

# Correlation of the 6-minute walk test with BMI and lower and upper limb strength tests results in older people. Preliminary studies

## Korelacja wyników testu 6-minutowego z BMI i siłą mięśniową kończyn górnych oraz dolnych wśród osób starszych. Badania wstępne

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### Abstract

**Introduction.** In normal, healthy adults, cardiovascular and pulmonary systems capacities are the limiting-factors of aerobic capacity. Moreover, in older people the interrelationships between muscle strength and endurance seems to be much more pronounced. **Aim.** The aim of this study was to assess the level of correlation between aerobic capacity and lower and upper limbs strength test. **Material and methods.** In these preliminary studies 109 patients (21 men, mean age: 68.46) were examined. Functional Fitness Test subtests: upper and lower limbs strength was assessed. Aerobic capacity was measured with 6-Minute Walk Test (6MWT). **Results.** Results of 6-minute walk test were correlated with lower limbs strength test results ( $r = 0.23, p = 0.022$ ) and mean result of upper limbs strength test ( $r = 0.3, p = 0.003$ ). BMI negatively correlated with mean result of upper limb strength test ( $r = -0.24, p = 0.014$ ), lower limb strength ( $r = -0.33, p = 0.001$ ) and 6-minute walk test ( $r = -0.22, p = 0.024$ ). **Conclusions.** In these preliminary studies a positive correlation between 6-minute walk test and upper and lower limb strength test scores were showed. Longitudinal studies on larger samples with regression analysis are needed to estimate the size of the influence of developing sarcopenia on aerobic capacity decline. (*Gerontol Pol* 2017; 25; 151-155)

**Keywords:** older people, functional assessment, BMI, limb strength, 6-minute walk test (6MWT), aerobic capacity

### Streszczenie

**Wstęp.** Funkcjonowanie układu krążenia oraz układu oddechowego zdrowych dorosłych osób jest czynnikiem ograniczającymi wyniki w testach wydolności tlenowej. Co więcej, u osób starszych współzależność między siłą mięśni, a wydolnością tlenową wydaje się być o wiele bardziej istotna. **Cel pracy.** Celem niniejszej pracy jest ocena poziomu korelacji pomiędzy wydolnością tlenową, a siłą kończyn dolnych i górnych. **Material i metody.** W wstępnych badaniach wzięło udział 109 pacjentów (21 mężczyźni, średnia wieku: 68,46). Następujące podtesty Functional Fitness Test zostały użyte: testy siły kończyn górnych i dolnych. Wydolność tlenową mierzono za pomocą testu 6-minutowego marszu (6MWT). **Wyniki.** Wyniki testu 6-minutowego marszu były dodatnio skorelowane z siłą kończyn dolnych ( $r = 0,23, p = 0,022$ ), oraz średnim rezultatem testu siły kończyn górnych ( $r = 0,3, p = 0,003$ ). BMI ujemnie korelowało z wynikami badania siły kończyn górnych ( $r = -0,24, p = 0,014$ ) i dolnych ( $r = -0,33, p = 0,001$ ) oraz testu 6-minutowego marszu ( $r = -0,22, p = 0,024$ ). **Wnioski.** W niniejszych,

wstępnych badaniach wykazaliśmy pozytywną korelację pomiędzy testem 6-minutowego marszu, a siłą górnych i dolnych kończyn. Potrzebne są podłużne badania na większej grupie osób z zastosowaniem analizy regresji, aby oszacować wielkość wpływu postępującej sarkopenii na stopień pogorszenia się wydolności tlenowej. (*Gerontol Pol* 2017; 25; 151-155)

**Słowa kluczowe:** ludzie starsi, ocena funkcjonalna, BMI, siła kończyn, 6-minutowy test marszu (6MWT), wydolność tlenowa

