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Intentional dehydration of taekwondo practitioners in relation to their stamina and motor skills level

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Key words: combat sports, body weight reduction, dehydration, motor skills

Abstract

Introduction. In sports where competitors are divided into weight classes, a problem of obtaining the desired body mass on the competition day occurs. This issue is present primarily in martial arts, with an exception of fencing. Therefore, adjusting body mass is a component of the training process and happens cyclically due to participation in tournaments (Sterkowicz, 2006). These procedures are used most frequently before competitions in order to fit into the limits of a lower or higher weight class (Sterkowicz et al., 2005). Taekwondo tournaments participants are divided into weight classes, just like is wrestling, judo, and other martial arts. The purpose of the division is to ensure fairness of the fights by selecting opponents of similar morphological and physiological characteristics. Nonetheless, decreasing body mass for the purpose of qualifying into the lower weight class is a frequent phenomenon (Janiszewska et al., 2012). A large percentage of the competitors reduces body mass during the short period preceding the official weighting before a tournament, then go back to the

natural body mass during the several hours before the tournament starts (Kazemi, 2005; Fleming, 2009). It is possible that the competitors reduce body mass as a result of discarding excessive fat reserves in specific body parts. However, very frequently it is competitors of very low fat body content rapidly reducing body mass before a tournament solely through dehydration, since it is the only way to qualify to the lower weight class (Shirreffs, 2009). Rapid and quick body mass reduction leading to dehydration, however, is not without influence on body functions. Reports on the problem suggest that occurring negative physiological consequences result in motor skill changes. Nonetheless, there are no reports unequivocally naming the type of motor skills connected to dehydration.
Thus, the purpose of the paper was to determine the influence of intentional dehydration on the level of the following motor skills: stamina (strength), coordination (simple reaction time and upper limb movement speed), and speed of taekwondo practitioners.

Introduction

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Material and method

Research material

10 taekwondo practitioners (4 women and 6 men) participated in the research. They are are members of Polish National Team, who succeed in international competitions. The age of research subjects was between 17 and 25. The average training experience equalled 5.7 years (5.5 years for women and 5.8 years for men). Some of the research subjects are champions of the most prestigious tournaments, such as Polish Championship, European Championship, World Championship, World Cup, International Championships and Matches. Other research subjects (60%) are practitioners with less achievements, who do not belong to the National Team.

Research method

The research was conducted before an international tournament, during the period of direct preparation to the competition. Measurements were taken twice – before and after the short-term body mass reduction. Each of the test subjects reduced body mass via body dehydration according to their own body mass reduction schedule which is used or had been used during preparation to a competition.

The data was gathered using a short questionnaire, in which the subject filled in their name, surname, and date of birth. The next part of the questionnaire contained questions regarding the sport itself: training experience, proficiency level, and achievements. The next research stage consisted of measurements of height (conducted with a Swiss anthropometer) and body mass (measured on electric scales). Body mass components (body fat tissue and hydration level) were measured with the BIA method. The following motor skills tests were then conducted:

- arm muscle strength using Jamar hydraulic hand dynamometer,
- maximum force moment of lower limb flexor and extensor muscles (quadriceps femoris muscle) using Biodex,
- stomach muscles – test: sit-ups – maximum number of sit-ups in 30 s,

- explosive strength - test: standing long jump
- simple reaction time to visual stimuli using Vienna Test System module,
- movement speed - test: upper limb tapping test.

Statistical analysis method

After testing distribution normality with the Shapiro-Wilk test, which determined lack of basis to reject the normal distribution hypothesis, basic statistical characteristics were calculated: averages and standards deviations. Comparisons of averages between the first and the second measurement of the whole group were conducted using variant analysis with repeated measurements. NIR tests were used for statistical evaluation of difference significance in detailed comparisons. Significance level of $a=0.05$ was assumed. Calculated probability $p<0.05$ was determined as statistically significant and therefore bolded in the tables. Calculations were conducted using StatSoft Statistica 10 software.

