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Original Paper

Biomedical Human Kinetics, 15, 35–42, 2023
DOI: 10.2478/bhk-2023-0005

The effects of body mass reduction on the anaerobic power and selected somatic characteristics of Greco-Roman wrestlers

Stanisław Kuźmicki, Artur Kruszewski, Marek Kruszewski

Faculty of Physical Education, Józef Piłsudski University of Physical Education, Warsaw, Poland

Abstract

Study aim: The aim of the study was to determine the effects of body weight loss on the levels of somatic features and peak power of senior Greco-Roman wrestlers from the Polish national team.
Material and methods: The study included 14 males, i.e. 7 wrestlers reducing their body weight and 7 wrestlers not changing their body weight. Seven days prior to a competition, the study participants began a 5-day process of losing body weight. The process involved reducing caloric intake from 3460 ± 683.1 kcal to 2160.0 ± 423.5 kcal per day.
Results: Over the period of 5 days, the participants reduced their body weight by 3.1 ± 0.7 kg ($p < 0.001$). There occurred a decrease in the value of endomorphy ($p < 0.01$) and mesomorphy ($p < 0.05$) and an increase in the value of ectomorphy ($p < 0.001$). Peak power did not change (1296 ± 100.9 W on day 5 of the examination), nor did relative peak power (19.9 ± 1.1W/kg).
Conclusions: In wrestlers 5-day rapid weight loss protocol may result in decrease of body circumferences and consecutive changes in somatic type without concurrent loss in lower-limb peak power.

Key words: Body weight loss – Somatic type – Peak power – Wrestling

Introduction

In combat sports such as wrestling, judo, jujitsu, karate and taekwondo, where in order to fairly compete, the athletes are divided into weight categories, weight loss (WL) is a common practice. This is due to the athletes' pursuit to compete in a weight category which is lower than their natural weight category [6, 21, 32, 38]. The competitors believe that the weight loss should not affect the level of their performance, so they will be able to gain an advantage over their opponents [4, 20, 26, 34]. In most cases, they apply a rapid weight loss (RWL) in the week before participating in the competition [3, 36]. In combat sports, the most common methods of RWL in such a short period are: limiting carbohydrates and fat consumption, decreasing fluid consumption, using sauna, use of airtight suits when making physical effort and giving up food the day before weighing [3, 5, 6]. Such practices can affect the result in terms of sport performance, but they can also interfere with body thermoregulation, cardiovascular function and metabolism and they affect the athlete's mental condition as well [34].

As implied by a study conducted by Artioli et al. [2], as their sporting career developed, almost all wrestlers in the senior category (over 20 years) used the WL. By changing their weight category to a lower one, they decide to compete against opponents with a different somatic structure than higher category wrestlers. This consequence is indicated by diversity of somatotypes between wrestlers of particular weight categories [30, 39, 45].

In wrestling and other martial arts, short intensive activities of anaerobic nature are present, which require that the fighters display high ability to develop maximum power, which largely determines their performance [13]. As it is demonstrated, RWL may not have a negative impact on athletes' anaerobic performance [4, 8, 18]. At the same time, other reports highlight the decline in the participants' performance [12, 25, 37], as well as a negative impact on the health of athletes who apply RWL [16, 32, 36]. Dehydration can lead to decreased plasma volume, further resulting in increased heart rate and decreased stroke volume [42]. Moreover, dehydration causes acute kidney damage and can further lead to adverse events in other body systems [24].

The objective of study was: 1) to assess changes in the percentage of body fat (%fat), arm muscle circumference, limbs and hip circumference and the somatic type of men, wrestlers in the Greco-Roman style senior category (over 20 years) as a result of the rapid RWL,

Author's address Stanisław Kuźmicki, Faculty of Physical Education, Józef Piłsudski University of Physical Education, Marymoncka Str. 34, 01-813 Warsaw, Poland stanislaw.kuzmicki@awf.edu.pl

2) to determine the impact of RWL on the peak power of the wrestlers' lower limbs at the highest level of sports championship.

