Determinants of Four Functional Tasks Among Older Adults: An Exploratory Regression Analysis

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Functional ability declines in later life. The purpose of this project was to determine if strength, postural control, and joint pain predict performance of four functional tasks among older adults. A sample of 28 older adults completed assessments of strength, postural control, joint pain, and four functional tasks. The duration to complete the functional tasks of: 1) getting out of bed, going to a chair, and then returning to bed; 2) crossing a street and getting onto a bus; 3) exiting the passenger side of a car; and 4) climbing a flight of 27 stairs was recorded. Step-wise regression equations indicated that seated row strength and dynamic postural control were significant predictors of all of the tasks and accounted for the largest proportion of the variance in each equation. These results indicate that measures of physical fitness may be more important predictors of functional tasks among older adults than chronological age.

Key Words: physical function, strength, balance

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ous investigators have reported that declines in postural control, balance, and/or leg strength are associated with an increased risk of falling among older adults (31,32,36).

Other investigators have reported that exercise programs employing strength or postural control training cannot only improve strength (9,10,34) and postural control (15,27) but can also improve the ability to perform select functional tasks, such as rising from a chair (17,24) and walking (9). Exercise programs have also shown to improve self-reported ADLs (2,14). Thus, it appears that physical fitness can be enhanced through various types of regular exercise and that these improvements can, in turn, enhance the ability to perform specific functional tasks among older adults.

The strength of various muscle groups (27,39) along with joint pain (11) appear to be correlated with actual and self-reported performance of functional tasks. Previous authors also have indicated that postural control is inversely correlated with falling among older adults (31,32). No study has examined if postural control and joint pain, in addition to muscle strength, can predict actual functional abilities among older adults. A better understanding of the important predictors of specific functional tasks will assist practitioners in designing exercise programs that will enhance functioning, reduce the need for assisted living, and possibly delay certain health problems. Thus, the purpose of this project was to determine the extent to which strength, postural control, and joint pain predict performance of four functional tasks among older adults.

**METHODS**

This descriptive study examined the relationships between age, joint pain, postural control, and strength, respectively, and performance of four functional tasks among a sample of older volunteers. One week following a familiarization trial with all of the data collection methods, 28 subjects were again tested. Based upon initial correlations demonstrating significant colinearity, test variables were combined into composite scores. Individual and composite score variables demonstrating significant correlations with performance of the four functional tasks were entered into regression equations to identify significant predictors.

**Subjects**

A sample of 28 community dwelling adults age 65 years or older was recruited from a pool of older adults who had previously participated in research projects with the investigators. Potential subjects were solicited by mail and instructed to telephone the research team if they were interested in participating in the 1-week study. Subjects were included in the study if they were age 65 years or older, able to stand for 15 minutes, and able to walk up two flights of stairs. Subjects were also excluded from the study if they reported a history of uncontrolled angina, cardiac myopathies that compromised cardiac functioning, or if they currently took nitrates, digitalis, or phenothiazides (1). This sample represents high functioning older adults who reported exercising an average of 2.7 hours per week. Subjects who were eligible for the project were scheduled for two testing sessions. At the beginning of the first testing session, all subjects signed an informed consent to participate in the study. Following this, subjects completed a short demographic information questionnaire and a joint pain assessment scale. During the first session, subjects completed a familiarization trial with each of the data collection protocols. Seven days later, subjects were retested and the results of these tests were used in the analysis. Subjects completed the assessments in the following order in order to minimize the effect of muscle fatigue as a result of the strength assessments on postural control and the functional tasks: postural control, functional tasks, leg strength, and arm strength.

**Joint Pain**

Joint pain was measured using the Joint Pain Subscale of the Arthritis Impact Measurement Scale. This subscale consists of four questions that assess arthritis-related joint pain or stiffness experienced during the past month. Subjects indicate on six-point Likert scales their degree of pain or stiffness. The scores on these items were then summed to arrive at a measure of joint pain (possible range = 6–24). Higher scores on the Arthritis Impact Measurement Scale indicated greater joint pain. This subscale has demonstrated good test-retest reliability among 625 adults with diagnosed joint disease or pain (alpha = .86, guttmann = .89). Single factor analysis indicated that the four items comprising the joint pain subscale were valid (.66–90) (18).

