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Grip Strength and Functional Measures in the Mature Adult: Brief Report II

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***Abstract*-** Grip strength has been shown to be closely linked to body strength in mature aged adults. However what may be of greater importance is the relationship between grip strength and functional movements in aging adults. Purpose: This study examined the relationship between grip strength and functional body movements in mature aged adults. Methods: Female (n=12, age=71.2±3.8 years, mass=66.3±9.2 kg) and male (n=16, age=72.9±4.7 years, mass=85.5±9.4 kg) participants completed functional body movements including: vertical jump (VJ), medicine ball (MB) throws (1.5, 3.0, & 5.0 Kgs), and a stair climb (SC) test. Likewise, all participants performed maximal hand grip (MG) with the Jamar hand grip dynamometer. Pearson correlation coefficients (PCC) were then calculated to determine the relationship between dominant hand MG and the functional body movement scores. Results: PCC's were as follows: MG-VJ (r=0.62), MG-$MB^{1.5}$ (r=0.86), MG-$MB^{3.0}$ (r=0.87), MG-$MB^{5.0}$ (r=0.91), and MG-SCP (r=0.79). All PCC's were statistically significant at P<0.01. Conclusions: Within the parameters of this study, MG strength is strongly reflective of functional body movements that require upper and lower body power output. In this regard, assessing grip strength may be beneficial to clinicians interested in assessing functional body movements in aging adults.

***Keywords*-** *grip, grip strength, mature adult*

I. Introduction

Aging is associated with muscle loss and strength a condition referred to as sarcopenia (1). Sarcopenia related loss of muscle strength and muscle function is associated with decrements in the ability to perform activities of daily living (ADLs) (2) and an increased risk of falls (3). Injuries related to falls often lead to permanent disability resulting in loss of independence (4).

Given the association between age related muscle loss/strength and mortality/injuries as well as the loss in the ability to perform ADLs, it may be of value to develop a practical clinical test that could provide insight into an aging individual's ability to perform ADLs.

In this regard, grip strength assessment may be of value. Consider the following: grip strength has been shown to be associated with reduced mortality in both the young and mature aged adults (5,6). In our previous work (7) we focused upon the relation between grip strength and muscle strength in regions of the body; which confirmed our hypothesis that grip strength is positively related to muscle strength in other regions of the body. Given our previous findings (7) we wanted to explore if there was a positive relationship between grip strength and functional body movements. Given the relationship between grip and muscle strength in other regions of the body, we felt it was reasonable to hypothesize that grip strength would be positively related to functional body movements. Our assumption is that functional body movements are representative of the ability to perform ADLs.

Hence, the purpose of this study was to determine if a meaningful positive relationship existed between grip strength and functional movements in a participant pool of mature aged adults. This brief report is a continuation of our earlier work (7).

II. Methods

Participants

Participants (n = 28) included both males and females in either their 7th, 8th, or 9th decade of life (68-88 years). Recruitment strategies included public announcements, flyers, and word of mouth. The participants were independent and community-dwelling with no previous background in resistance training. Participants were cleared for participation in the study by their personal physician. Prior to the execution of the study, all participants were verbally informed of the details of the study, read and signed an informed consent document approved by an Institutional Review Board for the use of Human Subjects.

TABLE I. PARTICIPANT DESCRIPTIVE CHARACTERISTICS (MEAN±SD)

Participants	N	Age (years)	Body Mass (kilograms)
Female	12	71.2±3.8	66.3±9.2
Male	16	72.9±4.7	85.5±9.4

Procedures

Maximal grip strength (MG) was assessed with a Jamar hand dynamometer. Participants completed two trials of maximal grip with both the dominant and non-dominant hand. Participants were seated with the shoulder at 0° abduction and flexion with the elbow at 90° flexion, as recommended by American Society of Hand Therapists (8). Participants were instructed to familiarize themselves with the Jamar by holding and squeezing the device prior to performing the maximal grip trials. Participants were then instructed to squeeze the device with a maximal effort for three seconds. The trials were separated by approximately 1 minute rest periods. The greatest MG score from the two trials was used for analysis.

Vertical jump (VJ) measures were collected with the Vertec vertical jump measuring device in a manner previously described (9). The participants were given three VJ attempts with a self-selected rest period between trials ranging from 1-3 minutes. The best score (centimeters) was recorded and used for subsequent analysis. Vertical jump measures collected in this manner have been reported as reliable with intra class correlations (ICC's) ranging from 0.87-0.89 (9).

Medicine ball (MB) throws were collected for three different MB masses: 1.5, 3.0, and 5.0 Kgs. The MB throws were collected (meters) with the participants in a seated position as previously described (10). The participants were given three trials at each of the three MBs. The participants were allowed a self-selected rest period between trials ranging from 1-3 minutes. Medicine ball measures collected in this manner have been reported as reliable with ICC's ≥0.98 (10).

Stair climb (SC) measures were collected for each participant as previously described (11). The best score of two trials separated by a 3 minute rest period was used for subsequent analysis. There were 12 stairs at 15.24 cm in height for a total of 1.83 meters.

Prior to study initiation, participants were instructed in proper execution of each task and appropriate breathing patterns in order to minimize cardiovascular stress (12). The participants were also allowed to practice each task assuring that they were familiar with the body mechanics of each movement.

Analysis

A personal computer with Microsoft Excel 2013 software was utilized for data management and statistical analysis. Standard descriptive statistics (mean and standard deviation) for age, height, and body mass were calculated. Pearson correlation coefficients (PCC) were calculated between maximal dominant grip strength and functional movement measures (significance $\alpha \leq 0.05$).