Material and methods

Participants

14 wrestlers, athletes of the Polish national senior team in a Greco-Roman style participated in the study. Members of the experimental group (E, n = 7) were reducing their body weight, while the control group (C, n = 7) were not reducing their body weight before participating in the Fédération Internationale des Luttes Associées FILA International Tournament. According to the requirements of the Declaration of Helsinki, athletes who underwent the measurements were informed about the purpose of the study, methods of proceeding, that they may cancel carrying out the experiment at any stage and they expressed their written consent to participate in the experiment. The study was approved by the Senate Ethics Committee of Scientific Research of the Physical Education University (SKE 01-19/2016).

The athletes were matched in pairs, and body weight was the criterion used to select the athletes. Both groups were not significantly different in terms of statistics as far as age, body mass and body height are concerned (Table 1).

Table 1. Participants' age, body height and body weight (mean ± SD)

	Age [y]	Body height [cm]	Body weight [kg]
E group	21.8 ± 2.9	170.2 ± 4.6	68.6 ± 7.6
C group	22.2 ± 3.1	169.2 ± 4.8	69.6 ± 8.6

E – experimental group, C – control group

Before they started RWL, group E diet comprised 3460 ± 683.1 kcal per day (carbohydrates 7.6 ± 1.9 g/kg, protein 1.9 ± 0.5 g/kg and fats 1.4 ± 0.3 g/kg). Seven days before the competition, wrestlers of this group decreased the amount of food they consumed daily to 2160 ± 423.5 kcal (carbohydrates 4.3 ± 1.0 g/kg protein, 1.9 ± 0.5 g/kg and fats, 0.7 ± 0.2 g/kg). Group C diet comprised 3510 ± 698.2 kcal per day (carbohydrates 7.6 ± 2.0 g/kg, protein 1.9 ± 0.5 g/kg and fats 1.4 ± 0.3 g/kg) and did not change during the study. Competitors of both groups did not limit the amount of fluid they consumed. The diet was assessed based on the ongoing recording of consumed food and beverages [41] using Albums of Photographs of Food and Dishes [40], which made it possible to determine the specific character of conventional limitation of energy value in the diet during the pre-competition body weight reduction by athletes. Athletes were trained to accurately record their diet, which they did for 5 successive days. The correct amount of food they consumed was determined by a dietician with extensive experience in the field of sports nutrition. Every day, for 5 days of the study, always at the same time before the morning workout, 14 somatic characteristics were measured, followed by carrying out assessment of the lower limb muscles peak power. Twice a day (in the morning and in the afternoon), all athletes participated in the 1.5-hour workouts based on means of workout typical for wrestling. They were separated by brief intervals of rest and were characterised by a high intensity and short duration. They were dominated by task fights, series of throws with one and multiple partners, parts of fighting and sparring fights.

Anthropometric measurements

Anthropometric measurements covered the following somatic characteristics: body weight, body height, skinfolds thickness (triceps, subscapular, supraspinale, abdominal, medial-calf), arm girth relax and tensed (with forearm flexed at 90° and with biceps tensed), circumferences (hip, thigh and calf), bicondylar femur breadth, bicondylar humerus breadth [31]. To measure the skinfolds thickness, Harpenden calliper was used) with a constant 10 g/mm² pressure and the 90 mm² pressure surface. All measurements were taken by the same investigator (with over 30-year experience), applying standard anthropometrical methods according to the procedure of the International Biological Programme [44]. The percentage content of fat in body weight was estimated using the Keys and Brożek [19] equation: %PF = 100 (4.201/D – 3.813), previously calculating body density according to the Piechaczek [35] formula: D' = 1.125180-0.000176LOGtriceps-0.000185LOGabdominal. AMC (arm muscle circumference) was calculated on the basis of MAC (mid arm circumference) and TSF (triceps skinfold thickness) using following equation: AMC (cm) = MAC (cm) – 0.1(π x TSF in mm). Somatotype was calculated by the Heath–Carter method [10].

