

**SEX DIMORPHISM OF HAND-GRIP ENDURANCE IN HEALTHY AND YOUNG PERSONS**

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**Abstract**

The aim of this work is to determine sex dimorphism in endurance of hand grip force in referent population of healthy and young persons. In the study participated 48 examinees, among whom 23 were women and 25 were men. Muscle force of hand's musculus flexor was measured by using the method of isometric dynamometry, where we used the standard hand grip-test. By multivariant analysis we determined that there is a significant difference between men and women in endurance of hand grip force, in relation to parameters of force level ( $F_{max}$ ,  $F_{80\%max}$ ,  $F_{50\%max}$  and  $F_{30\%max}$ ), for Wilk's Lambda 0.082,  $F=189.439$ ,  $p=0.000$ , so as for the time aspect of expressing the given force ( $tF_{80\%max}$ ,  $tF_{50\%max}$  and  $tF_{30\%max}$ ), for Wilk's Lambda 0.270,  $F=13.533$ ,  $p=0.000$ , and for parameters of force momentum as a direct endurance measure ( $ImpF_{80\%max}$ ,  $ImpF_{50\%max}$  i  $ImpF_{30\%max}$  and  $ImpF_{80\%rel}$ ,  $ImpF_{50\%rel}$  and  $ImpF_{30\%rel}$ ) for Wilk's Lambda 0.373,  $F=8.42$ ,  $p=0.000$  and Wilk's Lambda 0.406,  $F=7.33$ ,  $p=0.000$ , respectively. Our results can be used as a criteria in analytics and diagnostics by evaluation of physical abilities in different populations, so as in sports.

**Key words:** sex dimorphism, force endurance, hand grip

**Introduction**

With regards to basic physical i.e. motor abilities, in humans contractile ability represent the basic capability for moving, because without muscle contractions there is no movement (in dynamic conditions) or attempt of movement (in static conditions).

From aspects of metrologic procedures in physical education and sport i.e. of procedures of analytics and diagnostics of physical capabilities in healthy population and sportsmen (Mijanović & Vojvodić, 2010; Malý et al., 2010) muscle force is measured by dynamometry, and in isometric conditions of tension (Dopsaj et al., 2010). Many authors have studied the assessment of hand grip and characteristics of maximal isometric muscle force (Demura et al., 2003; Müller et al., 2000), so as the definition of basic parameters descriptive, functional and sex dimorphism in well-trained sportsmen (Dopsaj et al., 2007, Ivanović et al., 2009; Malý et al., 2010).

Also, the evaluation of hand grip force characteristics is used for the assessment of duration and quality of recovering after acute and chronic illnesses of neurogenic origin (Jaric et al., 2005) and in relation to the age (Ait-Said et al., 2007). The subject of this study was to examine the contractile abilities of hand as a basic manipulative organ especially form aspects of parameters in hand grip endurance. The aim of this study was to determine the characteristics of sex dimorphism of endurance in expressing the hand grip force in referent population of healthy and young persons.

**Methods***Samples*

The sample included 48 examinees, among whom 23 were women (Age=20.39±3.79, BH=170.37±5.04 cm, BW=61.87±3.87 kg, BMI=21.32±1.13 kg/m<sup>2</sup>) and 25 were men (Age=20.06±2.33, BH=181.02±5.23 cm, BW=82.04±5.09 kg, BMI=25.05±1.46 kg/m<sup>2</sup>). The examinees were the students of the University of Belgrade who were not regularly involved in any sport. They were familiar with the conditions of the testing and they participated voluntarily.

*Measuring method*

The force of hand's musculus flexor is measured by using isometric dynamometry where we used the standard hand grip-test (Dopsaj et al., 2009; Ivanović et al., 2009). This test was conducted in two parts (in the morning and in the afternoon) when the examinees, by random method, measured the capacity of maintaining the required hand grip force in both hands in the function of the given expression level in accordance with the procedure described previously (Dopsaj et al., 2011).

