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DIFFERENCES IN SPIROMETRIC PARAMETERS BETWEEN TAEKWONDO COMPETITORS

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Abstract
The basic aim of this research was to determine the differences in spirometric parameters between Croatian taekwondo competitors, medal winners at the state, European and World championships, and those competitors who did not win a medal at the mentioned competitions. The research was conducted on 54 (32 female, 22 male) Croatian taekwondo competitors. Besides the basic morphological measures, chronological age and training experience, the forced vital capacity (FVC) was measured, as well as forced expiratory volume in the first second (FEV1), Tiffeneau index (FEV1/FVC), medium part of the expiratory curve (FEF25-75) and forced expiratory flows at 50 % FVC (FEF50) and 25% FVC (FEF25).The differences between the groups of examinees were determined using the independent samples t-test. Statistically significant differences in spirometric parameters were obtained in the taekwondo competitors subsamples, and the differences were strongly emphasized in male competitors. The training process strengthens and causes the hypertrophy of the breathing muscles, as well as the increased conductivity of the airways, i.e., the increased ventilation function of the lungs. The mentioned differences are related to the growth of the total organism. As the size of the body increases, its need for oxygen increases, manifested by the increase of the size and the functions of the lungs. Since the medal winners were older, taller, heavier and had significantly longer training experience, the obtained results were expected.

Keywords: *function of the lungs, men, women, taekwondo, Croatia*

Introduction

Taekwondo is a polystructural acyclic sport dominated by fast techniques of kicks of the legs into the body and head of the opponent, while the hand kicks are allowed only towards the head of the opponent. The movements are performed in all three planes (Vučić, Čular, Milić, 2014).

According to the domination criteria of the energetic processes, taekwondo belongs to the group of high intensity anaerobic sports, characterized by fast and short actions. From the aerobic aspect, special energetic demands are set before the competitors by the need of participating in 4 or 5, and sometimes even more fights in one day of competition, with the aim of winning the gold medal (Čular, Krstulović, Tomljanović, 2011).

Aerobic abilities are the key to fast recovery between the rounds and matches at competitions. The high aerobic capacity positively influences faster recovery during and after the training, i.e., competition. Regarding the different energetic needs, the training process is conceived with the aim of developing all the energetic systems.

Research and studies related to taekwondo mostly cover the area of injuries, while the area of lung ventilation and functional diagnostics is barely covered. From the scientific point of view, the training of taekwondo athlete represents a great challenge to trainers, since taekwondo is, from the kinesiologic point of view, still a relatively unexplored area. In lack of relevant scientific research and cognitions, while planning and conducting training processes coaches still greatly depend on their own experience and traditional, unsubstantiated methods of preparing the competitors for the competition.

Based on the cited facts, the basic aim of this research was to determine the existence of differences in spirometric parameters between Croatian taekwondo competitors, winners of medals at state, European and World championships and those competitors who did not win a medal at the mentioned competitions.

Material and methods

The research was conducted on 54 Croatian taekwondo competitors. From the total number of examinees, 32 were women, and 22 men. Additionally, the examinees were divided into two groups: winners of medals at state, European and World championships and those competitors who did not win a medal at the mentioned competitions.

Except for the body height, body mass, chronological age and training experience, the following spirometric parameters were measured: forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), Tiffeneau index (FEV1/FVC), medium part of the expiratory curve (FEF25-75) and forced expiratory flows at 50 % FVC (FEF50) and 25% FVC (FEF25).

The dynamic spirometric examination was conducted in concordance with the recommendations of the American Thoracic Society (ATS, 1994), using the portable spirometer – microQuark PC Based Spirometer (Cosmed, Rome, Italy). The examinees sat with their nose clogged, and they performed three forced expiratory manoeuvres, as recommended by American Thoracic Society-ATS and European Respiratory Society-ERS.

The best of the three repeated forced expiratory measurements was used for the analysis. The results were expressed in relative values (percentage) in relation to the predicted values (Miller et al., 2005).

The data processing methods included the calculation of basic descriptive indicators: arithmetic mean (M), standard deviation (SD), Minimum (Min) and Maximum result (Max). Distribution normality was tested by the KS-test. The stability of the differences between the competitors who won the medals and those who did not was determined using the t-test for independent samples, and the data was processed by *Statistica Ver. 12.00* computer programme.

Results

Table 1 shows basic anthropological indicators of the examinees. It is obvious that there was a significant difference in all the measured parameters between the examinees who won the medal and those who did not win the medal at the competitions.