## Introduction

Two of geriatric giants, namely: immobility and instability refer to impairment of motor functioning. Moreover, cognitive functioning impairment seems to be strongly related of these two above mentioned factors [1-3]. In normal, healthy adults walking seems to be an automatic function, which does not use significant amount of cognitive capacity. However, in older people, motor system seems to be depended on cognitive system more, even while simple motor pattern are executed, such as walking [1-3]. Normally, cardiovascular and pulmonary systems effectiveness are the limiting-factors of aerobic capacity. On the other hand, endurance training influences on overall strength to very little, if any, extent. However, in older people the interrelationships between strength and endurance seems to be much more pronounced. Progressive loss of fat-free mass due to aging process could become a limiting factor for walking performance. Sarcopenia is associated with metabolic, physiological, and functional impairments and disability in elderly [4-6]. Aging is also associated with an increase of fat mass especially in western world [7]. In obese, particularly in morbidly obese women suffering from low back pain or hip arthritis were significantly more common than in lean women [8]. In turn, progressive functional impairments and decrease in physical activity elderly can lead to Frailty Syndrome, defined as the loss of physiologic reserve that increases the risk of disability [5,6]. Obesity is linked to activities of daily living, mobility and daily tasks performance decline, which finally can lead to the institutionalization of older people [4]. Therefore, functional mobility (strength, flexibility, endurance, agility) of older people is a crucial aspect of current efficiency and independence in daily living activities [9-11]. The higher level of independence translates into the higher quality of life [11].

6-Minute Walk Test (6MWT) is widely used aerobic capacity test. The score is a distance walked in six minutes, measured in meters. Others Researches on group of older women showed that being obese coincides with gaining worse results in 6-minute walking test [8].

Therefore, it would be reasonable to check the correlation between results of upper and lower limb strength test with 6MWT.

## Aim

The aim of this study is to assess the level of correlation between results of 6-minute walk test and lower and upper limbs strength test.

## Material and methods

Patients were enrolled into studies during public health-promoting lectures, in Day Care Centers for the Elderly, and on various meeting-groups for older people. Examination was conducted at Collegium Medicum University Hospital in Bydgoszcz, in Chair and Clinic of Geriatrics. Whole examination consisted of blood collection and neuropsychological, medical, social, economic, dietary and physiotherapy assessment. Whole examination took approximately 3 hours for one patient. Whole plan of examination was arranged to set blood collection, followed by neuropsychological assessment, as two of first examinations. In these preliminary studies 109 patients (21 men, mean age: 68.46, age range 58-88) were examined.

Participants were tested by Fullerton Functional Fitness Test [10]. To examine strength we have used two tests: arm curl test and 30-s chair stand. In both tests the score is the number of repetitions done in 30 seconds, participant were doing this test alone, to decrease competitive bias. Arm curl test was performed using two types of weight 2 kg for women and 3.5 kg for men. During the test, patient was holding the weight in comfortable grip, while sitting position on the chair with a backrest. We avoided full extension to the side of the chair, due to the risk of the injury experience in patients with under-diagnosed osteoporosis. Therefore, participants were told to start the movement from weight positioned on thigh. Then, supinating during flexion was advised so that the palm of the hand faced the bicep at the end of concentric phase, if the initial position of palm was in directed in another way. Left and right hand strength was assessed separately. Mean results were based on left and right hand score, if the data was available. If the evaluation of strength in one hand was impossible to evaluate because of motor system disturbances, for example, pain, the score was estimated as 0.

30-s chair stand test was performed on the chair with a backrest. Test protocol contains standing from sitting

position to a standing with full extension in knees and hips, without pushing off with the arms. Tests score was the number of repetition consisted of standing and sitting phase performed in 30 seconds.

Aerobic capacity was estimated by 6MWT [12]. The testing area was indoor and flat, as others [13] recommend. The corridor distance was 50 meters, to reduce patient's time spending on turning. Because whole examinations took huge amount of time per one patient (approximately 3-hours) we did not provide any practice of walking before actual test started. Patients were asked to walk as fast as he/or she is able to. Moreover, subjects were reminded that they ought to maintain same velocity during whole test as well as we reminded two times about duration of test and ask patients to think about the walk velocity which he or she is able to maintain during whole time. Most of patients were walking alone, if not enough time interval between next patients starting test was maintained to exclude competition factor. Some studies [14] showed that creating of competitive conditions can increase mean results of patients in this test up to 30 % comparing to group without such conditions. Others estimated mean result for 631 meters and was 84 m increased in men compared to women, results were based on 51 healthy subjects aged 50-85 [13].