*Variables*

Contractile characteristics from general aspect, so as from aspect of endurance in force are defined by using following variables: Parameters of manifested muscle force level - Maximal muscle hand grip force in left and right hand in relation to sex (Female i Male) -  $F_{maxL}$  i  $F_{maxR}$ , expressed in N. Levels of hand grip muscle force in both hands at 80%, 50% and 30% of the maximal value for hand grip in both hands  $F_{80\%maxL}$ ,  $F_{50\%maxL}$ ,  $F_{30\%maxL}$ ,  $F_{80\%maxR}$ ,  $F_{50\%maxR}$  and  $F_{30\%maxR}$ , expressed in N.

Time aspects of achieving the required force level -

- Time of realization the hand grip muscle force with both hands at 80%, 50% and 30% of the maximal hand grip force value -  $tF_{80\%L}$ ,  $tF_{80\%R}$ ,  $tF_{50\%L}$ ,  $tF_{50\%R}$ ,  $tF_{30\%L}$  and  $tF_{30\%R}$ , expressed in seconds (s).

Absolute values of force endurance parameters -

- Momentum of hand grip muscle force in left and right hands at 80%, 50% and 30% of the maximal hand grip force -  $ImpF_{80\%RELL}$ ,  $ImpF_{80\%RELR}$ ,  $ImpF_{50\%RELL}$ ,  $ImpF_{50\%RELR}$ ,  $ImpF_{30\%RELL}$  and  $ImpF_{30\%RELR}$ , expressed in Newtonseconds per kg of BW ( $Ns^{-kg}$ ).

Relative values of force endurance parameters -

- Relative value of force endurance parameters in left and right hand at 80%, 50% and 30% of the maximal hand grip force -  $ImpF_{80\%RELL}$ ,  $ImpF_{80\%RELR}$ ,  $ImpF_{50\%RELL}$ ,  $ImpF_{50\%RELR}$ ,  $ImpF_{30\%RELL}$  and  $ImpF_{30\%RELR}$ , expressed in Newtonseconds per kg of BW ( $Ns^{-kg}$ ).

Sex dimorphism is defined as an index relation of analyzed force characteristics - time of expressing the required force and force momentum, in both non-dominant and dominant hand, between tested men and women, and it is represented by following variables:

- Relation between measured force levels -  $F_{80\%maxLFemale/Male}$  and  $F_{80\%maxRFemale/Male}$ ;  $F_{50\%maxLFemale/Male}$  and  $F_{50\%maxRFemale/Male}$ ;  $F_{30\%maxLFemale/Male}$  and  $F_{30\%maxRFemale/Male}$ .
- Relation between time of expressing the muscle force at 80% out of  $F_{max}$  -  $tF_{80\%LFemale/Male}$  and  $tF_{80\%RFemale/Male}$ , at 50% out of  $F_{max}$  -  $tF_{50\%LFemale/Male}$  and  $tF_{50\%RFemale/Male}$ , and at 30% out of  $F_{max}$  -  $tF_{30\%LFemale/Male}$  and  $tF_{30\%RFemale/Male}$ .
- Relation between absolute value of muscle force momentum at 80% out of  $F_{max}$  -  $ImpF_{80\%LFemale/Male}$  and  $ImpF_{80\%RFemale/Male}$ , at 50% out of  $F_{max}$  -  $ImpF_{50\%LFemale/Male}$  and  $ImpF_{50\%RFemale/Male}$ , and at 30% out of  $F_{max}$  -  $ImpF_{30\%LFemale/Male}$  and  $ImpF_{30\%RFemale/Male}$ .

Relation between relative value of muscle force momentum at 80% out of  $F_{max}$  -  $ImpF_{80\%RELLFemale/Male}$  and  $ImpF_{80\%RELRFemale/Male}$ , at 50% out of  $F_{max}$  -  $ImpF_{50\%RELLFemale/Male}$  and  $ImpF_{50\%RELRFemale/Male}$ , and at 30% out of  $F_{max}$  -  $ImpF_{30\%RELLFemale/Male}$  and  $ImpF_{30\%RELRFemale/Male}$ .

