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THE INFLUENCE OF AGE ON THE REPRESENTATION OF SUBCUTANEOUS ADIPOSE TISSUE AND MUSCLE STRENGTH OF BICEPS IN FEMALES

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ABSTRACT

Aims: The aim of this study is to determine the age influence on the development of the muscle strength in biceps and on the representation of the subcutaneous adipose tissue.

Methods: The study was carried out in Department of Physiology, Faculty of Medicine, University of Novi Sad between October 2014- January 2015 and included 20 females between the ages of 18 - 25 years and 20 females between the ages of 50 – 60. For each subject, anthropometric parameters were determined, as well as dynamometric parameters of the biceps muscle strength, the ultrasound dimensions of the biceps and the thickness of subcutaneous adipose tissue. Caliper was used to determine the percentage of body fat based on skinfolds around the biceps. The collected data were then statistically analyzed.

Results: There was greater representation of body fat mass in older (30%±7.2) compared to younger women (20%±7) and these values were statistically significant. The ultrasound revealed statistically significant age differences; older women have greater values of subcutaneous fat (1.5±0.26mm) and dimensions of biceps (31.03±3.9mm) than younger women with values of subcutaneous fat (1.2±0.1mm) and dimensions of biceps (29.04±4.2mm). There was greater mean value of muscular strength of biceps in younger women (35±6kg) compared to older women (32±8.5kg). It was established that there was a positive statistically significant correlation between body fat percentage and thickness of adipose tissue ($r=0.55$) ($p<0.05$), as well as between mean muscular strength and ultrasound measurement of biceps ($r=0.37$) ($p<0.05$).

Conclusion: Older women have greater representation of subcutaneous adipose tissue, while younger women have greater muscle strength of biceps.

Keywords: Body composition, muscle strength, ultrasonography

INTRODUCTION

The measurement of muscle strength and subcutaneous adipose tissue of biceps can be used to estimate the physical development of the musculature, the representation of muscle and adipose tissue in young and older women.

Muscular power is the explosive aspect of strength involving the product of strength and speed of movement. Power is the functional application of both strength and speed. It is the key component for most athletic performances (1).

Even when unloaded, muscles must still generate enough force to move the bones to which they are attached. The development of this muscle force depends on: the number of motor units activated, the type of motor units activated, the size of the muscle, the muscle initial length when activated, the angle of the joint and the muscle speed of action (1).

The muscle biceps brachii provides greater muscle strength in comparison of all muscles of the upper extremities. It is one of the most dominant upper limb muscles, with which we perform the highest number of daily, usual activities. Its main function is to flex the forearm at the elbow and supinate the forearm as the prime mover with synergists to assist.

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Just beneath the skin and above the biceps there is a subcutaneous tissue which consists of adipocytes and veins.

Skeletal muscle contractile function diminishes with aging, disease and disuse. In vivo muscle contractile function depends on a variety of factors such as force, contractile velocity and power generating capacity ultimately derived from the summed contribution of single muscle fibers (2).

The aging process is characterized by a decrease in muscle strength, loss of muscle mass (sarcopenia), an increase of intramuscular fat and modifications of neural drives. These physiological modifications can potentially contribute to significant impairments in muscle quality (3).

The reliable measurement of human muscle size is essential in determining how muscle mass contribute to muscle function. Although muscle force is primarily determined by the physiological cross-section area, the power generating capacity is largely determined by muscle volume. Therefore it is important to obtain reliable estimate of muscle volume. Anthropometry does not allow any distinction between contractile material, fat and bone, thus cannot distinguish between the muscle groups. However, these distinctions can be determined with ultrasound (4).

Ultrasonography technique has been successfully used to measure the thickness of human skeletal muscle and subcutaneous adipose tissue in vivo. The observer has to select the measurement site accurately and to find the interfaces between subcutaneous fat and muscle as well as between muscle and bone (5).

The aim of this study is to determine the age influence on the development of the muscle strength in biceps and on the representation of the subcutaneous adipose tissue.