Results

Table 1 presents the basic statistics descriptions of results obtained in two measurements of men and women: before and after body mass reduction. Groups of both men and women, despite their low numbers, were very uniform groups in terms of basic somatic features and slightly less uniform in terms of analysed body mass components. Particularly high variability was noted in fat tissue percental content. Variability of all somatic parameters was slightly higher among women than among men. Considerably more varied, both among men and women, were motor skills test results. Among them, in the case of both sexes, the highest dispersion was noted in results of force moment of quadriceps femoris muscle (knee joint flexor) (tab. 1). Variability of most results increased in the second measurement.

Table 1. Statistics descriptions of analysed variables before and after in the group of men and women.

	Men				Women			
	Before reduction		After reduction		Before reduction		After reduction	
Variable	średnia	SD	średnia	SD	średnia	SD	średnia	SD
Body height	177,63	7,03	-		166,75	8,66		-
Body weight	74,32	10,15	72,26	10,25	59,90	9,06	58,10	8,49
Fat mass [%]	14,60	5,04	12,44	5,75	18,70	5,21	18,00	6,83
Muscle mass	59,98	7,52	59,94	8,31	45,60	3,85	44,83	2,57
Total body water [%]	61,96	3,89	63,72	4,26	58,37	3,84	58,83	5,02
Strength of the dominant hand	54,00	8,46	52,80	7,31	38,00	3,46	38,00	2,00
Flexor strenght	268,80	46,08	285,40	72,17	208,00	32,53	184,33	62,93
Extensor strength	528,80	113,87	523,20	129,23	424,67	89,75	469,33	89,58
The sit-up from the lying down position	39,40	5,96	38,40	4,89	34,00	6,38	32,00	5,92
The long jump from standstill	242,00	10,75	247,40	14,23	180,00	11,76	187,00	8,77
Time reaction	0,26	0,03	0,28	0,02	0,34	0,05	0,29	0,05
Speed of hand movements	8,78	0,29	8,96	0,43	10,09	0,34	9,49	1,12

Drawing comparisons between averages of men and women shows low sex variability of the analysed parameters in favour of men. It applies to body mass, muscle mass, and strength.

Table 2 presents calculated probability in post-hoc tests for analysed parameters averages comparisons before and after body mass reduction.

Statistically significant body mass decrease was noted at both men and women. Weight loss in a short time was significant and equalled, respectively, 2.37 kg and 1.8 kg. It proves the effectiveness of actions of the practitioners. Differences between the sexes occurred in the specific components of body mass. Fat tissue decrease (by 2.16%) was statistically significant for men. Interestingly, water content increase (by 1.76%) was statistically significant as well. No muscle mass decrease was noted. For women, statistically significant body mass decrease was accompanied by very low and statistically insignificant losses of fat tissue and muscle mass. Similarly to men, water content increased, albeit it was statistically insignificant. It is

note-worthy since the competitors were supposed to reduce body mass primarily by radical and rapid dehydration. Therefore the issue requires further observation and research.

Table 2. Results of comparison between variables before and after NIR test reduction. Statistical significance $p<0.05$

Variable	Men	Women
Body weight	**0,001**	**0,007**
Fat mass [%]	**0,009**	0,382
Muscle mass	0,947	0,346
Total body water [%]	**0,006**	0,439
Strength of the dominant hand	0,599	1,000
Flexor strenght	0,441	0,398
Extensor strength	0,917	0,527
The sit-up from the lying down position	0,197	0,207
The long jump from standstill	0,249	0,248
Time reaction	0,281	**0,022**
Speed of hand movements	0,333	**0,037**

Body mass reduction did not considerably influence motor skills of examined men. However, slight degradation of their strength and coordination test results was noted. For women, on the other hand, improvement of reaction time and arm movement speed were noted. The changes were statistically significant. In other tests, similarly to men, no statistically significant changes of motor skills were noted.