**Postural Control**

Postural control was measured using a Smart Balance Master. The Smart Balance Master (Neurocom International, Portland, OR) is an instrument that measures sensory organization of balance, center of gravity characteristics under varied environmental conditions, and voluntary control of movement. The Smart Balance Master assesses a person’s balance capabilities under challenging visual and support surface conditions similar to those encountered in daily life. The Smart Balance Master is a software-driven computerized instrument consisting of dual force plates that rest on pressure transducers. Similar forceplates have demonstrated reproducible measures within 0.5°, with 24-hour test-retest reliability deemed acceptable (r = .52–.96) (13).

Four protocols were used to measure four components of postural stability in the anterior-posterior di-
mension. Subjects were measured in their stocking feet and given instructions to keep their arms by their sides, look straight ahead at the monitor directly in front of them, and maintain their position on the platform without moving their feet throughout the testing (37). If their feet did move during testing, they were realigned before proceeding. The first three protocols measured percent of postural sway while the individual stood still on a stable support surface. These measures were collected with eyes open, eyes closed, and eyes open with visual feedback of their center of gravity respectively displayed on the video monitor. A value of 100 would indicate that the subject did not move their center of gravity during the assessment. Thus, higher numbers on these measures indicated less postural sway and greater postural control.

The fourth postural control protocol assessed the individual's postural stability while they shifted their center of gravity to attain eight targets set at 75% of their limits of stability. Limits of stability is conceptualized as the angular distance from the center of gravity when positioned directly over the base of support to the position at which point balance can no longer be maintained (22). Limits of stability is conceptualized as an elliptical cone around the person's center of gravity, with the theoretical limits set at 8° anterior, 4.5° posterior, and 8° laterally (23). Based upon the individual's height and weight, eight targets were established at 75% of the individual's theoretical limits of stability. These targets were set directly anterior at 0° and at 45°, 90°, 135°, 180°, 225°, 270°, and 315°. The individual's center of gravity, center of base of support, and the eight targets set at 75% of limits of stability were displayed on a video screen in front of the individual while standing on the Balance Master. Individuals were instructed to move their center-of-gravity icon on the video screen by leaning at the ankles without moving their feet. They were instructed to practice moving the icon to each of the eight different targets prior to testing. Once individuals had learned how to control and shift their center of gravity, they were instructed to position their center-of-gravity icon over their base of support. Subjects were then instructed to move their center-of-gravity icon as quickly as possible in a straight line to the 0° target. Subjects were instructed to repeat this protocol with each of the remaining seven targets. If the subject was unable to attain the proper shift in their center of gravity to a target within 5 seconds, the trial was terminated, they were assigned 5 seconds for their movement time to the specific target, and the next target was attempted. Subjects' average time to targets was calculated as the mean time required by each subject to attain the eight targets set at 75% of their limits of stability. Greater average time to targets indicated reduced postural control.

Dynamic postural control was a significant predictor of all functional tasks.

Functional Tasks

Measurement of the four functional tasks involved standardized protocols developed for older adults (33). Two of these protocols, the stair test and the car exit test, have been used by previous investigators who were examining the functional performance of older adults with arthritis (8). Each of the four tasks selected were chosen because they represented tasks which are commonly encountered during everyday living. Subjects were instructed to perform each task "as quickly as you can." Multiple consecutive trials of each of these tasks have demonstrated high interclass correlations ($r = .93-.95$) (20). All of these protocols have demonstrated acceptable test-retest reliability over a 7-day period ($r = .75-.88$). The construct validity of these tests was supported by the significant correlations between these tests and objective measures of strength.

Street crossing test To assess the functional task of navigating curbs, intersection crossings, and getting on a bus, the following simulation test was implemented. Each subject was timed as they stepped off a 6" platform, proceeded across the equivalent of a 4-lane intersection, stepped up on a 6" platform, turned 180° and stepped 5" up onto a simulated bus entryway, and then climbed three 10" steps to the level of the seating area. The starting position was standing on the 6" platform with arms relaxed. The test time began on the subject's first movement to step off the curb and ended when the subject placed both feet on the upper level of the simulated bus platform. Each subject performed three trials of this assessment, and the mean of these three trials was considered their street crossing score.