#### Statistical analysis

At the first, all the results were analyzed using descriptive method where we calculated: values of central tendency (mean value of variable - MEAN), and dispersion values (standard deviation - SD, variation coefficient -cV%). For the determination of differences between groups of variables in the function of sex and functional dimorphism we used the multivariate *analysis* of variance (MANOVA), while for the determination of differences between pairs of individual variables we used Bonferoni criterion. All statistic analyses were done by the application of software package Excel 2003 and SPSS Win 17.0.

## Results and discussion

Table 1 shows the results of basic descriptive statistics of variables of muscle force, time and sexual dimorphism index between subjects. The results of this study showed that the level of  $F_{max}$  of tested sample for the left and right hand was  $287.26 \pm 34.66$  N and  $314.79 \pm 36.22$  N in girls and  $570.31 \pm 60.28$  N and  $609.99 \pm 56.07$  N in men (Table 1). Compared to other studies in this field it can be determined that the male subjects had a value of maximum hand grip of the dominant hand for 23.18% higher than the Japanese students in which he was 495.2 N, and less for 12.13 % than the female subjects 12.13 %, where  $F_{max}$  was 353 N (Demura et al., 2003). The study which involved students from the Republic of Croatia (Markovic et al., 2004) determined the average hand grip force of 534 N, which is also less compared to the results of our examinees. In relation to the maximum value of the hand grip the sexual dimorphism index in our study was 0.5037 for the left hand and 0.5161 for the right hand, so that female examinees had for 98.53% lower values of maximum hand grip for the left hand compared to the male examinees, and 93.78% lower values of maximum hand grip in the right hand. When we compare our results with those from 2007 (Dopsaj et al., 2007) where the index of sexual dimorphism of maximum hand grip for the left hand was 0.5829, and 0.5922 for the right, we see that our subjects had a lower index value of sexual dimorphism, as follows: in left hand for 15.72% and in right hand for 14.74%. The study from 2009 (Dopsaj et al., 2009) determined sexual dimorphism of the maximum hand grip for the left hand 0.5228 and 0.5940 for the right hand, which is also higher compared to our results, in relation to the left hand higher for 3.79% and to the right hand for 15.09%. From our research it can be seen that male respondents had a greater maximum grip force in comparison to women, but that the female examinees had more endurance in terms of time when it comes to force of submaximal values (Table 1). All of these time intervals are statistically different between men and women tested at the level of  $p = 0.000$  (Table 4). It is believed that men always produce more force than women because of greater muscle mass and body weight (Imrhan, 2003; Pebles & Norris, 2003). However, more research has proven that women are more durable than men, and show less fatigue while maintaining the required submaximal level of force, in relation to the level of 30-75% of maximum hand grip (West et al., 1995) and intermittently maintaining 50% of contraction of the adductor pollicis (Fulco et al., 1999) which is in line with our research. In relation to the absolute value of force momentum women had higher values than men as follows (Table 2): in left hand for 6.27% - the value of force momentum at 80% out of  $F_{max}$  (5438.46 vs. 5117.53 Ns) and 19.36% - value of force momentum at 30% out of  $F_{max}$  (21167.58 vs 17734.03 Ns), and in right hand for 16.92% higher values of force momentum at 30% of  $F_{max}$  (21790.67 vs 18637.08 Ns).

