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How functional fitness relates to muscular power among older adults

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Abstract

The current study examined the relationship between functional fitness measures and muscular power among older adults. A 30-second chair stand test, 10-meter habitual walking test, and an 8-foot up-and-go test were all used as measures of functional fitness and muscular power was measured by Tendo analysis. The purpose of this study was to determine what aspects of functional fitness were associated with muscular power while then provide evidence that functional fitness can predict muscular power among older adults. Fifty-seven participants over 65 years old completed both the functional fitness and muscular power measures. Three separate correlations between functional fitness measures (30-sec chair stand, 8-foot up-and-go, and habitual walk) and muscular power, specifically relative peak power, revealed significant associations in all three. The 30-second chair stand test showed the strongest relationship; r = .72, p < .05. The 8-foot up-and-go and the 10-meter or habitual walk task was found to be negatively correlated with relative peak power; r = -.56, p < .05; r = -.29, p < .05. These findings support other research that showed functional fitness measures to be a valid tool for predicting muscular power. Increased functional fitness and muscular power is important in older adults to remain independent and specific training regimens allow individuals to maintain functional fitness as well as muscular power.

Introduction

Muscular strength and power play a major role in the ability of older adults to perform activities of daily living (ADLs). Individuals with low functional fitness have many restrictions that impair them from doing simple daily activities. Functional fitness involves a lot of strength and stability, such as lifting things to put groceries away or squatting to pick something off the floor (Ehrman et al., 2009, p. 135). Not being able to do these small tasks can mentally and physically alter the way older individuals live. Increased muscular power makes ADLs easier to perform while creating more independence among older adults (Ehrman et al., 2009, p. 143). However, when older adults lose muscular strength and power, their ability to perform functional tasks decreases greatly (Hruda, Hicks, & McCartney, 2003).

Age and muscular strength are inversely related. Muscular power decreases due to an age-related decrease in muscle mass (sarcopenia) and loss of muscle fibers (Bottaro et al. 2007). Not only does muscular strength decrease but muscular power is also affected by a decrease in strength. Since muscular power is the result of force and velocity, it seems to be a better determinate of functionality as opposed to muscular strength alone. This is because power does not only include how much force one can produce, but how fast they can produce this force as well (Hruda et al., 2003). When thinking of older adults, muscular power would not typically come to mind but it is an essential aspect of being functionally fit. Being able to perform ADLs such as climbing stairs or getting out of bed requires quick, forceful contractions which older individuals lack (Bottaro et al. 2007). Not having muscular power as an elder can be physically and mentally disabling to their quality of life. When muscular power is reduced, the fast-twitch (type II) muscle fibers are the main type affected. These muscle fibers permit quick, forceful contractions (Henwood & Taafee 2005). Studies have shown that resistance training can prevent further deterioration of these muscle fibers and produce gains in muscular power that was once lost.

Muscular power in general is important, but lower body power is especially significant in functionality (Bean et al., 2002). In a particular study performed by Bassey et al. (1992), gait speed, chair-stand time, and stair-climb time were all significantly associated with leg power (Bean et al., 2002). In addition, Binder et al. found that advancements in lower body power correlated to improvements in gait speed (Protas & Tisser, 2009). Power has been assessed in previous studies and in most it was assessed by a leg-press machine designed to measure power. Measuring muscular power in older adults is difficult but the sit-to-stand task has been used previously to estimate muscular power among this population. The purpose of this study was to evaluate the relationship between functional fitness and muscular power among older adults. The aim of this study was:

AIM: To determine what aspects of functional fitness are associated with muscular power among older adults.

Hypothesis: Functional fitness can be predictive of muscular power. Older adults with increased functionality will have greater muscular power and therefore a greater ability to perform ADLs.

Methodology

Sixty subjects over 65 years were recruited from a local retirement community to participate in this investigation. All subjects signed a written informed consent previously approved by the Institution Review Board at the University of Arkansas. Upon signing the informed consent and physician clearance, all participants reported to the Human Performance

Lab to complete the following assessments: height and weight, 10-meter habitual walking speed task, 30-second chair stand, the eight-foot up-and-go, and Tendo chair stand analyzer.