MATERIAL AND METHODS

Testing the parameters of muscle strength of the biceps, the ultrasonically measured dimensions of the biceps and subcutaneous adipose tissue was conducted in the laboratory for functional testing in Department of Physiology, Faculty of Medicine, University of Novi Sad between October 2014- January 2015.

The study included a total of 40 females, who are divided into two groups. One group contained 20 people about 21±2 years old and the other group included 20 people aged 54±3 years. After detailed examination, all the subjects were thoroughly introduced to the protocol of testing. The participants voluntarily participated in this study, which was confirmed by the written consent for participation.

For each subject anthropometric parameters were determined: body height (BH), body weight (BW) and body fat mass (BFM). BH was measured by anthropometry by Martins with a precision of 0.1 cm. For the measurement of BW, medical decimal scales were used with sliding weights and precision of 0.1 kg. For measurements of BFM, the method of bioelectrical impedance was used by device Otron BF300. The values of fat tissue were obtained in kilograms and their percentage in relation to the total weight of the body.

Testing involved the dynamometric measuring of muscle strength of the biceps by using dynamometric device, Dyno Concept 2. All the participants received standardized instructions before the tests, they warmed up in duration and intensity, did 3 trial contractions on the device and are strictly informed about the technique for using a dynamometer. The starting position for participants was to sit in a chair while relying on the chest. In this position, the subject could achieve the largest engagement of the biceps in coping with stress and largely reduce the impact of the contribution of other muscles and body movement put forward in the execution of movement. Each subject performed a series of 5 maximal contractions with the greatest possible force against a constant resistance of the dynamometer. The results were recorded in the software system of the apparatus and were expressed as maximal strength (max) and mean muscle strength (ave) in kilograms, power (watts), speed of contraction (vel) and force (work) which were then used during the analyzing of statistical data.

The ultrasound machine, Toshiba Nemio 20 was used for the measurement of the dimensions of the biceps and the thickness of the subcutaneous adipose tissue. During measuring, the participant was sitting and the hand of the participant was placed in the supine position with the back of it resting on her knee. By precisely placing the probe on the pre-established point which located on the front surface of the upper arm, approximately 60% distance between the acromion of the scapula and the outside epicondyle of the hummers, two measurements were performed: the ultrasound visualization

of the biceps and the subcutaneous adipose tissue. At the same time, measurements were carried out with the probe placed in vertical and horizontal positions. After the measurement, average values from the final results were obtained for the dimensions of the biceps muscle and the thickness of the subcutaneous adipose tissue, which were then used for statistical processing.

Caliper was used to determine the percentage of BFM based on skinfolds around the biceps.

The collected data were coded and entered into a database of a personal computer. Statistical analysis was performed using the software package Statistica 12.0 (Statistica, StatSoft®, Tulsa, USA). The results are presented using standard statistical variables such as numbers, percentages, mean ± standard deviation. A test of statistical significance between the two groups was determined by Student's t test. The correlation between the different parameters was performed by Pearson's correlation coefficient. P <0.05 is considered to be statistically significant.

RESULTS

In Table 1; the anthropometric values, BW, BH and BFM percentage measured by the method of bioelectrical impedance in both groups are demonstrated. It can be seen that the older women have greater representation of BFM (30%±7.2) compared to the younger women (20%±7), while BH is greater in the younger women and the differences in these described parameters were statistically significant (p<0.05).

Table 1: Display of the anthropometric parameters (n=40)

	Group 1 (n=20) (Older females)	*Group 2 (n=20) (Younger females)*	*p-Value*
BW(kg)	66.5 ± 15.5	62.1 ± 11.1	p<0.05
BH(cm)	164.7 ± 6.14	168.5 ± 4.8	p<0.05
BF(%)	30 ± 7.2	20 ± 7	p<0.05

The age differences in ultrasound measurements, in terms of dimensions of the biceps and the thickness of the subcutaneous adipose tissue are represented in Table 2. It is observed that the older women have greater subcutaneous fat (1.5mm±0.26) than the younger women (1.2mm±0.1), which shows statistically significant differences (p <0.05). The values of the dimensions of the biceps are greater in the older women (31.03mm±3.9) compared to the younger women (29.04mm±4.2) but these values do not show statistically significant differences between these two groups (p>0.05).