Table 1 Basic descriptive statistics of variables of muscle force and time

|               | F <sub>maxL</sub> (N) | F <sub>80%L</sub> (N) | tF <sub>80%L</sub> (S) | F <sub>50%L</sub> (N) | tF <sub>50%L</sub> (S) | F <sub>30%L</sub> (N) | tF <sub>30%L</sub> (S) | F <sub>maxR</sub> (N) | F <sub>80%R</sub> (N) | tF <sub>80%R</sub> (S) | F <sub>50%R</sub> (N) | tF <sub>50%R</sub> (S) | F <sub>30%R</sub> (N) | tF <sub>30%R</sub> (S) |
|---------------|-----------------------|-----------------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|-----------------------|-----------------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|
| Female (N=23) |                       |                       |                        |                       |                        |                       |                        |                       |                       |                        |                       |                        |                       |                        |
| MEAN          | 287.26                | 229.81                | 23.69                  | 143.63                | 74.42                  | 86.18                 | 244.90                 | 314.79                | 251.84                | 23.30                  | 157.40                | 74.94                  | 94.44                 | 230.62                 |
| SD            | 34.66                 | 27.73                 | 8.05                   | 17.33                 | 21.62                  | 10.40                 | 68.23                  | 36.22                 | 28.97                 | 9.35                   | 18.11                 | 23.81                  | 10.87                 | 65.51                  |
| cV%           | 12.07                 | 12.07                 | 34.00                  | 12.07                 | 29.05                  | 12.07                 | 27.86                  | 11.51                 | 11.51                 | 40.14                  | 11.51                 | 31.77                  | 11.51                 | 28.41                  |
| Male (N=25)   |                       |                       |                        |                       |                        |                       |                        |                       |                       |                        |                       |                        |                       |                        |
| MEAN          | 570.31                | 456.25                | 11.19                  | 285.16                | 49.03                  | 171.09                | 102.39                 | 609.99                | 487.99                | 12.08                  | 305.00                | 55.12                  | 183.00                | 100.80                 |
| SD            | 60.28                 | 48.23                 | 3.64                   | 30.14                 | 11.20                  | 18.09                 | 33.71                  | 56.07                 | 44.85                 | 6.25                   | 28.03                 | 9.69                   | 16.82                 | 31.67                  |
| cV%           | 10.57                 | 10.57                 | 32.53                  | 10.57                 | 22.84                  | 10.57                 | 32.92                  | 9.19                  | 9.19                  | 51.68                  | 9.19                  | 17.57                  | 9.19                  | 31.42                  |
| Index         |                       | 0.5037                | 2.1174                 | 0.5037                | 1.5180                 | 0.5037                | 2.3917                 |                       | 0.5161                | 1.9279                 | 0.5161                | 1.3597                 | 0.5161                | 2.2879                 |

Table 2 Basic descriptive statistics of variables of absolute and relative indicators of force momentum and sexual dimorphism between subjects.

|               | ImpF <sub>80%L</sub> (Ns) | ImpF <sub>50%L</sub> (Ns) | ImpF <sub>30%L</sub> (Ns) | ImpF <sub>80%R</sub> (Ns) | ImpF <sub>50%R</sub> (Ns) | ImpF <sub>30%R</sub> (Ns) | ImpF <sub>80%EL</sub> (Ns/kg) | ImpF <sub>50%EL</sub> (Ns/kg) | ImpF <sub>30%EL</sub> (Ns/kg) | ImpF <sub>80%ELR</sub> (Ns/kg) | ImpF <sub>50%ELR</sub> (Ns/kg) | ImpF <sub>30%ELR</sub> (Ns/kg) |
|---------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Female (N=23) |                           |                           |                           |                           |                           |                           |                               |                               |                               |                                |                                |                                |
| MEAN          | 5438.46                   | 10846.94                  | 21167.58                  | 5846.98                   | 11861.24                  | 21790.67                  | 88.66                         | 175.97                        | 344.20                        | 94.92                          | 192.73                         | 353.96                         |
| SD            | 1993.12                   | 3800.56                   | 6923.67                   | 2378.13                   | 4201.56                   | 6896.99                   | 33.78                         | 60.72                         | 112.76                        | 38.96                          | 67.53                          | 111.56                         |
| cV%           | 36.65                     | 35.04                     | 32.71                     | 40.67                     | 35.42                     | 31.65                     | 38.10                         | 34.50                         | 32.76                         | 41.05                          | 35.04                          | 31.52                          |
| Male (N=25)   |                           |                           |                           |                           |                           |                           |                               |                               |                               |                                |                                |                                |
| MEAN          | 5117.53                   | 13903.61                  | 17734.03                  | 5946.22                   | 16823.84                  | 18637.08                  | 62.67                         | 170.13                        | 215.53                        | 73.60                          | 205.96                         | 227.55                         |
| SD            | 1894.78                   | 3437.76                   | 6881.92                   | 3123.38                   | 3533.24                   | 6876.53                   | 23.00                         | 40.00                         | 77.28                         | 40.85                          | 41.63                          | 81.22                          |
| cV%           | 37.03                     | 24.73                     | 38.81                     | 52.53                     | 21.00                     | 36.90                     | 36.70                         | 23.51                         | 35.86                         | 55.51                          | 20.21                          | 35.69                          |
| Index         | 1.0627                    | 0.7802                    | 1.1936                    | 0.9833                    | 0.7050                    | 1.1692                    | 1.4147                        | 1.0344                        | 1.5970                        | 1.2898                         | 0.9358                         | 1.5555                         |