The first test to determine functional fitness was the 30-second chair stand, which is an assessment of lower-body strength and functional fitness for individuals over 60 years old. This test begins with the participant sitting on the edge of a chair with their arms crossed over their chest. This is to prevent the use of upper body strength to push out of the chair; therefore, it is all lower limb strength when attempting to stand. One chair stand is recorded as standing up all the way up from the chair to straight legs then all the way down seated again. Each participant was timed for 30 seconds and it was recorded how many chair stands they could complete in this amount of time. Another of the six tests from the SFT is the 8-foot up-and-go. How long it took them to stand up from a chair, walk 8 feet to a marker, return back to the chair, and sit down was timed. All participants walked as quickly and safely as possible without running. The last test to determine functional fitness was gait speed. A 10-meter walk test was used to determine habitual walking speed. Timing gates with lasers (Model 63501 IR) from the Lafayette Instrument Co. to record how long it took each participant to walk 10-meters at their normal pace were utilized. Individuals started at a marker that was 5-meters before the first timing gate and end 5-meters after the last timing gait. The participants performed this test twice with a 90-120 second rest between. This same protocol was repeated but the individual walked 10-meters as quickly and safely as possible to determine their maximum gait speed. If any of the two trials differed more than 0.5 seconds, that particular test was performed once more and the two closest times were recorded.

The Tendo Weightlifting Analyzer (V-207) detects muscular power and strength by recording maximal lower body muscular power. Height and weight of the participants were obtained to enter into the computer in order to calculate power relative to each individual. Each participant put a belt around their waist and adjusted it until it was snug and then sat down in a chair. Once they were comfortable, a carabiner was linked from the Tendo machine to a carabiner on the participant's belt. Connected to the machine, it can detect the speed of the chair stand and then compute that into power output based on their height and weight. The procedures asked the participant to stand from a seated position (with arms across body and feet planted) as quickly as possible; a total of five trials were completed. One minute of recovery was allowed between each trail of the power chair stand. More pre-tests were administered, but for the purpose of this thesis question, only the tests described above were analyzed. These pre-tests were administered at both the Butterfield Trail Village and the University of Arkansas HPER building.

Data Analysis Procedures

Correlations between variables were evaluated by Pearson's Product Moment Correlation. Analyses were used to make comparisons between functional fitness (*30-second chair stand, 8-foot up-and-go, and gait speed*) and muscular power. This correlation was used to predict which functional fitness test is most positively correlated with muscular power.

Results

The analyzed sample included 57 older individuals over the age of 65 (41 females; $M_{age} = 78.1$, $SD_{age} = 6.4$; 16 males; $M_{age} = 78.2$, $SD_{age} = 7.3$). Three separate correlations between functional fitness measures (30-sec chair stand, 8-foot up-and-go, and habitual walk) were made in relation with muscular power, specifically relative peak power. The number of chair stands completed in 30-seconds significantly correlated with relative peak power; $r = .72$, $p < .05$. The 8-foot up-and-go test was found to be negatively correlated with relative peak power; $r = -.56$, p

< .05. Lastly, the 10-meter or habitual walk task significantly correlated with relative peak power; $r = -.29$, $p < .05$.

Table 1

Subject Demographics for All Participants

Measure	Female	Male
Age (yrs)	78.1±6.5	78.2±7.3
Height (cm)	160.5±5.4	176.6±8.2
Weight (kg)	65.7±10.8	88.8±11.7
30-Sec Chair Stand (reps)	12.1±4.0	13.1±3.0
8-Foot Up-and-Go (sec)	6.91±1.8	6.46±1.4
10-Meter Habitual Walk (sec)	7.77±1.8	7.61±1.7
Relative Peak Power (Watts/kg)	6.64±2.1	8.18±1.8