Table 2: Display of ultrasound measurements of the biceps and the thickness of the subcutaneous adipose tissue (n=40)

	Group 1 (Older females) (n=20)	*Group 2 (Younger females) (n=20)*	*p-Value*
US Biceps (mm)	31.03 ± 3.9	29.04 ± 4.2	P<0.05
US Adipose tissue (mm)	1.5 ± 0.26*	1.2 ± 0.1*	P<0.05

Figure 1 demonstrates the difference in the strength of the biceps between the two groups. The mean value of the muscular strength of the biceps in the group of the younger women (35kg±6) is greater than the mean value in the group of the older women (32kg±8.5) but these values do not show statistically significant differences between these two groups (p>0.05). The values of dynamometric parameters Power and Velocity were measured and they do not differ statistically significant (Figure 2-3).

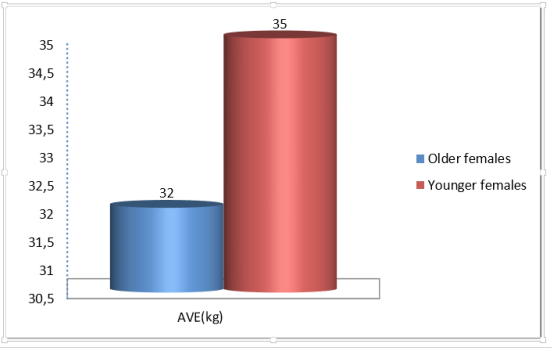

Figure 1: Display of the mean value of muscular strength

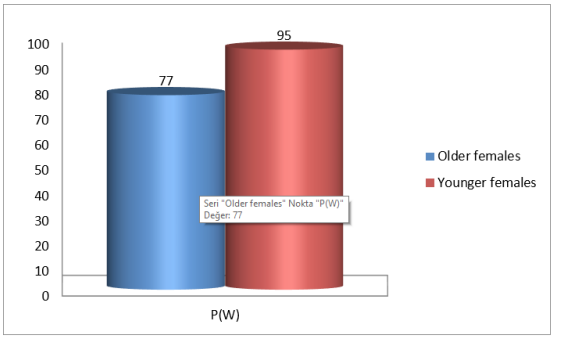

Figure 2: Display of values of dynamometric parameter Power

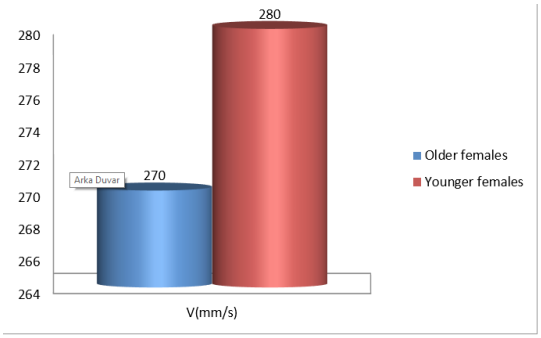

Figure 3: Display of values of the dynamometric parameter Velocity

Correlations between anthropometric parameters, ultrasound measurements and dynamometric parameters were investigated. A statistically significant positive correlation (r=0.78) (p<0.05) is shown between BFM percentage and BW. Furthermore, statistically significant positive correlations were found between the parameters of the ultrasonic measurement of biceps dimensions and BW (r=0.65) (p<0.05), between the values of the dimensions of biceps and subcutaneous adipose tissue (r=0.38) (p<0.05), between the values of the dimensions of biceps and the mean value of muscular strength measured on a dynamometer (r=0.37) (p<0.05), between BW and the mean value of muscular strength (r=0.49) (p<0.05), between the BH and the mean value of the muscular strength (r=0.35) (p<0.05). There was also a statistically significant positive correlation between the BFM percentage and the ultrasound measurement of the biceps (r=0.57) (p<0.05), as well as the statistically significant correlation between the BFM percentage and the ultrasound measurement of the subcutaneous adipose tissue (r=0.55) (p<0.05).