Table 3 MANOVA results of the tested variables

| Effect - Pol  | Wilks' Lambda Value | F      | Hypothesis df | Error df | p value |
|---|---------------------|--------|---------------|----------|---------|
| Differences F <sub>max</sub> , F80%, F50% and F30% M vs F                                     | 0.082               | 189.44 | 2.00          | 34.00    | 0.000   |
| Differences tF80%, tF50% and tF30% M vs F   | 0.270               | 13.53  | 6.00          | 30.00    | 0.000   |
| Differences ImpF80%, ImpF50% and ImpF30% M vs F   | 0.373               | 8.42   | 6.00          | 30.00    | 0.000   |
| Differences ImpF <sub>80%rel</sub> , ImpF <sub>50%rel</sub> and ImpF <sub>30%rel</sub> M vs F | 0.406               | 7.33   | 6.00          | 30.00    | 0.000   |

Table 4 MANOVA results of the tested variables by group.

| Dependent Variable   | Type III Sum of Squares | df | Mean Square | F      | Sig.  |
|--|-------------------------|----|-------------|--------|-------|
| <i>Differences F<sub>max</sub>, F80%, F50% and F30% M vs F</i>                                   |                         |    |             |        |       |
| F <sub>max</sub> Left  | 740568.96               | 1  | 740568.96   | 301.95 | 0.000 |
| F80% Left  | 473956.32               | 1  | 473956.32   | 301.95 | 0.000 |
| F50% Left  | 185138.47               | 1  | 185138.47   | 301.96 | 0.000 |
| F30% Left  | 66651.42                | 1  | 66651.42    | 301.96 | 0.000 |
| F <sub>max</sub> Right   | 805478.80               | 1  | 805478.80   | 357.40 | 0.000 |
| F80% Right   | 515506.43               | 1  | 515506.43   | 357.40 | 0.000 |
| F50% Right   | 201369.70               | 1  | 201369.70   | 357.40 | 0.000 |
| F30% Right   | 72493.09                | 1  | 72493.092   | 357.40 | 0.000 |
| <i>Differences tF80%, tF50% and tF30% M vs F</i>   |                         |    |             |        |       |
| tF80% Left   | 1444.17                 | 1  | 1444.17     | 37.70  | 0.000 |
| tF50% Left   | 5960.95                 | 1  | 5960.95     | 20.45  | 0.000 |
| tF30% Left   | 187703.82               | 1  | 187703.82   | 65.96  | 0.000 |
| tF80% Right  | 1161.99                 | 1  | 1161.99     | 18.59  | 0.000 |
| tF50% Right  | 3632.10                 | 1  | 3632.10     | 11.23  | 0.000 |
| tF30% Right  | 155775.87               | 1  | 155775.87   | 59.90  | 0.000 |
| <i>Differences ImpF80%, ImpF50% and ImpF30% M vs F</i>   |                         |    |             |        |       |
| ImpF80% Left   | 952021.16               | 1  | 952021.16   | 0.25   | 0.619 |
| ImpF50% Left   | 8.636E7                 | 1  | 8.636E7     | 6.60   | 0.015 |
| ImpF30% Left   | 1.090E8                 | 1  | 1.090E8     | 2.29   | 0.139 |
| ImpF80% Right  | 91034.43                | 1  | 91034.43    | 0.01   | 0.914 |
| ImpF50% Right  | 2.276E8                 | 1  | 2.276E8     | 15.18  | 0.000 |
| ImpF30% Right  | 9.193E7                 | 1  | 9.193E7     | 1.94   | 0.173 |
| <i>Differences ImpF<sub>80%rel</sub>, ImpF<sub>50%rel</sub> and ImpF<sub>30%rel</sub> M vs F</i> |                         |    |             |        |       |
| ImpF <sub>80%rel</sub> Left  | 6246.21                 | 1  | 6246.21     | 7.56   | 0.009 |
| ImpF <sub>50%rel</sub> Left  | 315.82                  | 1  | 315.82      | 0.12   | 0.730 |
| ImpF <sub>30%rel</sub> Left  | 153016.80               | 1  | 153016.80   | 16.55  | 0.000 |
| ImpF <sub>80%rel</sub> Right   | 4203.57                 | 1  | 4203.57     | 2.64   | 0.114 |
| ImpF <sub>50%rel</sub> Right   | 1617.71                 | 1  | 1617.71     | 0.52   | 0.475 |
| ImpF <sub>30%rel</sub> Right   | 147695.60               | 1  | 147695.60   | 15.65  | 0.000 |