Measurements of peak muscle power of the lower limbs

To assess peak muscle power of the lower limbs, 10 seconds stationary Excalibur Sport (Lode Ergometry Menager, Netherland) exercise bicycle ergometer test was used. In the bicycle ergometer, modular software was installed. It was enhanced using Expansion 'Wingate Test Plus' modular version. The test consisted in performing a maximum 10s effort with load of 7.5% of the body weight (0.75 Nm/kg) selected on an individual basis. Before the actual test, an athlete performed a standardized general 10-minute warm-up and one minute specific warm-up with a load (0.05 Nm/kg) and a frequency of 50–60 pedal revolutions per minute. The maximum effort began immediately after the warm-up was finished, without interrupting pedalling by the participant, who immediately increased the frequency of pedalling reaching the borders of

his capabilities once the bicycle ergometer automatically activated pre-programmed load. During the warm-up, time left to the participant to begin the test was displayed on the screen and the last 10s of it were exposed. The participant also received clear verbal information. Once the test was commenced and completed, information was displayed on the monitor, and the participant was given a clear verbal signal by the person who conducted the test in the same way as it was previously.

All participants have performed this test many times before. Before the test, the participants were informed how the test would be done and what they were expected to do in each phases of the test. During five-day RWL protocol the measurements were conducted one a day for every participant.

To make the analysis, absolute peak power, i.e. the highest value of the power the participants generated during 10 seconds of maximum effort, and the relative peak power that represented the ratio of the absolute peak power and body weight (W/kg) were used.

Statistics

The results were analysed using the STATISTICA™ software, version 9.1. To evaluate differences between the average values, (ANOVA) variance analysis was used for repeated measurements using the Duncan's post-hoc test. The statistical significance of differences between the values of evaluated features was set at the level $p < 0.05$.

Results

The results of measurements of body weight and fat tissue percentage content for both groups are shown in Table 2.

In group E, RWL was occurring (Table 2), while in group C fluctuations in body weight were not significant. Body weight in Group E was reduced as early as on day 2. ($p < 0.001$) and increased in the subsequent days of the study. Changes in percentage content of fat tissue were similar ($p < 0.001$). The final body weight loss in group E as compared to the initial level amounted to 3.1 ± 0.7 kg, and fat tissue loss amounted to 1.0 ± 0.3 kg.

Average values of arm muscle circumference ($p < 0.01$), arm circumference in tension ($p < 0.001$), hip circumference ($p < 0.001$), thigh circumference ($p < 0.01$) and the shin circumference ($p < 0.001$) have decreased compared to the initial values (Table 3).

Somatic types of the participants of both groups of wrestlers who were evaluated during the first day of

Table 2. Body mass and fat mass percentage in consecutive measurements in the groups E and C (mean±SD)

Variable		Day 1	Day 2	Day 3	Day 4	Day 5
Body mass [kg]	E group	68.6 ± 7.6	67.6 ± 7.4***	66.9 ± 7.4***	66.3 ± 7.1***	65.5 ± 7.0***
	C group	69.6 ± 8.6	69.5 ± 8.7	69.6 ± 8.6	69.6 ± 8.7	69.62 ± 8.7
Body fat [%]	E group	14.3 ± 3.1	14.0 ± 3.3***	13.9 ± 3.4***	13.6 ± 3.4***	13.3 ± 3.4***
	C group	13.3 ± 1.7	13.3 ± 1.7	13.3 ± 1.7	13.3 ± 1.7	13.3 ± 1.7

Significant difference with respect to initial level in the group E: *** $p < 0.001$; E – experimental group, C – control group.

Table 3. Changes in somatic characteristics on consecutive days of measurements in the group E and C (mean±SD)

