*26.0 ± 7.9
Pinch steadiness (%)	1.4 ± 0.4	1.8 ± 0.7	†*2.2 ± 0.8
FDI steadiness (%)	2.2 ± 0.9	2.7 ± 1.1	†*4.7 ± 2.9
Archimedes spiral (mm)	0.40 ± 0.09	0.49 ± 0.21	*0.71 ± .84
Operation™ (score)	9.24 ± 1.8	8.52 ± 2.0	†*6.08 ± 2.1
Pegboard (s)	59.3 ± 6.0	*65.7 ± 8.6	†*88.9 ± 15.7
Star cutout (errors)	1.72 ± 2.3	1.84 ± 2.0	†*3.0 ± 2.6

Data are mean ± SD. The two steadiness measurements correspond to coefficients of variation for force (%). * $p < 0.05$ compared with young adults. † $p < 0.05$ compared with middle-aged adults.

Table 2. Multiple regression predictions of two measures of hand function (Pegboard and Operation™).

	Overall Prediction	<u>Strength</u>			<u>Steadiness</u>	
		<u>Grip</u>	<u>Pinch</u>	<u>FDI</u>	<u>Pinch</u>	<u>FDI</u>
Pegboard	0.36	-0.34	-0.20	-0.25	0.46	0.57
Operation™	0.40	0.45	0.36	0.39	-0.57	-0.47

The data indicate the overall prediction (R^2) of each equation (row) and the relative associations (r; part correlations) of the significant predictors for the performance on the Grooved Pegboard and Operation™ tests ($p < 0.001$). The variables used in the multiple regression models to predict functional performance are bolded.