

## FITNESS PROFILE OF JELENA ARNAUTOVIĆ, SENIOR CHAMPION AND MEMBER OF THE JUDO NATIONAL TEAM: CASE STUDY

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### ABSTRACT

*Judo is a sport that integrates different segments of the anthropological space of competitors. Defining the profile of a judoka, of any weight category, in addition to adequate analysis of morphological dimensions, physical status, implies the discovery and assessment of motor (physical) abilities, which are often defined by the term fitness profile. Based on good detection, analysis and evaluation of these parameters, it is possible to define the so-called fitness model of female judokas, especially heavier categories. As an adequate benchmark for this assumption are the results achieved by J.A. the female senior champion of Bosnia and Herzegovina (BIH) and the two-time champion of the Balkans (2018 and 2019 year).*

**Keywords:** *Physical abilities, female judokas, detection, evaluation.*

### 1. INTRODUCTION

Judo is an Olympic sport with a long history, founded by Jigoro Kano. In 1964 he was included in the Olympic Games (for men), and in 1992 for women. It belongs to the category of martial arts which is characterized by high integration of most motor abilities (speed of movement, explosive power, repetitive power, flexibility, coordination, balance) enabling good realization of judo technique (Pavlović, 2021). It is classified as a sport by weight categories, where the athlete tries to throw the opponent on his back or control him during most of the fight, using different techniques, in accordance with the rules (Franchini, Nunes, Moraes, Del Vecchio, 2007; Franchini et al., 2011; Franchini et al., 2011; Miarka et al., 2012). Precisely because of the demands of combat, application of technique, and tactics, judokas usually try to increase their muscle mass and decrease the percentage of fat in each weight category in order to gain an advantage over weaker opponents (Artioli et al., 2010; Brito et al., 2012; Franchini, Brito, & Artioli, 2012).

Apart from the technical and tactical aspects, physical fitness has proven to be a decisive factor in judo performance. Most research confirms that the success of judo athletes requires high levels of upper body anaerobic capacity and muscle strength (Franchini, Takito, Kiss, MAPD, & Strerkowicz, 2005; Franchini et al., 2011; Kim, Cho, Jung, & Yoon, 2011) as well as adequate physical status (Kons, Ache-Dias, & Detanico, 2017). According to Miarka et al. (2012), a high level of muscle strength is required for decisive moments of the fight (efficiency of throwing technique and efficiency of counterattack), in order to score points or finish the fight, which defines the basic structure of judo competition (Detanico, Budal Arins, Dal Pupo, & Dos Santos, 2012). As judo is categorized by weight, one of the

most difficult challenges for elite judokas is to achieve excellent physical condition while maintaining optimal body weight. From a physiological point of view, anaerobic strength and capacity, strength and aerobic power are considered to be the main characteristics that judokas should develop. Low body fat and high arm muscle mass are associated with better judo performance (Drid et al., 2009, 2015; Kubo et al., (2006).

Therefore, the anthropometric profile of an elite athlete could be a relevant factor for success in competition and for performance on specific judo tests. The results of research (Casals et al., 2017) show that heavier judokas perform worse than lighter ones, but they can also have similar competitive success in their weight categories as lighter judokas. Higher percentages of muscle mass, bone mass and lower ectomorpha are associated with better specific judo fitness. Some research states that the somatotype profile of male judokas is mesomorphic (Franchini, Sterkowicz-Przybycien, & Takito, 2014), while the endomorphic component dominates in judokas (Franchini et al., 2011). Moreover, body composition and judokas' somatotypes appear to influence other performance indicators, such as anaerobic strength, muscle torque, power output, and maximal oxygen consumption& (Kim, Cho, Jung, & Yoon, 2011; Lewandowska, Busko, Pastuszek, & Boguszezewska, 2011).

Judo is a dynamic, physically demanding sport, which requires a high degree of physical fitness and strength from the competitors. Strength training is often used by judokas to increase muscle strength and endurance, change body composition and achieve better athletic results. In general, such training leads to a change in muscle size and structure, muscle cross-sectional area, increasing muscle strength and muscle function, potentially improving the strength and agility of competitors, which is especially useful in experienced athletes (Stachoń et al., 2016). Some studies suggest that practicing martial arts such as judo provides various physiological benefits in strength, anaerobic capacity, speed, balance, and flexibility as well as an overall improvement in cardiorespiratory fitness (Douris et al., 2004).