Correlation of above mentioned variables was measured with r-Pearson test. All statistical analyses were performed using statistical package (StatSoft, Inc. (2014). STATISTICA (data analysis software system), version 12. www.statsoft.com).

## Results

**Table I. Description of Participants (n = 109)**

Characteristics (n1, n2)	Percentage/Mean (SD)
Age	68.46 (5.79)
Still maintain a job position	17.43%
Current smoking	7.33%
6-minute walk test (n1 = 108, n2 = 105)	518.57 (83.44)
BMI (n1 = 102)	26.82 (3.93)
Lower Limb Strength (n1 = 103)	14.67 (4.68)
Upper Limb strength – mean (n1 = 109, n2 = 105)	19.58 (6.32)

The *n* in circle brackets after tests name indicates number of participants before (n1) and after (n2) ignoring outliers.

Participants age ranged from 58 to 88 years old. Mean Body Mass Index (BMI) in our study-group was calculated as 26.82, ranged from 18.70 to 40.18. 19 participants still maintained a job position. Moreover, there were 8 current smokers in this group only. Results of 6-minute walk test ranged from 360 to 710 meters. Mean results

in this test was more than 100 meter lower, than other noted [13]. However, our sample group was two times more numerous, as well as older (mean = 65 vs. 68.80 years old) [13]. In the arm curl test, 4 patients were unable to perform the test by one of hands due to motor system problem. Lower limb strength score ranged from 4 to 28 repetitions. Mean results left and right upper limb strength test score ranged from 5 to 36.5 repetitions.

### 1. Correlation of 6-minute walk, lower and upper limb strength assessment test with age, weight, height, BMI

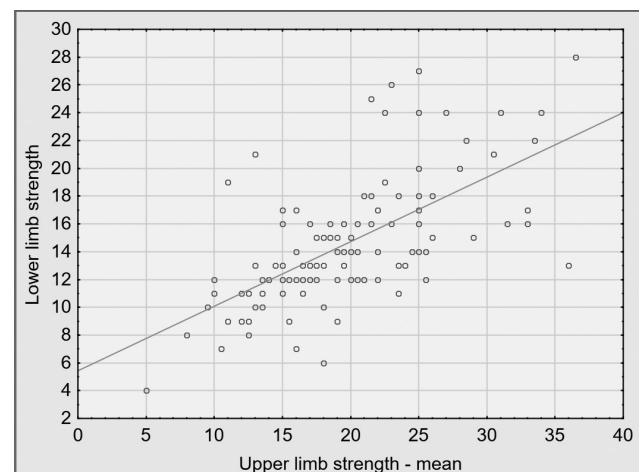
Initial results of 6-minute walk test ranged from 225 to 975 meters, after ignoring 3 outliers in analysis, final results ranged from 360 to 710 meters. In overall, results from 103 participants were taken into account during analysis.

Age was negatively correlated with mean result of upper limb strength test and 6-minute walk test ( $r = -0.22$ ,  $p = 0.022$  and  $r = -0.14$ ,  $p = 0.154$ ) respectively. BMI negatively correlated with mean result of upper limb strength test, lower limb strength and 6-minute walk test ( $r = -0.24$ ,  $p = 0.014$ ,  $r = -0.33$ ,  $p = 0.001$ ,  $r = -0.22$ ,  $p = 0.024$ ) respectively. No statistically significant results were obtained in correlation of used functional tests with weight and height ( $p > 0.05$ ).