Out of bed test To assess the functional task of rising out of bed and traveling to and from the bathroom, subjects were timed as they arose from a bed, traveled to a chair, sat, and then returned to the bed. Each subject was asked to rise from a supine position in a twin bed, traverse 20 feet to an 18-inch chair (simulated commode), sit in the chair until their back touched the back of the chair, and then return to the bed. The starting position was with the subject lying supine with the palms of their hands on their thighs. The test began with the subject's first movement and ended when the subject returned to a seated position on
the bed with both feet touching the floor. Each subject performed three trials of this assessment, and the mean of these three trials was considered their rising out of bed score.

**Car exit test** To assess the functional task of exiting the passenger side of a car, subjects were timed as they exited the passenger side of a mid-sized Oldsmobile Delta 88. The starting position was with the subject seated, facing forward with hands on thighs, and the car door closed. The test time began on the subject’s first movement and ended when the car door closed. Each subject performed three trials of this assessment, and the mean of these three trials was considered their car exit score.

**Stair test** To assess the functional task of climbing stairs, subjects were timed as they negotiated up two flights of stairs. Each subject was instructed to climb two flights of 13 7” steps. The starting position was with the subject standing facing the stairs, no further than 12” from the first step, with hands at sides. Subjects were told they could use the handrail on their right side to assist them up the stairs. The test began on the subject’s first movement. The end of the test was when both of the subject’s feet reached the top of the 26th stair tread. Each subject performed three trials of this assessment, and the mean of these three trials was considered their stair test score.

### Strength

Strength was assessed while the subject performed three lower and three upper body exercises using Theraband elastic bands (35). The testing sequence was the lower body strength exercises (squats, hip flexion, and ankle dorsiflexion) followed by the upper body strength exercises (biceps curls, triceps extensions, and two-handed seated rows). The elastic bands (Therabands, Hygenics Corporation, Akron, OH) were color-coded as to their resistance. Resistance offered by the bands was influenced by band thickness, initial length of the unstretched band, stretch distance, and temperature. Eight 5-foot pieces of band of various thickness were used for testing purposes. The color, initial length of the unstretched band, and the stretch distance of the bands for each subject were documented in order to calculate individual strength index for each of the six strength exercises. This score was calculated by measuring the resistance the band provided under the stretch distance recorded for each individual’s strength assessment via a force transducer. The procedure for calculating resistance from the Theraband color, length, and stretch distance has been described previously (20, 21). This level of resistance, measured in kilograms, was multiplied by the number of repetitions of the exercise the subject was able to perform to arrive at a strength index for each exercise for each subject. If a subject was unable to perform any exercise with the lowest resistance band, they were assigned a strength index score for the exercise of zero. An example of calculating a strength index score for squats is provided in Table 1.

Test-retest reliability of these methods to assess strength was significant and ranged from .48 for ankle dorsiflexion to .93 for the squat exercise (20).

All strength testing was performed in a laboratory with a constant temperature of 23°C. The subjects were first familiarized with the movements and techniques involved for properly performing each of the strength testing exercises. Each subject was allowed to warm up by performing the specific exercise movements prior to the actual test. The warm-up was followed by 2 minutes of rest. The investigator then chose the band or bands that he estimated would be the subject’s 1 to 20 repetition maximum (RM). For example, a 4 RM would be a resistance with which four repetitions but not five can be performed by the subject. A maximum of 20 repetitions was chosen because pilot testing indicated 1-6 repetitions was too small of a range to yield variability between subjects using the limited array of resistance provided by the Therabands. The subject was instructed to perform as many repetitions as possibly while maintaining proper form during the repetitions. All subjects were able to perform all of the strength assessment protocols through their respective range of motion without resistance. The criteria for a completion of a repetition (the beginning and ending joint angles) varied with the exercise being performed and was preestablished by the investigators and communicated to the subjects.