Table 3: Display of correlation of the measured parameters in participants(*p< 0.05)

	BW	*BH*	*BF*	*UL BICEPS*	*UL ADIPOSE TISSUE*	*CALIPER*
BF	0.78*	-0.25		0.57*	0.55*	-0.23
US BICEPS	0.65*	-0.04	0.57*		0.38*	-0.04
US ADIPOSE TISSUE	0.38*	-0.43*	0.55*	0.38*		-0.30
AVE	0.49*	0.35*	0.12	0.37*	-0.17	0.07

DISCUSSION

Anthropometric characteristics, parameters of the biceps muscle strength and the ultrasonic measurement of the dimensions of the biceps and the subcutaneous adipose tissue can be used to estimate the physical development of muscles, amount of BFM and muscle mass in humans.

Brightness-mode (B-mode) ultrasonography has the same advantage as CT or MRI in visualizing fat and muscle tissues and has been successfully used to evaluate muscle thickness in an older population. In addition B-mode muscle thickness measurements are easily applicable in clinical and field surveys with no dangerous effects and measured values can be significant predictors of limb muscle volume (6).

By analyzing the results of the entire sample, the existence of age differences was established in ultrasound measurements in terms of dimensions of biceps and thickness of subcutaneous adipose tissue. The dimensions of adipose tissue around biceps are about 0.2 mm higher in the group of the older women for than in the younger women and also the dimensions of biceps are higher in the group of the older women about 3mm higher compared to the younger women.

Abe et al. (7) compared muscle loss between young and old Japanese women and they had found a higher average value of biceps muscle thickness in older women. The results of their cross-sectional study showed that muscle size of biceps was greater in older women than in younger women which may be considered as incompatible with our study.

Volz et al. (8) used portable ultranoscope in assessing the body composition of college-age women and the mean value of dimensions of biceps on ultrasound in their study is 5.7mm. In their study, they found a highly significant negative correlation (r=-0.54) between dimension of biceps and body density, while in our study there was a positive correlation between BFM percentage and the ultrasound measurement of biceps (r=0.57) (p<0.05).

Dynamometry is a simple method for assessing various aspects of power. The measurements are simple and comfortable to perform. By dynamometric measurements, we found that there was a difference in strength of the biceps between two examined groups. There was also a higher mean value of muscular strength in younger women compared to older women. There was a positive correlation (r=0.49) (p<0.05) between the parameters of the BW and the mean value of muscular strength and also there was a positive correlation (r=0.35)

($p<0.05$) between BH and the mean value of muscular strength. Thus, we can conclude that if values of BW and BH in a participant are greater, it could be assumed that the value of their power in biceps will be greater.

Tibana et al. (9) carried out their study on overweight/obese women who did resistance training for strength testing. They compared their results of resistance training after eight weeks and there were no statistically significant differences on total muscle mass and biceps muscle thickness.

Bioelectrical impedance was used for the measurements of BFM and older women, compared to younger women, had greater BFM. A positive correlation($r=0.57$) ($p<0.05$) was established between BF and the ultrasound measurement of biceps.

Abe et al. (7) estimated percent BFM from subcutaneous fat thickness by using an ultrasound derived prediction equation and fat-free mass was calculated. As a result, there was no difference in fat free mass between younger and older women, in their study.

Consequently in this study, it is determined that the representation of adipose tissue increases over years, while the muscle strength of biceps declines during aging.

Ethics Committee Approval: This study was approved by Scientific Researches ethics committee of Novi Sad University Faculty of Medicine.
Informed Consent: Written informed consent was obtained from the participants of this study.
Conflict of Interest: The authors declared no conflict of interest.
Financial Disclosure: The authors declared that this study received no financial support.

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