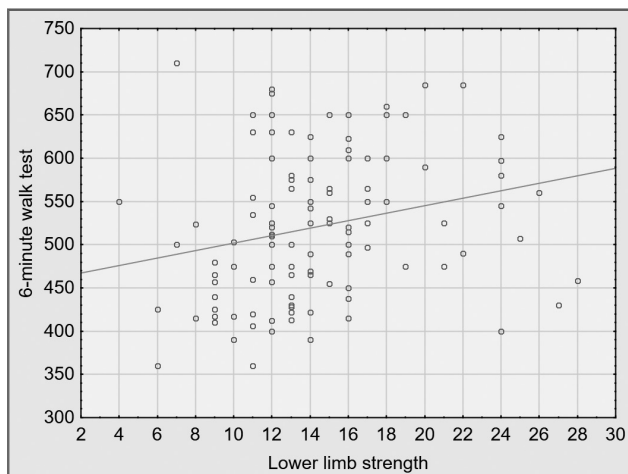
### 2. Correlation of 6-minute walk with lower and upper limb strength assessment

Lower limb strength was strongly, positively correlated with mean result of upper limb strength ( $r = 0.6790$ ,  $p < 0.001$ ) (figure 1).

Results of 6-minute walk test were positively correlated with lower limbs strength test results ( $r = 0.23$ ,  $p = 0.022$ ) (figure 2).

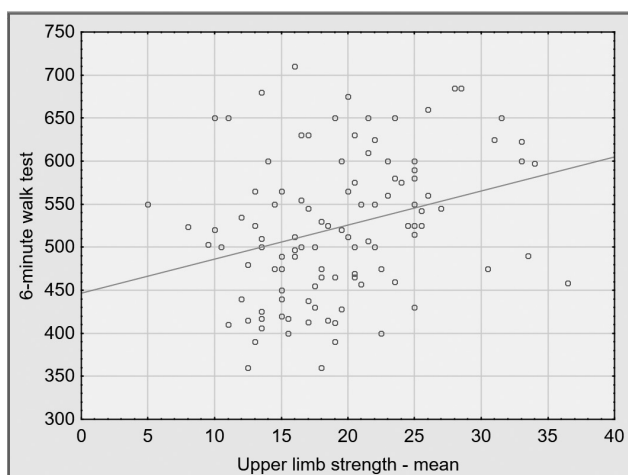


**Figure 1. Scatterplot showing correlation between lower limb strength and mean result of upper limb strength test**



**Figure 2. Scatterplot showing correlation between 6-minute walk test and lower limb strength**

Results of 6-minute walk test were correlated mean result of upper limbs strength test ( $r = 0.3$ ,  $p = 0.003$ ) (figure 3).



**Figure 3. Scatterplot showing correlation between 6-minute walk test and mean result of upper limb strength test**

## Discussion

The main finding of above studies is a positive correlation between upper limbs strength test score with 6-minute walk test score. Moreover, age was negative-

ly correlated with mean result of upper and lower limb strength test and 6-minute walk test.

BMI was correlated negatively with results of 6-minute walk test in our researches. However, high BMI must not necessarily indicate high proportion of fat mass to fat-free mass, indeed, it could be the opposite. Therefore, subsequent studies should taken into account more variables, such as percentage of fat and fat-free mass of participants. Other limitations of the above study is the fact, that participants were not categorized due to their health state, as other have done [15]. Interestingly, other researches on older people showed [16] that both: calorie-restricted diet and exercise-induced weight loss group significantly decreased their body weight after 12 months of intervention. However, absolute VO<sub>2</sub>max (maximal aerobic capacity) significantly decreased in the calorie-restricted group while exercise based group significantly improved in absolute VO<sub>2</sub>max. Moreover, only calorie-restricted group noted significant reduction of thigh muscle volume and composite knee flexion strength [16]. Therefore, well-planned physical exercise protocol with physician supervision in its planning and executing seems to be crucial in case older people with high fat mass and diminished strength and aerobic capacity. However, longitudinal studies on larger samples are needed to estimate the level of contribution of sarcopenia to decline of aerobic capacity tests results in older people.

## Conclusions

In these preliminary studies, we showed positive correlation between 6-minute walk test and upper and lower limb strength test scores. Mean result of upper limb strength was strongly, positively correlated with lower limb strength. Negative correlation of age and mean result of upper limb strength test with 6-minute walk test was noticed. Also, BMI negatively correlated with selected functional tests results.

## Conflict of interest

None

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