Table 1 Basic anthropological indicators of female competitors (N=32)

	Medallists (N = 10)				No medal (N = 22)			
Variables	M	Min	Max	SD	M	Min	Max	SD
Age (years)	15.26	12.94	19.10	1.98	11.53	10.08	13.75	0.85
Body weight (kg)	52.80	43.00	64.00	6.03	41.32	29.00	66.00	9.61
Body height (cm)	169.50	160.00	181.00	7.06	151.05	135.00	175.00	10.42
Experience (years)	6.60	3.00	10.00	2.12	2.91	2.00	5.00	1.02

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation

Table 2 shows basic anthropological indicators of male competitors (N=22)

	Medallists (N = 9)				No medal (N = 13)			
Variables	M	Min	Max	SD	M	Min	Max	SD
Age (years)	16.40	14.75	21.59	2.12	10.92	9.85	12.43	0.78
Body weight (kg)	62.00	49.00	84.00	10.05	37.85	28.00	55.00	6.79
Body height (cm)	176.00	167.00	186.00	5.85	147.15	135.00	162.00	7.83
Experience (years)	7.33	4.00	10.00	2.06	2.77	2.00	5.00	1.01

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation

Inspection of Table 3 shows that none of the variables exceeded the critical value of the K-S test and we can claim that they did not significantly deviate from normal distribution. Also, a very large span of the spirometric parameters results is noticed, which varies from the lower referent interval with mild ventilation obstructive difficulties, up to the above average values.

Table 3 Spirometric parameters of female medal winners (N=10)

Variables	M	Min	Max	SD	maxD	K-S p
FVC (%)	95.98	83.20	110.70	8.20	0.14	p > .20
FEV1 (%)	102.95	76.20	121.20	10.32	0.14	p > .20
FEV1/FVC (%)	105.96	91.30	113.30	6.01	0.17	p > .20
FEF25-75 (%)	112.95	81.10	157.60	22.50	0.11	p > .20
FEF50 (%)	105.09	72.40	151.20	22.89	0.09	p > .20
FEF25 (%)	142.09	79.60	187.40	30.77	0.14	p > .20

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation; max D – coefficient of the Kolmogorov-Smirnov test; K-S p - the level of significance of the K-S test coefficient

Table 4 shows that all the variables had normal distribution. The minimum values of spirometric parameters show mild restrictive difficulties and medium serious obstructive ventilation difficulties. The observed maximum values were above average.

Table 4 Spirometric parameters of female competitors without the medal (N=22)

Variables	M	Min	Max	SD	maxD	K-S p
FVC (%)	91.19	71.50	120.20	13.16	0.23	p > .20
FEV1 (%)	99.32	85.10	130.90	14.19	0.23	p > .20
FEV1/FVC (%)	106.29	95.70	112.10	5.30	0.23	p > .20
FEF25-75 (%)	110.94	70.10	152.90	26.75	0.19	p > .20
FEF50 (%)	107.30	66.30	147.20	26.33	0.21	p > .20
FEF25 (%)	109.55	61.80	158.90	29.25	0.13	p > .20

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation; max D – coefficient of the Kolmogorov-Smirnov test; K-S p - the level of significance of the K-S test coefficient

Table 5 shows descriptive indicators of spirometric parameters of male medallists. It is obvious that all the measured variables had the distribution that did not significantly deviate from the normal one. The minimum values of spirometric parameters are on the lower referent limit, while the maximum values are above average.

Table 5 Spirometric parameters of male medallists (N=9)

Variables	M	Min	Max	SD	maxD	K-S p
FVC (%)	98.72	80.80	115.10	11.10	0.19	p > .20
FEV1 (%)	110.81	82.40	127.30	13.65	0.18	p > .20
FEV1/FVC (%)	112.17	101.90	117.90	4.55	0.13	p > .20
FEF25-75 (%)	122.64	80.30	144.80	18.37	0.15	p > .20
FEF50 (%)	121.48	82.90	148.30	18.93	0.17	p > .20
FEF25 (%)	119.23	62.10	156.50	24.23	0.21	p > .20

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation; max D – coefficient of the Kolmogorov-Smirnov test; K-S p - the level of significance of the K-S test coefficient

Table 6 shows that all the used variables did not deviate significantly from normal distribution. The minimum values show restrictive and mild obstructive ventilation difficulties, while the maximum values are somewhat above the average of the norm value.

Table 6 Spirometric parameters of male competitors without the medal (N=13)

Variables	M	Min	Max	SD	maxD	K-S p
FVC (%)	90.89	67.90	102.80	11.64	0.26	p > .20
FEV1 (%)	93.69	79.30	99.40	6.66	0.23	p > .20
FEV1/FVC (%)	105.86	96.40	118.40	9.31	0.30	p > .20
FEF25-75 (%)	96.02	78.10	113.70	11.13	0.14	p > .20
FEF50 (%)	94.94	74.90	116.30	13.60	0.11	p > .20
FEF25 (%)	93.93	76.20	113.70	13.33	0.15	p > .20

Legend: M – mean; MIN – minimum result; MAX – maximum result; SD – standard deviation; max D – coefficient of the Kolmogorov-Smirnov test; K-S p - the level of significance of the K-S test coefficient

Table 7 shows the differences in spirometric parameters (determined by independent samples t-test) between Croatian female medallists and those without medals at state, European and World championships. The medal winners on average had higher values than the competitors without the medals. These differences were statistically significant in the FEF25 variable.