Associations between Relative Peak Power and Chair Stand

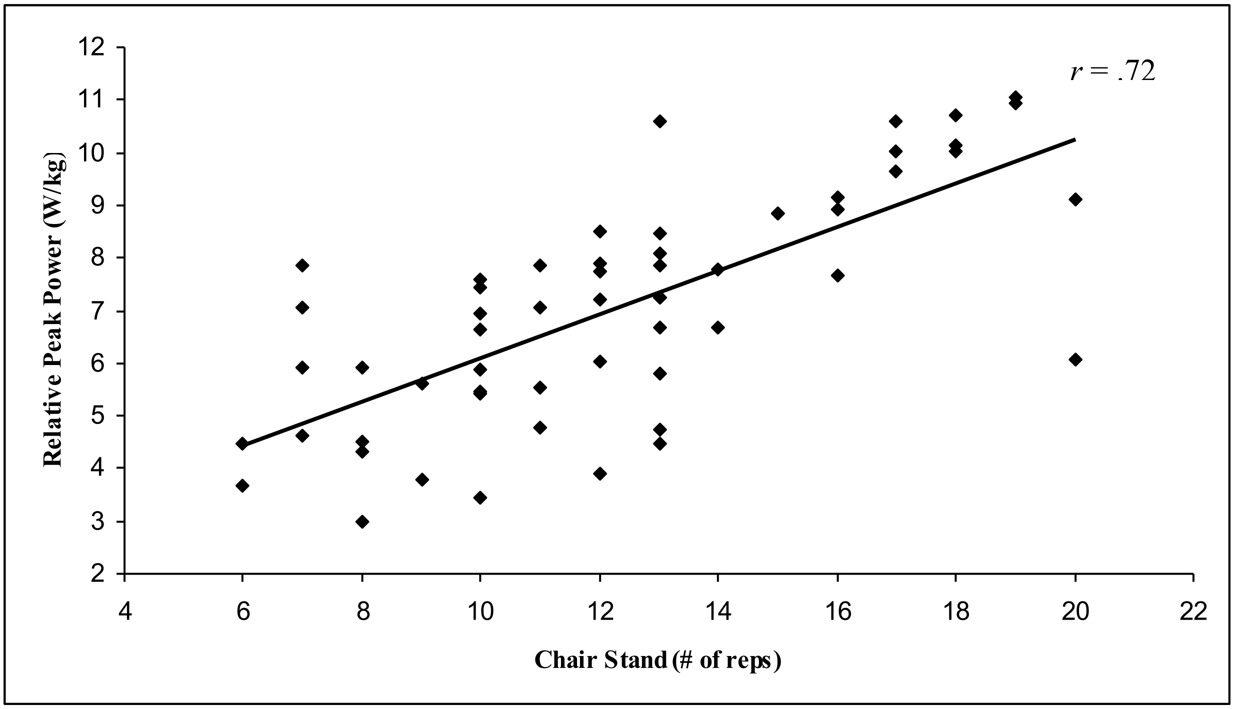

Figure 1. Displays associations between relative peak power and number of chair stands completed.

Associations between Relative Peak Power and 8-Foot Up-and-Go

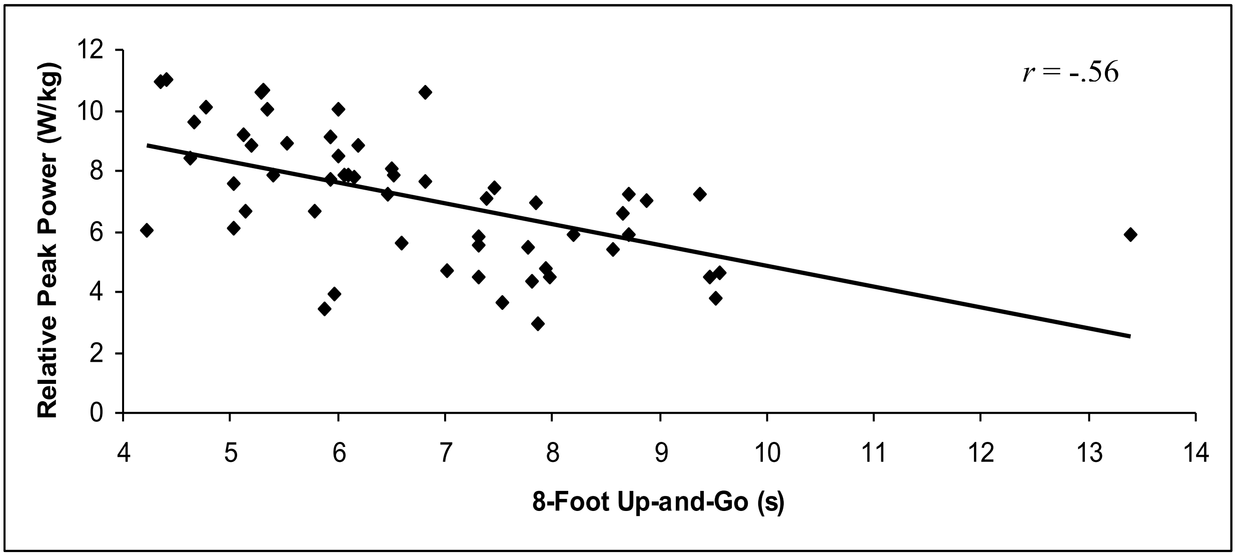

Figure 2. Displays associations between relative peak power and 8-foot up-and-go.