Variable		Day 1	Day 2	Day 3	Day 4	Day 5
Arm muscle circumference [cm]	E group	29.3 ± 2.2	29.1 ± 2.0	28.9 ± 1.8	28.7 ± 2.2*	28.5 ± 2.1**
	C group	29.5 ± 2.3	29.5 ± 2.3	29.6 ± 2.4	29.6 ± 2.4	29.5 ± 2.3
Arm tensed circumference [cm]	E group	35.0 ± 1.9	34.6 ± 1.8	34.5 ± 1.6*	34.2 ± 1.8**	33.9 ± 1.8***
	C group	35.3 ± 2.0	35.3 ± 2.0	35.4 ± 2.1	35.4 ± 2.1	35.3 ± 2.0
Hip circumference [cm]	E group	91.6 ± 2.3	90.4 ± 2.5*	89.6 ± 2.7***	88.9 ± 2.4***	88.5 ± 2.7***
	C group	92.1 ± 2.5	92.2 ± 2.5	92.2 ± 2.4	92.2 ± 2.4	92.1 ± 2.3
Thigh circumference [cm]	E group	54.1 ± 1.8	53.7 ± 2.1	53.5 ± 1.9*	53.1 ± 1.6**	52.7 ± 1.7***
	C group	54.3 ± 1.9	54.3 ± 1.8	54.4 ± 1.9	54.3 ± 1.8	54.3 ± 1.8
Calf circumference [cm]	E group	35.7 ± 1.5	35.4 ± 1.7	34.9 ± 1.8**	34.6 ± 1.5***	34.3 ± 1.6***
	C group	35.9 ± 1.7	35.9 ± 1.5	36.0 ± 1.8	36.0 ± 1.8	35.9 ± 1.7

Significant difference in relation to initial level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; E – experimental group, C – control group.

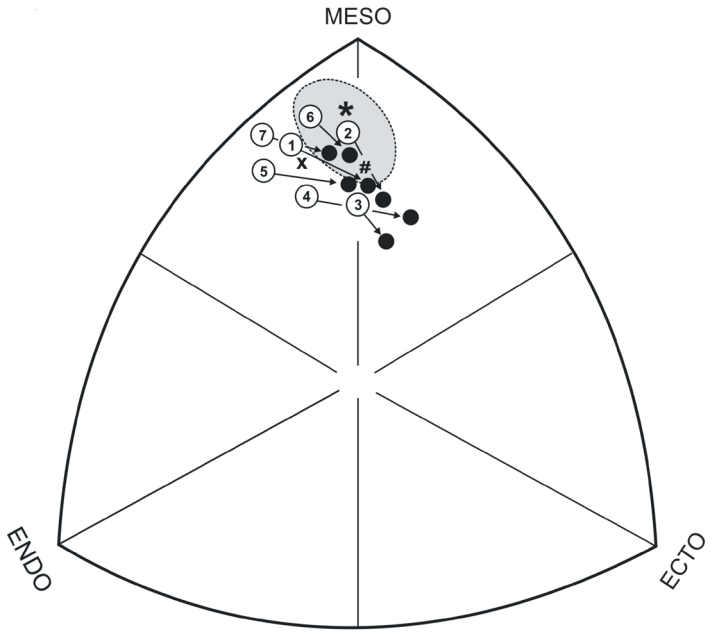


Figure 1. Breakdown of Groups E and C wrestlers' somatotypes

○ – group E wrestlers' somatic types on the first day of measurements; ● – group E wrestlers' somatic types on the fifth day of measurements; Shaded field – the area occupied by group C wrestlers; **x** – group E average value of the somatic type on the first day of measurements; # – group E average value of the somatic type on the fifth day of measurements; ✱ – group C average value of the somatic type on the first and on the fifth day of measurements.

the study were located in the somatogram's area of low endomorphy values, high mesomorphy values and low ectomorphy values (Fig. 1). The participants of group E as compared to group C (shaded area) were shifted towards higher endomorphy and lower mesomorphy values. After five days of RWL, the somatic types of wrestlers of group E in the somatogram were shifted towards lower endomorphy values and lower mesomorphy values and higher ectomorphy values (the average values of endo – from 2.8 ± 0.6 to 2.1 ± 0.6, $p < 0.01$; meso – from 6.0 ± 0.4 to 5.5 ± 0.3, $p < 0.05$ and ectomorphy from 1.6 ± 0.6 to 2.5 ± 0.5, $p < 0.001$). While the average values of the examined components obtained on the first day of measurements in group C amounted to: endo – 2.2 ± 0.5; meso – 6.4 ± 0.4 and ectomorphy 1.6 ± 0.8 and five days after study commenced, they remained at the same level.