III. RESULTS

All of the participants were able to complete the MG and five functional body movement assessments (MG, VJ, $MB^{1.5}$, $MB^{3.0}$, $MB^{5.0}$, and SC). Table 1 provides the subject descriptive statistics for age and body mass (mean± standard deviation).

Table 2 provides the Pearson correlation coefficients (r) between MG and the functional body movement scores. The PCC's ranged from high (r=0.62) to very high (r=0.91) (13). All PCC's were statistically significant (p<0.01).

TABLE II. PEARSON CORRELATION COEFFICIENTS (R) BETWEEN MAXIMAL DOMINANT GRIP STRENGTH AND FUNCTIONAL BODY MOVEMENTS

	Vertical Jump	Medicine Ball 1.5 Kg	Medicine Ball 3.0 Kg	Medicine Ball 5.0 Kg	Stair Climb
Grip Strength	0.62*	0.86*	0.87*	0.91*	-0.37*

*p<0.01

TABLE III. FUNCTIONAL BODY MOVEMENTS SCORES (MEAN±SD)

Strength Measure	Male (n=16)	Female (n=12)
Maximal Grip (Kg)	30.3±5.6	10.6±3.3
Vertical Jump (cm)	27.9±6.8	18.7±5.3
Medicine Ball 1.5 Kg (m)	5.1±0.7	3.4±0.5
3.0 Kg (m)	4.0±0.5	2.7±0.4
5.0 Kg (m)	3.3±0.3	2.2±0.3
Stair Climb (seconds)	2.9±0.5	3.3±0.6

Table 3 lists the MG and functional body movement scores for all of the variables collected for both genders (mean±SD).

IV. DISCUSSION

The purpose of this study was to determine if a meaningful positive relationship existed between maximal grip strength and functional body movements in mature adults. The relationships between MG and the functional body movements in this study ranged from high to very high with exception of the timed SC.

The functional body movements (VJ, MB and SC) selected for this study were all muscular power oriented for both the upper and lower body. When the SC scores were converted to measures of power output (Watts=Newtons*meters/second) the PCC between MG and stair climb power output (SCP) was also high (r=0.79). Hence, the PCC's reported in this study as a measure of muscular power output ranged from high to very high (13).

As previously stated (7), the MGs recorded during the current study were inexplicably lower than norms reported elsewhere (14). VJ measures were consistent with those reported by Perchthaler et al. (15). The MB throws recorded in this study were also consistent with previously reported MB scores in the mature adult population (10). The SC times were also very close to those in a previous study using a similar participant pool and stair case (step number and height) (11).

A previous meta-analysis revealed that the odds ratios for mortality as a function of grip strength persisted after correcting for gender (6). As such, we included both genders in the calculation of the PCCs.

During the development of this study we aimed to select functional body movements that required muscular power. While our previous work established a strong link between MG and body strength in mature adults (7), we felt that muscular power, the combination of strength and the rate that it can be applied may be more important with regards to the ability to perform ADLs. Research indicates that the ability to develop a high degree of muscular power appears to diminish with age (16,17). An increase in power enables the older adult to improve performance in tasks that require strength with speed, which relates to many functional and recreational activities (climbing stairs, walking/gait speed, recovering from a fall, golf, biking, etc.) (17,18). For example, Bassey et al. (1992) found strong correlations between leg extensor power and functional abilities such as chair-rising speed, stair-climbing speed, walking speed, and stair climbing power (19).

Consistent with our previous work (7), the results of our current study demonstrate that MG is equally effective with regards to estimating functional body movements that require the application of muscular power.

A limitation to the current study is the number of participants. Future studies examining MG and estimating functional body movements should grow the participant pool in order to verify the relationships established in the current study. It would also be of interest to determine if subsequent exercise prescription that is based on low MG leads to advanced physical capabilities as is seen with those participating in masters caliber sports (20,21,22,23,24,25).

Exercise prescription focusing on improving muscular strength in mature adults has proven effective (26,27,28). With that said, clinicians would be well advised to include exercises that mimic ADLs in to any exercise prescription. This process would best assure that muscular strength gains as a result of implementing an exercise protocol would translate into improved functionality. This process would be analogous to athletes including skill specific training and exercise modalities that focus on specificity of training in order to optimize a transfer of muscular strength and power to the field of play (29).

Additional future studies should also examine different aspects of MG as found with advanced technology such as the Grip Force Map system (30,31,32). The Grip Force Map system employs tactile array technology that allows a detailed force map of the hand while gripping an optimal diametered cylinder that is covered with a tactile array surface. The force map provides information regarding the force and pressure generated by each finger within the context of the entire hand. Detailed information regarding MG may provide further insight as the relationship between MG and functional body movements.

Given the high PCCs between MG and functional body movements established in this study, it appears that grip strength measures may serve as a clinically friendly screening assessment of functional body movements. Grip strength measures could be easily assessed as part of an annual physical exam allowing practitioners a starting point for exercise prescription. Such a practice would be of particular value to patients experiencing sarcopenia.

V. CONCLUSIONS

Within the parameters of this study it is concluded that:

1. Maximal dominant grip strength is positively associated with functional body movements that are muscular power oriented for both the upper and lower body.
2. Given the relationship between MG and functional body movements, clinicians might be well advised to collect MG as part of a mature adult’s annual exam.

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