Associations between Relative Peak Power and Habitual Walking Speed

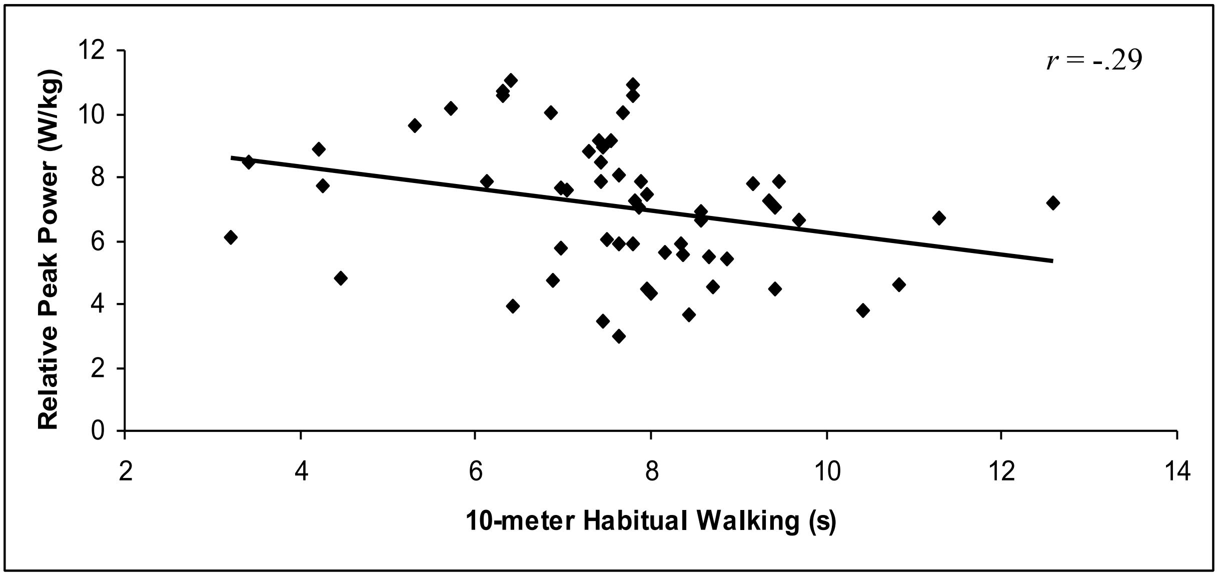

Figure 3. Displays associations between relative peak power and 10-meter habitual walking speed.

Discussion

The major finding of this study was that functional fitness, as defined by 30-second chair stand, 8-foot up-and-go, and habitual walking speed, is a significant predictor of relative peak power. The results were consistent with the proposed hypotheses that functional fitness can be a valid tool for predicting muscular power and older adults with increased functionality will have greater muscular power. The greatest significance was found between the 30-second chair stand tasks when correlated to relative peak power, thereby showing the chair stand task to be the strongest predictor of relative peak power. The present findings, as expected, showed the 8-foot up-and-go and 10 meter habitual walk tests to be inversely related to relative peak power.

These results support other findings, in that functional fitness is an important component of muscular power. Bassey et al. (1992) and Skelton et al. (1994) both proposed that muscular power provides a better marker of functionality and overall functional fitness than muscular strength alone. Hruda and colleagues (2003) found that baseline performances on functional fitness tasks, defined by the 30-second chair stand, 8-foot up-and-go, and the 6-minute walk tests, were significantly correlated to concentric average power (average leg extension power). In a similar study among healthy older adults, Skelton et al. (1994) found significant correlations between functional tests of explosive chair rise and box stepping, and muscular strength and power. Current findings also are in agreement with a study administered by Bassey and associates (1992) who found gait speed, chair-stand time, and stair-climb time all to be significantly associated with leg power. Bean et al. (2002) used stair climb, chair stand, tandem, habitual, and maximal gait speed, and the Short Physical Performance Battery (SPPB) to assess functional fitness. In comparison they found leg power and strength to be significantly associated with all of the measures of functional fitness. However, it is worth noting that leg power reported more variance than did leg strength (Bean et al., 2002). These findings support the current research project suggesting muscular power is an equal or possibly better determinate of functionality among older adults.