The assessment of the squat exercise was completed while each subject stood from a seated position with their back against a vertical surface. The subject was positioned with the backs of their shoes 18 inches away from the vertical surface. A belt was placed around the subject’s waist with the Theraband(s) attached to the floor and to the belt. The initial position of the squat exercise was with a subject’s knees at 90° of flexion (in a seated position) measured with a goniometer and marked on the wall next to the subject’s waist belt. The

### Table 1. Example of calculating squat index score.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Number of Repetitions</th>
<th>Resistance (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 kg (single band)</td>
<td>7</td>
<td>455 kg</td>
</tr>
<tr>
<td>910 kg (two bands)</td>
<td>2</td>
<td>1820 kg</td>
</tr>
</tbody>
</table>

Total stretch distance = 40 - 22 = 18 inches

Initial length of green Theraband with subject in starting position (knees at 90° of flexion) = 40 inches

Length of Theraband with subject in ending position (knees at 0° of flexion, fully extended) = 22 inches

Resistance via force transducer of stretching 22-inch green Theraband 18 inches = 65 kg

Squat strength index score: 65 kg (resistance of a single band) x 7 (repetitions) x 2 (green bands) = 910 kg
ending position was when the subject’s knees were fully extended in the standing position. During the hip flexion and dorsiflexion assessments, each subject was placed in the supine position with a waist restraint while only the dominant leg was assessed. The distance from unrestricted maximum plantar flexion to unrestricted maximum dorsiflexion was then measured and set as the criteria for a successful repetition of ankle dorsiflexion strength. The criteria for a successful repetition of hip flexion was defined as movement of the hip from 0 to 90° of hip flexion (established with a goniometer) while the band was secured around the ankle. For all of the upper body exercises, the subjects were seated in an upright position, restrained at the waist, and the exercise was performed with both arms with the same degree of resistance applied to each arm. A successful biceps curl repetition was defined as movement of the elbows from maximum extension to maximum flexion while holding a handle attached to the Theraband(s), which was attached 36 inches below the seat of the chair. Conversely, a successful triceps extension was defined as movement of the elbows from maximum flexion to maximum extension while holding a handle which was attached to Theraband(s), which was attached approximately 18 inches above the subject’s shoulders. Finally, a successful seated row exercise repetition was defined as the subject starting with their arms outstretched from the shoulder, parallel to the floor with the elbows at full extension. Each hand was positioned with the palm toward the floor while holding a handle attached to Theraband(s), which was attached approximately 18 inches in front of their outstretched hand. The ending position of a successful seated row exercise was when both of the subject’s elbows achieved a position 4 inches posterior to the anterior portion of the back support of the apparatus on which they were seated.

Analysis

Analysis of the data was carried out in two phases, a descriptive and a predictive phase. The descriptive phase involved summarizing the data through various statistics, examining correlations between the variables, and narrowing the number of predictor variables, which were included in the second phase of the analysis. The purpose of the study was addressed in the second phase of data analysis. This involved constructing regression equations that would include the significant predictors of performance on the functional tasks. Since this study was exploratory in nature, variables that accounted for a significant amount of the dependent variables’ variance at the .15 level were included in the regression equations.

RESULTS

Descriptive statistics of the sample are presented in Table 2. These data indicate that the average age of the sample was over 75 years, and they reported some degree of arthritic joint pain. The sample also exhibited postural control measures similar to those reported by previous authors examining postural control among older adults using the Smart Balance Master (7). Table 2 also indicates that biceps curls and squats were beyond the ability of the one subject each, even with the minimal resistance provided by the Therabands. These subjects who were unable to perform these exercises even with the minimal resistance were given a value of zero for the specific strength measure.

Table 3 presents Pearson r correlations between all of the measures. The purpose of calculating all of these correlations was to examine which variables would be included in the regression equations to predict the functional tasks. High colinearity between variables suggested variables that might be combined to increase the predictive power of the individual regression equations. Predictor variables that correlated at the .40 level or greater were considered to exhibit a significant degree of colinearity and were combined when included in the regression equations. Age was significantly positively correlated with only one of the functional tasks: car exit-
ing \((r = .43)\). The age of the sample was not correlated with joint pain, postural control, or strength indices. Conversely, joint pain was positively correlated with the time required to perform all of the functional tasks.

The only other variables associated with joint pain were hip flexion strength index \((r = -.37)\) and seated row strength index \((r = -.59)\).