In relation to relative indicators of force momentum (Figure 2), the biggest difference in favor of female examinees was in the value of force momentum at 30% out of Fmax and it was for the left hand 59.7% higher than in the male subjects i.e. 55.55% compared to the right hand. The smallest difference between the examinees was in the level of relative indicator of force momentum at 50% out of Fmax, in relation to the left hand women were better for 3.43%, and compared to the right hand men were better for 6.86%.

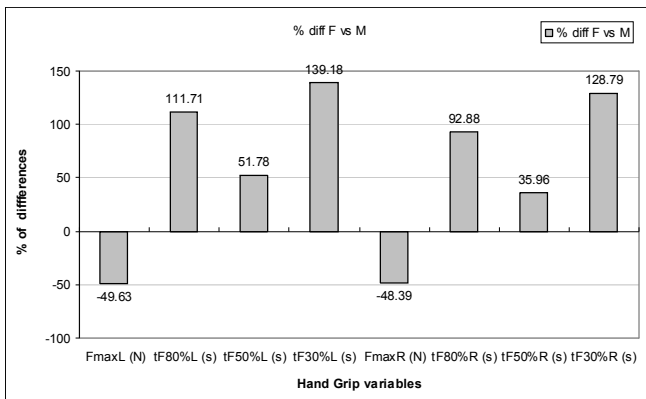


Figure 1 Illustration of differences (in %) between characteristics of Fmax and time of the hand grip endurance in tested subjects in the function of sex.

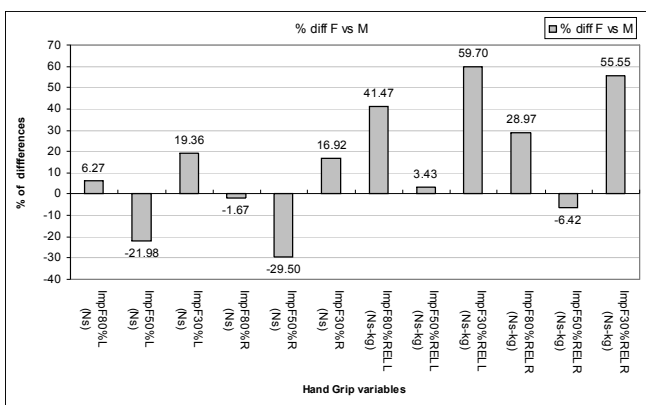


Figure 2. Illustration of difference (in %) between characteristics of Impf (absolute and relative values) in the hand grip of the test subjects in the function of sex

The reason why women have more endurance than men can be this lower maximal force with which women perform the same action as the men, including a smaller demand for oxygen, and the greater availability of oxygen and metabolic byproducts clearance, which contributes to delay fatigue. Some authors argue that the difference between the sexes in different neuromuscular activation, i.e. that the greater endurance in women is related to the changing of muscle activation pattern (Hicks et al., 2001).