On the first day of measurements lower limb absolute peak power did not statistically differ between wrestlers form E and C groups (Table 4). In the following days of the protocol no between group difference was observed for this variable. A significant difference in the absolute peak power was noted between the first and the fifth days of the measurements in the group E, as well as the group C. Value of the relative peak power in the first day of the measurements was significantly higher ($p < 0.01$) for the group E than for the group C. However, on the third day the was no significant difference in the variable between the groups. No significant difference in the relative peak power was noted between the first and the fifth

Table 4. Peak power in consecutive measurements in the groups E and C (mean ± SD)

Variable		Day 1	Day 2	Day 3	Day 4	Day 5
Peak power (W)	E group	1262 ± 159	1345 ± 176	1384 ± 170	1318 ± 79	1296 ± 101
	C group	1563 ± 259	1525 ± 250	1518 ± 239	1536 ± 258	1531 ± 242
Peak power (W/kg)	E group	18.5 ± 1.6	19.9 ± 1.2	20.7 ± 1.2	20.0 ± 1.4	19.9 ± 1.1
	C group	22.4 ± 1.4**	21.9 ± 1.8*	21.8 ± 1.2	22.0 ± 1.5*	21.9 ± 1.4*

Significant difference between group E and C: * $p < 0.05$, ** $p < 0.01$; E – experimental group, C – control group.

days of the measurements for the group E, as well as the group C.

Discussion

Wrestlers examined started their RML seven days before participating in the competition and after 5 days they have lost more than 3.1 ± 0.7 kg (4.6 ± 1.1%) of body weight. As a result, the values of their arm circumferences in tension and arm muscles, thigh circumference, shin circumference and hip circumference were reduced. Similar decreases in body weight due to RML were reported by Alderman et al. [1], Kordi et al. [22] and Marttinen et al. [28]. In the present study, wrestlers' body weight loss was accompanied by a decrease of fat mass from 14.3 ± 3.1% to the level of 13.3 ± 3.4%. Yaşar et al. [45] have found among the elite of Turkish contestants, differentiation of fat mass size adequately to the weight categories. In the light weight wrestlers, body fat was 9.9%, in the middle weight wrestlers, body fat was 11.8% and in the heavy weight wrestlers, body fat was 18.6%.

The wrestlers who were participants in this testing had the Sheldon's somatic types, among which mesomorphy, a tissue component that indicates how massive the build of the human body is, was clearly dominating [10]. The shares of endomorphy, which defines the share of fat tissue in the somatic type, and ectomorphy that indicates the level of slenderness, were clearly smaller. After five days of RWL, the somatic types of wrestlers of group E in the somatogram were shifted towards lower endomorphy values (from 2.8 ± 0.6 to 2.1 ± 0.6) and lower mesomorphy values (from 6.0 ± 0.4 to 5.5 ± 0.3) and to higher ectomorphy values (from 1.6 ± 0.6 to 2.5 ± 0.5, $p < 0.001$). The somatic types of wrestlers [39, 45], were also dominated by mesomorphy while endomorphy (except for the heaviest weight categories and ectomorphy levels were much lower. In the somatogram, competitors of lighter categories, as compared to heavier categories, were shifted towards lower endo – and mesomorphy values and higher ectomorphy values. Sterkowicz-Przybycień et al. [39] calculated the somatotype of 23 elite Polish male wrestlers as 1.7–6.3–1.3 in light weight and 2.2–6.8–1.1 in heavy weight, and the endomorphic component increased significantly. Öcal Kaplan et al. [33] reported the somatotype mean of 57 elite Turkish wrestlers aged 23.3 as 2.1–6.1–1.2 in light weight, 2.6–6.7–0.7 in middle weight, 4.1–7.9–0.2 in heavy weight. A similar trend was currently observed in somatotype components when wrestlers who changed their weight category from higher category to a lower one were examined. Interestingly is that in our experiment E group changed a somatotype from endomorph mesomorph into balanced mesomorph. So, measurements reported by other authors should underline a location of their measurements in training process.

