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Grip and Body Strength Measures in the Mature Adult: A Brief Report

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Abstract- Many in the exercise and sport medicine discipline believe a complete physical fitness assessment including measures of muscular strength should be part of an adult's annual medical exam. Conducting a complete fitness test including measures of muscular strength is not practical in the current medical exam paradigm. In this regard, a simple field test that could reflect body strength measures would be of value. Purpose: This study examined the relationship between grip strength and selected body strength measures in the older adult. 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 1 RM tests with the leg press (LP), biceps curl (BC), triceps extension (TE), lat pull down (LPD), and machine bench press (BP). An aggregate strength score was also calculated as the sum of the individual 1 RM tests and was considered a total body strength score (TS). Likewise, all participants performed maximal hand grip (MG) attempts with the Jamar hand grip dynamometer. Pearson correlation coefficients (PCC) were then calculated in order to determine the relationship between dominant hand MG and the 1 RM results. Results: PCC's were as follows: MG-LP (r=0.61), MG-BC (r=0.85), MG-TE (r=0.80), MG-LPD (r=0.87), MG-BP (r=0.77), and MG-TS (r=0.83). All PCC's were significant at P<0.01. Conclusions: Within the parameters of this study, grip strength is strongly reflective of total body strength and may be beneficial to clinicians interested in assessing strength as part on an annual medical exam.

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 is associated with decrements in the ability to perform activities of daily living (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 relation between age related muscle loss/strength loss and mortality/injuries it may be of value to find a simple test that can estimate muscle strength in the clinical setting.

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 adults (5,6). What factors are associated with grip strength and reduced mortality are yet to be determined. However, with that said, it is reasonable to hypothesize that grip strength is positively related to muscle strength in other regions of the body.

The purpose of this study was to determine if a meaningful positive relationship exists between grip strength and muscle strength in other regions of the body in a participant pool of mature adults.

II. METHODS

A. *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 volunteers 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.

B. *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 (7). 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 3 seconds. The trials were separated by approximately 1 min. The greatest MG from the two trials was used for analysis.

Maximal strength measures (one repetition maximum-1RM) were collected for the leg press (LP), biceps curl (BC), triceps extension (TE), lat pull down (LPD), and machine bench press (BP). Prior to study initiation, participants were instructed in proper execution of each exercise and appropriate breathing patterns in order to minimize cardiovascular stress (8). The participants performed multiple exercise sessions prior to the maximal strength test session assuring that they were familiar with the body mechanics of each movement. Following the familiarization exercise sessions, a 1RM was then assessed and recorded for each exercise using established methods described previously (9). An aggregate strength score was also calculated as the sum of the individual 1RM tests and was considered a total body strength score (TS). Strength measures collected as those described during the current study have all been previously reported as reliable (10).

C. 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 1-RM body strength measures (significance $\alpha \leq 0.05$).

III. Results

All of the participants were able to complete the six strength assessments (MG, LP, BC, LPD, TE, and BP). 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 other 1RM strength scores as well as the TS. The PCC's ranged from high (r=0.61) to very high (r=0.87) (10). MG was very highly associated with TS (r=0.83). All PCC's were significant ($p<0.01$).

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

TABLE II. Pearson Correlation Coefficients (r) between maximal dominant grip strength and 1-RM body strength measures. *p<0.01

	Leg Press	Biceps Curl	Lat Pull	Triceps Extension	Bench Press	Total Body
Grip Strength	0.61*	0.85*	0.87*	0.80*	0.77*	0.83*

TABLE III. Strength measures 1-RM (kg: mean±SD)

Strength Measure	Male (n=16)	Female (n=12)
Maximal Grip	30.3±5.6	10.6±3.3
Leg Press	100.4±25.1	70.3±14.8
Biceps Curl	50.9±10.4	27.7±5.5
Lat Pull Down	59.5±9.8	34.7±5.7
Triceps Extension	59.7±11.3	36.5±5.3
Bench Press	51.4±16.0	25.6±5.6
Total Body Strength	321.9±60.8	194.7±29.5

Table 3 lists the strength values for all of the variables collected in kilograms (mean±SD).

IV. Discussion

The purpose of this study was to determine if a meaningful positive relationship existed between maximal grip strength and muscle strength in other regions of the body including total body strength in mature adults. The relationships between MG and the other strength measures ranged from high to very high indicating that MG is indicative of strength in other regions of the body and of total body strength.

The MGs recorded during the current study were inexplicably lower than norms reported elsewhere (11). Whereas the regional body strength measures were reasonably consistent with those previously reported (12,13).

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. Further, normalizing strength measures relative to body mass did not improve the PCCs.

Of special note is the impact of a potential outlier score on the PCCs calculated. If one participant's scores were removed from the calculations, all of the PCCs reported in the current study would increase. PCC between MG and: LP=0.65, BC=0.91, LPD=0.93, TE=0.89, BP=0.84, and TS=0.89; which suggests an even greater relationship between MG and strength in other regions of the body and of total body strength.

A limitation to the current study is the number of participants. Future studies examining MG and regional/whole body strength measures 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 (14,15,16,17,18,19).

Additional future studies should also examine different aspects of MG as found with advanced technology such as the Grip Force Map system (20,21,22). 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 regional/total body strength.

Given the high PCCs between MG and other regional/total body strength measures established in this study, it appears that grip strength measures may serve as a clinically friendly screening assessment of total body strength. 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 regional body strength measures and is highly correlated with total body strength.

2. Given the relationship between muscular strength and physical health, clinicians might be well advised to implement a simple grip strength assessment as part of an annual physical exam in order to estimate a patient's health risks associated with low muscular strength.

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