The measures of postural sway with eyes open, postural sway with eyes closed, and postural sway with video feedback were not significantly correlated with any of the functional tasks. These three measures demonstrated significant collinearity but were not included in the regression equations because of their low correlations with performance on the functional tasks. The other measure of postural control, average time to targets set at 75% of limits of stability was not correlated to postural control with eyes open \((r = -.09)\), with eyes closed \((r = .12)\), or with video feedback \((r = .08)\).

The data indicated that one subject could not perform the biceps curl and another subject could not perform the squat exercise using the lowest resistance band. These subjects were afflicted with joint disorders in the involved joints and thus were unable to perform the exercise with resistance. The strength data demonstrated a pattern of relationships with performance on the functional tasks. The only upper body strength index significantly correlated with all of the functional tasks was the seated rows.

None of the other measures of upper body strength yielded significant correlations with the functional tasks. The hip flexion strength index was significantly correlated with all four of the functional tasks. The squat strength index demonstrated a significant correlation with all of the functional tasks, except the street crossing test. Finally, the ankle dorsiflexion strength index was not correlated with any of the functional tasks. Even more interesting was that the ankle dorsiflexion strength index was not significantly related to the squat \((r = .22)\) or hip strength \((r = .25)\) indices. The squat and hip flexion strength indices were strongly positively correlated with each other \((r = .77)\). Based upon these findings, a squat/hip strength index score was calculated by converting the individual’s squat and hip indices into T-scores and then summing these values. No attempt was made to incorporate the ankle dorsiflexion index into the squat/hip index score because of the low correlation between these indices. The seated row strength index was included independently in all of the regression equations to predict the functional tasks.

The second phase of the analysis involved constructing step-wise regression equations in an attempt to predict the variability of each of the functional tasks. The number of predictor vari-

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### TABLE 3. Correlations between functional abilities, joint pain, age, strength, and postural control \((N = 28)\).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age</th>
<th>Joint Pain</th>
<th>Functional Tests</th>
<th>Postural Control</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Street Crossing</td>
<td>Eyes Open/With Video Feedback</td>
<td>Biceps Curls/Triceps Extension/Seated Rows/Squats/Ankle Dorsiflexion</td>
</tr>
<tr>
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<td>.28</td>
<td>.26</td>
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<td>.09</td>
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<td>.39*</td>
<td>.36*</td>
<td>.06</td>
<td>.17</td>
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<tr>
<td>Functional tests</td>
<td></td>
<td></td>
<td>Street Crossing</td>
<td>Eyes Open</td>
<td>EYES Closed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.93*</td>
<td>.87</td>
<td>.86*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Out of Bed</td>
<td>.90*</td>
<td>.80*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Car exit</td>
<td>.80*</td>
<td>.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stair test</td>
<td>-10</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Postural control</td>
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<td>.49*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eyes closed</td>
<td>.68*</td>
<td>.12</td>
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<td></td>
<td></td>
<td></td>
<td>With video</td>
<td>feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average time to</td>
<td>targets</td>
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</tr>
<tr>
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<td></td>
<td>Biceps curls</td>
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<td>Triceps extension</td>
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<td></td>
<td></td>
<td></td>
<td>Seated rows</td>
<td>.31</td>
<td>.21</td>
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</table>

* \(p < .05\).

\(\dagger\) \(p < .01\).
The final model to predict street cross-
dex score was included, at which time
was initially included in the model to
equation, the seated row strength in-
only significant predictor variables of
strength score and the average move-
ment time to targets, accounting for a
total of 36% of the variance. In the
third step in the construction of this
equation, the seated row strength in-
dex score was included, at which time
the contribution of joint pain to the
model was greater than .15 and thus
was dropped from the final model.

The final model to predict street cross-
ing included average time to targets
and seated row strength index, ac-
counting for a total of 45% of the vari-
ance. The regression equation to pre-
dict the car exit test included average
time to targets, seated row strength
index, age, and the squat/hip strength
index score as significant predictor
variables, which combined accounted
for 55% of the total variance. Finally,
TABLE 4 indicates that the average time
to targets, the seated row strength
index score, and the squat/hip strength
index score were significant predictors
of the stair test, accounting for 66% of
the variance in this functional task.