Discussion

The purpose of the paper was to determine the influence of intentional dehydration (body mass reduction) on stamina and motor skills level of taekwondo practitioners. Research of Sterkowicz (2006) showed, that body mass reduction was a popular procedure among martial arts practitioners, since 76% among 131 test subjects reduced body mass. Analysis of percentages showed that average body mass reduction equalled 3.5% for women and 5.5% for men, and were similar to results of research on judo practitioners (W-3.4 and M-4.9%) (Yoshioka, 2006). Qualified competitors reduced more body mass (5.2%) than unqualified

(4.2%). The differences were nonetheless not statistically significant, but exceeding 1-2% (Cisoń et al., 2006; Ziemlański, 1987) of body mass decrease due to rapid dehydration of untrained individuals could have a clinical significance. Water content decrease in the body leads to decrease of stamina due to hindered body temperature regulation. The literature notes terminal cases, in which the competitors adjusted body mass by enforcing increased perspiration, which in consequence cause dehydration and hyperthermia (Utter, 2001). The material gathered by Sterkowicz (2006) includes two cases of men who in a week decreased body mass by 16.3, or even 18.3% of natural body mass. Tests of American wrestlers suggest that 77% of them decreased body mass by over 2.27 kg (Kinigham et al., 2001), which in the case of author's own research gives similar results in regards to men. Before taekwondo tournaments, 53% of competitors reduced body mass (Kazemi et al., 2006). Research conducted by Coufalova et al. (2013) on practitioners of judo, karate, muay thai, boxing, and kickboxing, showed that 77.4% of research subjects regularly reduced body mass during preparation for tournaments. Average body mass equalled 3.9 kg and oscillated between 1 and 10 kg. Research of Janiszewska (2012) showed that over a half (56%) of examined girls declared body mass reduction between a tournament for the purpose of qualifying into the desired weight class. Average body mass of competitors who reduced body mass was on average 6.5 kg lower than of competitors who did not reduce body mass. Pre-competition body mass reduction applied more frequently competitors of the lower weight classes. Higher BMI values were noted in the body mass reduction group, however, the differences were slight. Girls reducing body mass characterised with lower values of anthropometric parameters (body mass, fat content) in lower ranges of correct values than girls not reducing body mass. Nevertheless, no significant differences in fat content between the two groups were noted. In research conducted by Fleming and Costarelli (2007), body mass decrease in fortnight pre-competition reduction resulted from reducing non-fat body mass by 1%, with simultaneous lack of changes in fat content. These results are opposite of author's own research results, where fat content decrease by 2.16% was noted for men, while statistically insignificant fat tissue losses were noted among examined women. Similar results were obtained in research of *Tsai* et al. (2001), when in analysis of four-week period of pre-competition body mass reduction among female taekwondo practitioners, significant differences in body mass without significant changes in fat tissue content were noted. These sparse earlier reports on pre-competition body mass reduction may suggest that body mass reduction among female competitors resulted from reduction of non-fat body mass, most probably in consequence of dehydration. It stands in opposition to the results of author's own

research, in which it was determined that water content increased by 1.76% for men, and increased for women as well, albeit the value was statistically insignificant for the latter. Research on wrestling and judo practitioners showed that dehydration negatively influenced strength and power of examined muscles, but it had very slight influence on skeletal muscles mass (Rico et al., 2015). Research on judo practitioners did not prove the influence of body mass reduction on maximum strength of competitors lower and upper limbs (Coufalova, 2014). Research conducted by Durkalec-Michalski et al. (2014) on boxing and wrestling competitors showed that body mass reduction caused reduction of fat tissue, non-fat body mass, and water content, as well as decrease of maximum muscle power. The variability of results presented above suggests a need for further research.

Conclusions

1. Body mass decrease was noted at both men and women, which proves the effectiveness of actions of the practitioners.
2. For men, fat tissue content decreased. No muscle mass decrease was noted.
3. For women, body mass decrease was accompanied by very low losses of fat tissue and muscle mass.
4. Body water content level increased for both men and women.
5. Slight degradation of strength and coordination test results of men was noted. For women, on the other hand, improvement of reaction time and arm movement speed were noted.

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