Diversity of the somatic types depending on the weight category of the Polish wrestlers was also indicated by Sterkowicz-Przybycień et al. [39], while in Korean wrestlers it was indicated by Ji-Woong Noh et al. [17]. Wrestlers of heavier weight categories with higher mesomorphy values as compared to competitors of lighter categories, are characterised by broad epiphyses where strong muscles with relatively large circumferences are attached [15]. They determine the maximum power level that wrestlers reach, while a decrease in fat tissue is directly linked with the increase of the values of the relative power [14]. In judo, where weight categories are also present and fight characteristics is very similar to wrestling, peak power is strongly correlated with mesomorphy (in positive terms) and endomorphy (in negative terms), and therefore it is believed that the body build can be an important factor that influences the result of the fight in this discipline of sport [27].

In the present study it was demonstrated that as a result of wrestlers' body weight reduction during a five-day RWL, examined wrestlers demonstrated no reduction in peak power (on the first day of the study 1262 ± 159 W and on the fifth day of the study 1296 ± 101 W) nor in the relative peak power (on the first day of the study 18.5 ± 1.6 W/kg and on the fifth day of the study 19.9 ± 1.1 W/kg). Similarly, Cheuvront et al. [11], and Watson et al. [43] found no reduction in the level of the maximum anaerobic power as a result of dehydration during RWL. Also Marttinen et al. [28] found that wrestlers who lowered the body weight by 4% did not demonstrate any changes in grip strength. As suggested by Kraemer et al. [23], experienced wrestlers do not demonstrate deterioration in their performance as a result of RWL, although in combination with stress and fatigue they may demonstrate deterioration of strength performance, as assumed by Buford et al. [7].

However Ratamess et al. [37] found a decrease in grip strength, a decrease in the maximum power that wrestlers achieve during a vertical jump and the power measured by Wingate, which were correlated with a decrease in body weight and body fat mass in wrestlers. According to Lambert et al. [25] a few-day RWL in the range 3.3-6.0%, influences the wrestler's poor results in the fight, while dehydration in the range of 3–4% of the body weight can decrease muscles resistance during intensive efforts [29].

Studies by Artioli et al. [4] demonstrated that 5% RWL, followed by 4 hour regeneration by hydrating the body has no impact on anaerobic performance and the athlete's maximum power. The authors believe that during the regeneration process, time in which athletes can rehydrate, is essential. The researchers suppose that athletes who reduce their body weight on regular basis are less likely to decrease their performance as a result of applying it.

WL may have a negative impact on the athletes' level of performance, but it may also affect their health, which would be caused by malnutrition and dehydration. Dehydration has a much greater negative impact including the dangerous health consequences [32]. In order to eliminate risks resulting from WL, guidelines and audit procedures were introduced to discourage wrestlers from applying these practices [32]. The first recommendations were compiled in 1976 followed by the next ones in 1996. The guidelines and audit procedures were clarified more strictly by American College of Sports Medicine [9]. However, most competitors are asked by their coaches to carry out RWL [2, 3, 22]. According to Artioli et al. [3], in this situation the best thing is for both the coach and the competitors to be fully aware of the risks arising from RWL and being familiar with recommended procedures concerning the gradual weight loss and to be compliant with them [9].

In order to minimalize health risks associated with intensive wrestling training of pre-competition period wrestlers in experimental group as described in the procedures section were not fluid restricted. Research of this still very significant and common to athletes phenomenon must meet strict requirements. However so obtained knowledge may be of crucial importance to both coaches and athletes in decisive process of planning pre-competition RWL.

Conclusions

1. Before the competition, the 5-day reduction in body weight does not determine the change in peak power of the lower limbs measured by the bicycle ergometer test in Greco-Roman wrestlers.

2. Body mass reduction is accompanied by decreases in arm, arm tensed, thigh, calf, and hip circumferences and body fat mass which in turn leads to change in the somatic type of wrestlers: decrease in endomorphy as well as mesomorphy and increase in ectomorphy.

Conflict of interest: Authors state no conflict of interest.

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Received 26.02.2022
Accepted 06.12.2022

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