**DISCUSSION**

The primary hypothesis of this
study, that strength and postural con-
trol are important predictors of func-
tional ability among healthy older
adults, was supported. The findings
partially supported this hypotheses by
demonstrating that a significant
amount of the variance of each of the
functional activities studied could
be accounted for by measures of
muscle strength and dynamic pos-
tural control. These findings are simi-
lar to those of previous investigators
who reported that various measures
of postural control and muscle
strength are important predictors of
functional tasks among healthy com-
unity-dwelling older adults. In con-
trast to the literature, the findings do
not support the proposed relation-
ships between performance of the
functional tasks selected and age or
joint pain. In addition, the findings
indicate a number of interesting rela-
tionships between measures of
strength, postural control, and joint
pain.

The correlations in Table 3 re-
veal a lack of association between
strength and postural control, also
reported by previous investigators
(15,26). This lack of association be-
tween muscle strength and postural
control may be due to the fact that
the two functions, mediated through
muscle contraction, are the result of
physiological mechanisms. This sup-

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable Entered</th>
<th>PE</th>
<th>F</th>
<th>p&lt;</th>
<th>Partial R²</th>
<th>Total R²</th>
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</thead>
<tbody>
<tr>
<td>Out of bed test*</td>
<td>Seated row strength</td>
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<td>9.20</td>
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<td>.20</td>
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<td>Average movement time to targets</td>
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<td>6.24</td>
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<td>Street crossing test*</td>
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<td>7.35</td>
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<td>Joint pain (removed)</td>
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<td>11.99</td>
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<td>Car exit test*</td>
<td>Average movement time to targets</td>
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<td>6.67</td>
<td>.01</td>
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<td>2.37</td>
<td>.10</td>
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<td>.50</td>
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<td>Squat/hip strength</td>
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<td>2.32</td>
<td>.14</td>
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<td>-4.03</td>
<td>1.38</td>
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<tr>
<td>Stair test</td>
<td>Average movement time to targets</td>
<td>3.40</td>
<td>17.41</td>
<td>.00</td>
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<td></td>
<td>Seated row strength</td>
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<td>.00</td>
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<td>.62</td>
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<tr>
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<td>Squat/hip strength</td>
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<td>2.61</td>
<td>.12</td>
<td>.04</td>
<td>.66</td>
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<tr>
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<td>Intercept</td>
<td>-3.20</td>
<td>.49</td>
<td>.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Effect size = 3.6 (N = 28, u = 5)(6); power of the test = .78(3).
* Effect size = 3.9 (N = 28, u = 5)(6); power of the test = .92(3).
* Effect size = 4.1 (N = 28, u = 5)(6); power of the test = .95(3).
* Effect size = 4.3 (N = 28, u = 5)(6); power of the test = .99(3).
PE = Parameter estimate.
ports the contention that muscle strength makes a minimal contribution to healthy older adults maintaining postural control. Other components of postural control, such as nerve firing patterns, coordination of nervous input at the spinal and upper levels, proprioception, visual acuity, and vestibular intactness, may need to be examined for their relative contribution to the maintenance of postural control among healthy older adults. This lack of association between strength and postural control is supported by the conclusions of Buchner et al (5), who reported that no linear relationship exists between strength and postural control during walking among older adults.

Another interesting finding is the lack of association between measures of postural control while standing still and while moving. This lack of association may be attributed relatively low variability and ceiling effect observed within the measures of postural stability with eyes open, closed, and with video feedback. This ceiling effect was not observed in the measure of postural control that involved movement of the individual’s center of gravity within their limits of stability. This measure of postural control while moving may demand greater coordination of all of the systems contributing to postural control and may more closely approximate the demand on these systems while performing the functional tasks. This contention is supported by the significant and near-significant correlations between average time to the targets and all four of the measures of functional ability. These correlations, along with the lack of association between postural control while attempting to stand still and average time to the targets, indicate that these two groups of measures are assessing different constructs and that the dynamic component may be the important predictor of functional tasks among older adults. These statistics support the hypothesis that the Smart Balance Master measures at least two independent components of postural control, i.e., static control and control with movement within 75% of the limits of stability or dynamic postural control. This hypothesis is consistent with previous researchers who have reported theoretical and actual differences between maintaining postural control in one position and moving one’s center of gravity to different positions within one’s limits of stability (29,34).