## Conclusion

This study aimed to determine sexual dimorphism in the endurance of hand grip force in the population of healthy and young people. The results showed that the index of sexual dimorphism in relation to the maximum value of the hand grip force endurance among our examinees for the left hand was 0.5037, compared to the right hand where it was 0.5161. In relation to the time aspect of expressing the force, sexual dimorphism index while maintaining the force at 80% out of Fmax for the left hand was 2.1174, and 1.9279 for the right hand. Sexual dimorphism index as compared to the endurance time of required force level of 50% out of Fmax for the left hand was 1.518, and 1.3597 for the right hand, while for maintaining the specific level of force at 30% out of Fmax for the left hand was 2.3917, and for the right 2.2879 hand. Multivariate analysis showed that there is a significant difference between the sexes for maximum hand grip endurance, which is Wilks' Lambda Value 0.082,  $F = 189.44$ ,  $p = 0.000$ , for the time aspect of the expression of force is Wilks' Lambda Value 0.270,  $F = 13.53$ ,  $p = 0.000$ , for absolute values of force momentum is Wilks' Lambda Value 0.373,  $F = 8.42$ ,  $p = 0.000$  and for relative values of force momentum (Wilks' Lambda Value 0.406,  $F = 7.33$ ,  $p = 0.000$ ). The results can be used as criteria for further research in the field of kinesiology, anthropometrics, in assessment of physical abilities in different populations of individuals, in relation to applied but different training methods in sport or in convalescents with injuries of the upper extremities etc.

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## SPOLNI DIMORFIZAM IZDRŽLJIVOSTI STISKA ŠAKE KOD ZDRAVIH MLADIH OSOBA

### Sažetak

Cilj ovog rada je utvrditi spolni dimorfizam izdržljivosti u sili stiska šake kod referentne populacije zdravih i mladih osoba. U istraživanju je sudjelovalo 48 ispitanika, i to 23 ispitanika ženskog i 25 ispitanika muškog spola. Mišićna sila pregibača prstiju šake je mjerena metodom izometričke dinamometrije, gdje je korišten standardizirani test - stisak šake. Multivarijantnom analizom je utvrđeno da postoji značajna razlika u izdržljivosti u sili stiska šake između ženskog i muškog spola, i to u odnosu na parametre razine sile ( $F_{max}$ ,  $F_{80\% max}$ ,  $F_{50\% max}$  i  $F_{30\% max}$ ) za Wilks 'Lambda 0.082,  $F = 189.439$ ,  $p=0.000$ , za vremenski aspekt iskazivanja date sile ( $tF_{80\% max}$ ,  $tF_{50\% max}$  i  $tF_{30\% max}$ ) za Wilks 'Lambda 0.270,  $F=13.533$ ,  $p=0.000$ , te za parametre impulsa sile kao direktne mjere izdržljivosti ( $ImpF_{80\% max}$ ,  $ImpF_{50\% max}$  i  $ImpF_{30\% max}$  i  $ImpF_{80\% rel}$ ,  $ImpF_{50\% rel}$  i  $ImpF_{30\% rel}$ ) za Wilks 'Lambda 0.373,  $F = 8.42$ ,  $p = 0.000$  i Wilks' Lambda 0.406,  $F=7.33$ ,  $p=0000$ , respektivno. Dobiveni rezultati mogu koristiti kao kriteriririji u analitici i dijagnostici pri procjeni fizičkih sposobnosti kod različite populacije ljudi, kao i u sportu.

**Ključne riječi:** spolni dimorfizam, izdržljivost u snazi, stisak šake

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