Table 7 Differences of spirometric parameters of female competitors

	Medallists (N = 10)		No medal (N = 22)		
	M	SD	M	SD	P
FVC (%)	95.98	8.20	91.19	13.16	0.217
FEV1 (%)	102.95	10.32	99.32	14.19	0.449
FEV1/FVC (%)	105.96	6.01	106.29	5.30	0.889
FEF25-75 (%)	112.95	22.50	110.94	26.75	0.826
FEF50 (%)	105.09	22.89	107.30	26.33	0.810
FEF25 (%)	142.09	30.77	109.55	29.25	0.009

Legend: M – mean; SD – standard deviation; p – independent samples t-test significance level

Table 8 shows that there were statistically significant differences between Croatian medallists and those who did not win a medal in 4 to 6 measured spirometric parameters. The medallists achieved significantly higher values in FEV1, FEF25-75, FEF50 and FEF25 parameters.

Table 8 Differences of spirometric parameters of male competitors

	Medallists (N = 9)		No medal (N = 13)		
	M	SD	M	SD	P
FVC (%)	98.72	11.10	90.89	11.64	0.126
FEV1 (%)	110.81	13.65	93.69	6.66	0.004
FEV1/FVC (%)	112.17	4.55	105.86	9.31	0.054
FEF25-75 (%)	122.64	18.37	96.02	11.13	0.001
FEF50 (%)	121.48	18.93	94.94	13.60	0.002
FEF25 (%)	119.23	24.23	93.93	13.33	0.010

Legend: M – mean; SD – standard deviation; p – significance level of the independent samples t-test

Discussion

Regarding the ± 20% of the accepted value as the acceptable level of normal values, we can conclude that the competitors of both genders had regular spirometic results. However, observing the minimum result values of both groups, we can notice serious difficulties of restrictive, obstructive and combined type in some individuals.

The obtained results of the morphological measures in female competitors in this research are congruent with previous findings (Marković, Mišigoj-Durakovićand Trninić, 2005; Čular, Erceg, Gabrilo., 2009). In both studies the female medallists were taller and heavier, compared to competitors without the medal.

Also, the anthropometry indicators results in male medallists are congruent with the results of previous studies (Čular et al., 2011; Čular et al., 2013). The medallists were taller and heavier, in relation to other competitors.

Observing the results of spirometric parameters in women, the results are somewhat unexpected. Although the medal winners were on average better in all the measured parameters, statistically significant difference was noticed only in FEF25 parameter.

The obtained results of spirometric parameter differences in male examinees were expected, the medallists were statistically significantly better in almost all measured parameters, which is congruent with the results of previous research (Čular et al., 2009; Erceg, Grgantov, Rađa, Milić, 2013).

The lung volume of athletes depends on the size of the body and it changes approximately in the same way as the height, until the age of 25. The mentioned changes are mostly expressed through widening of the existing alveoli and airways. Still, the influence of training on the respiratory system is significantly important. The exercises that demand high minute breathing volume encourage the growth and development of thorax in taekwondo competitors and the thorax becomes wider, longer and has more capacity. The so-called “sports lungs” develop a larger thorax, with larger air volume, and larger blood volume as well, and greater surface of lung alveoli. Further on, the training strengthens and causes the hypertrophy of the breathing muscles, as well as more economic breathing with lower frequency. In healthy people, the physical strain causes the increase of airways conductivity, i.e., the increase of the ventilation lung function. This effect of physical strain is based on the increase of the number of functionally active small airways and the dilatation of the bronchi and the bronchioles, and is probably the result of the decrease of the sympathicus tone. The conduct of taekwondo training during a prolonged period of time significantly improves the oxygen transport and usage system. The listed changes are related to growth of the total body. As the size of the body increases, its need for the oxygen increases as well, and this is manifested in the augmentation of lung size and function. Since the male medallists were older, taller, heavier and had significantly longer training status, the obtained results were expected.

Although, regarding the morphological measures, chronological age and training status, the situation in women was similar, the expected statistically significant differences in the spirometric parameters were not obtained. This can be explained by the fact that this sample did not show significant difference in chronological age and training status, or height and weight.

Conclusions

The basic aim of this research was to determine the existence of significant differences in spirometric parameters between the Croatian taekwondo competitors, winners of medals at the state, European and World championships, and the competitors who did not win any medal at the mentioned championships.

The observed subsamples of taekwondo competitors showed statistically significant differences in the spirometric parameters between the medal winners and other competitors. Those differences were more expressed in male competitors. It is well known that training strengthens and causes the hypertrophy of the breathing muscles, as well as the increase of the airways conductivity, i.e., the increase of the ventilation lung function. The medal winners in both subsamples of examinees had more experience in the training process, which explains the obtained differences.

The number of examinees should be increased in future research, and the smoking and passive smoking questionnaire should be conducted, as well as allergy and asthma status, because partial results indicate the potential existence of the mentioned lung diseases.

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