Another interesting finding was the lack of association between measures of upper and lower body strength and the weak associations between muscles of the upper and lower body which are not directly opposed to one another. These findings may be attributable to the wide range or variability in the assessments of strength. These findings may also support the hypothesis that strength changes at different rates in the muscles of the upper and lower body in later life, and that these proposed differing rates of change may be related to disuse rather than associated with chronological aging (4,30). The data further showed that lower and upper body strength measures could independently account for a significant amount of the variance in the four functional tasks. For example, both squat/hip and seated row strength were independently important when predicting the car exit test and the stair test, accounting for 5% and 4% of the variance, respectively, while the seated row strength index significantly predicted between 8 and 22% of the variance for all of the functional tasks. These findings indicate that the leg strength of a majority of the sample may have been at or beyond the necessary threshold to perform these tasks, with other variables (seated row strength and/or dynamic postural control) emerging as significant predictors. This assumption that the leg strength of the sample exceeded the threshold to perform the functional tasks appears to support the hypotheses that the older adults in this sample may be experiencing different rates of change in the strength of their upper and lower body.

Joint pain was correlated with all of the functional tasks but did not appear as a significant predictor in any of the regression models to predict the functional tasks. Joint pain did emerge initially as a significant predictor of the street crossing test, accounting for 22% of the variance, but then was removed from the final model once seated row strength was
added. The removal of joint pain from this model may be due to the significant relationship found between seated row strength and joint pain ($r = -0.59$). These correlations between joint pain and strength are consistent with those of Marks (16), who reported that increased knee joint pain resulted in decreased quadriceps strength. This conclusion is also consistent with previous investigators who have reported a significant inverse correlation between pain and joint function among individuals suffering from osteoarthritis (19). Thus, the significant correlations between the functional tasks and strength may be mediated through the inhibitory effect that joint pain has on muscle functioning. An alternative explanation for these findings is that the Arthritis Impact Measurement Scale questionnaire assessed nonspecific joint pain which may not have been relevant to the joints which were involved in any of the functional task assessments.

Age was not correlated with or a predictor of performance in any functional tasks except the car exit test, in which it explained only 6% of the variance. These findings suggest that age may be a poor predictor, after age 65, of activities of daily living. There is growing evidence to indicate that the declines in functional ability seen in older adults are not primarily the result of chronological aging but, in fact, may be the result of inactivity (4,30). This hypothesis is supported by the weak association between age and performing the functional tests and the findings that strength measures were predictive of performance of all functional tests.

Finally, dynamic postural control was a significant predictor of all functional tasks. This can be explained because all four of the functional tasks studied involved movement of the individual’s center of gravity within their limits of stability. These tasks demanded movement of the body through vertical and horizontal space which may have involved displacement of the body’s center of gravity from its base of support within the limits of stability. This movement of the body’s center of gravity within the limits of stability is similar to the assessments of dynamic postural control. This finding in addition to the lack of association between any of the postural control variables and any of the strength measures reinforces the conclusion that these are two different characteristics among active older adults, and each may play an important role in the functional ability of older adults.

**CONCLUSION**

These findings, which indicate that measures of strength, particularly squat/hip, and seated row strength and dynamic postural control are significant predictors of the four functional tasks, must be interpreted cautiously. These measures were only able to predict a limited amount of the variability in the four functional tasks. This observation encourages the search for additional variables, which may comprehensively predict performance of functional tasks among older adults. Generalizability of these findings is limited to healthy community-dwelling older adults. This target population omits a large proportion of older adults who are frail, institutionalized, or relatively inactive. A larger, more heterogeneous sample might yield even more powerful descriptions of the ability of strength, postural control, and joint pain to predict the ability to perform functional tasks. A more diverse sample may also be more representative of all older adults. Future studies employing a larger and more representative sample are needed to confirm the importance of strength and postural control in predicting different functional tasks among older adults. Additionally, these future studies using similar assessments of strength and postural control and a wider variety of functional tasks (bathing, cooking, simple home maintenance) may provide a more complete assessment of tasks which older adults encounter when living independently. Correlating more and different measures of physical fitness with the functional tasks will allow better descriptions of the predictors of the functional tasks and direct the types of interventions which may have the greatest impact upon functional independence among older adults.

**REFERENCES**