Functional fitness among older adults is extremely important in staying healthy and independent. Declines in muscular strength and power as people age can have detrimental effects on their quality of life by inhibiting their ability to perform ADLs such as lifting objects, rising from a chair, or even walking (Henwood &Taaffe, 2005). When functional limitations begin to arise, declines in lower body power seem to be the predictor of future disablement (Bean et al., 2002). Sarcopenia affects 45% of elderly adults in the U.S. and is related to a reduced quality of life (Katula, Rejeski, & Marsh, 2008). It is imperative to maintain muscular power in order for individuals remain independent. For an older adult, independence enhances their quality and satisfaction of life. This functional independence allows older individuals to feel capable and in turn increases their self-efficacy, especially in their ability to perform ADLs (Katula et al., 2008). Even though sarcopenia is related to the aging process, it does not have to be an inevitable consequence to aging. Preventive exercise measures can be taken to attenuate the age-related decreases in muscular strength and power that physically and mentally disables older adults.

Many exercise programs have been tested among older adults to help increase and maintain functional fitness levels. Further research is needed to determine how to maintain functional fitness but, currently, resistance training appears to be most beneficial regimen in most studies. Traditional or low-velocity resistance training has shown to improve muscular fitness but recent studies have incorporated High Velocity Resistance Training (HVRT) or Power Training (PT). This type of resistance training is exactly like traditional methods except the speed of the concentric contraction is increased as much as possible (Tschopp, Sattelmayer, &

Hilfiker, 2011). Multiple studies have compared high and low velocity resistance training regimens and all produced similar results, with HVRT having the greatest benefits (Tschopp et al., 2011; Bottaro et al., 2007; Fielding et al., 2002). Although both regimens are effective in increasing muscular strength, HVRT resulted in a greater improvement in muscular power, which as stated, is shown to be a better predictor in overall functional fitness. These findings also showed that adaptations to resistance programs are specific to velocity and contraction type during training (Bottaro et al., 2007). Fielding et al., (2002) found that among older women HVRT increased peak power more significantly than low-velocity resistance training (LVRT). Peak power is one's maximum capacity to do work in a unit of time. This is important because peak power has been associated with lower functionality and increased levels of disability (Fielding et al., 2002). Beneficial effects of HVRT have shown to happen in short amounts of time (12 weeks) and if training is halted due to injury or stopped altogether, the effects can be maintained for 4-12 weeks (Pereira, Izquierdo, Silva, Costa, Gonzalex-Badillo, and Marques, 2012). The main finding of Pereira et al., (2012) was that detraining effects were seen greater in muscular strength rather than power. Uniquely, the researchers found that muscular power and performance gains were not fully lost after ending training, possibly due to neuromuscular adaptations. These exercise programs are important for knowing how to maintain or increase functional fitness. The current findings showed functional fitness to be significantly correlated to muscular power and having an effective regimen to aid in slowing the ageing process is important among older adults.

A specific study that compared HVRT and LVRT examined physical improvements as well as mental effects each condition had on older adults (Katula et al., 2008). The researchers compared the effects to one another as well as to a control group to examine the effect a specific training program plays in quality of life and individual self-efficacy. They defined quality of life as having a sense of functional and mental well-being. Katula and colleagues found that individuals in the HVRT regimen significantly increased their self-efficacy and all measures of quality of life from baseline testing, while the LVRT group only showed significant increases in mental well-being in one of the three measurements. When the researchers measured participant's satisfaction with physical function the HVRT group experienced a large change from pre- to post-testing, while the LVRT group reported a much smaller change (Katula et al., 2008). Not only does HVRT offer greater functional benefits, it may offer elderly individuals even greater benefits of increased self-efficacy and overall quality of life in order to maintain independence. The findings of this study showed functionality to be significantly related to power so as these measures increase, so can quality of life. This could lead to future research in assessing the measures of the current study with quality of life measures.

This study focused on the relationship between functional fitness and muscular power but only the individual's lower extremities were taken into account. Upper extremity strength and power, as well as balance are also important components to functional fitness, whether it be carrying groceries or gripping a hand rail while walking down stairs (Skelton et al., 1994). Another limitation to the study was the demographics of the individuals—the sample consisted mainly of Caucasian individuals living in a community-based retirement village. In conclusion, functional fitness as measured by 8-foot up-and-go, 30-second chair stand, and 10-meter walking speed are significant predictors of relative peak power among older adults. Increased functional fitness can help maintain and prolong independence among the elderly population which is why exercise regimens to increase functionality are so important.

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