The structure of judo movement is very demanding for most muscle groups, so contractile forces play an important role in performing judo throwing techniques (Imamura, Iteya, Hreljac, & Escamilla, 2007). In this way, the strength of the extensors and flexors of the thigh and shoulder muscles can distinguish successful and less successful athletes in judo competitions. During competition, periods of maximum or submaximal intensity were separated by longer or shorter breaks (Drapšin, Drid, Grujić, & Trivić, 2009). Most matches last about 3-4 minutes, with occasional bouts of high-intensity activity (20-30sec.), Requiring developed aerobic and anaerobic endurance. Due to these characteristics of judo, elite judokas have high muscle strength depending on the weight category, and achieve very good results on endurance tests, push-ups, push-ups, sit-ups and other motor tests from the motor space, the so-called fitness abilities (Franchini et al., 2011). The aim current case study aims to detect and evaluate of fitness profile of female judokas (Jelena Arnautović ) as a relevant parameter in the result success.

## **2. METHODS AND MATERIALS**

### **2.1 The Sample**

The study was conducted with Jelena Arnautović (27 years old, Body height 186cm; Body weight 118,6kg; BMI 34,3kg/m<sup>2</sup>; Body fat 37,5%; Body water 47,69%; Body muscle 70,4kg) a member of Judo Club "Romanija" and BIH national Judo team. She was Vice-Champion of BIH for seniors and younger seniors (U23); She is the 2018 (Kavadarci, North Macedonia) and 2019 (Tirana, Albania) Balkan Champion female seniors (+78).

## 2.2 The Variables

A total of 23 variables were applied for Fitness Profile evaluations (Bosco, Luhtanen, & Komi, 1983; Sayers et al., 1999; Mackenzie, 2005).

1. Push-Up (20")
2. Sit-Ups test (30")
3. HGSRight hand (kg)
4. HGSLeft hand (kg)
5. Speed of throwing a handball ball with 7m (m/s)
6. Throwing the ball 3kg standing (m)
7. Throwing the ball 3kg sitting (m)
8. Throwing the ball 3kg lying on his back (m)
9. Illinois agility run test (sec.)
10. Squat test-endurance (sec.)
11. Squat jump - SJ (cm)
12. Countermovement jump-CMJ (cm)
13. Countermovement jump, arm swing-CMJ<sub>arm</sub> (cm)
14. Energy of elasticity\*(EE)
15. Coordination index\*\* (CI)
16. Standing Broad Jump (cm)
17. Triple Jump Standing (m)
18. Speed 10m (sec.)
19. Speed 20m.(sec.)
20. Speed 30m (sec.)
21. Peak anaerobic power - SJPAP (W)\*\*\*
22. Peak anaerobic power - CMJPAP (W)\*\*\*
23. Peak anaerobic power - CMJ<sub>arm</sub> PAP (W)\*\*\*

## 2.3 Testing Protocol

Anthropometric measurements were performed according to the methodology of the International Society for the Assessment of Kinanthropometry- ISAK standard procedures. The standard metric instruments were applied: Stadiometer-used for measuring body height (SECA 206, Germany). Body weight and Body Composition were assessed with the bioelectrical impedance method using a body composition analyser (Tanita InnerScanV BC545N, Japan), in accordance with the measurement protocol. The HGS of the was measured by the method of isometric dynamometry (digital dynamometer CAMRY-EH101, USA). The results are expressed in kilograms (kg) with a measurement accuracy of 0.01 kg. To estimate arm speed, the subject threw the handball ball from a distance of 7m with the dominant right hand (3x). The speed of movement of the ball was measured by the Velocity Speed Radar Gun-Bushnell (model 101911, USA). Ergo Tester Jump Globus (Italy) was used to estimate the explosive power of the extremities (SJ, CMJ, CMJ<sub>arm swing</sub>). All measurements were conducted during training in the month of October, 2021, were in accordance with the procedures of the Declaration of Helsinki.

## 3. RESULTS

The aim of the study was to evaluate the fitness profile of judokas female, vice champion BIH. To assess the qualitative and quantitative fitness profile (fitness abilities) of our sample, 23 tests were defined which detected the degree of physical fitness (Table 1, Figure 1, 2).

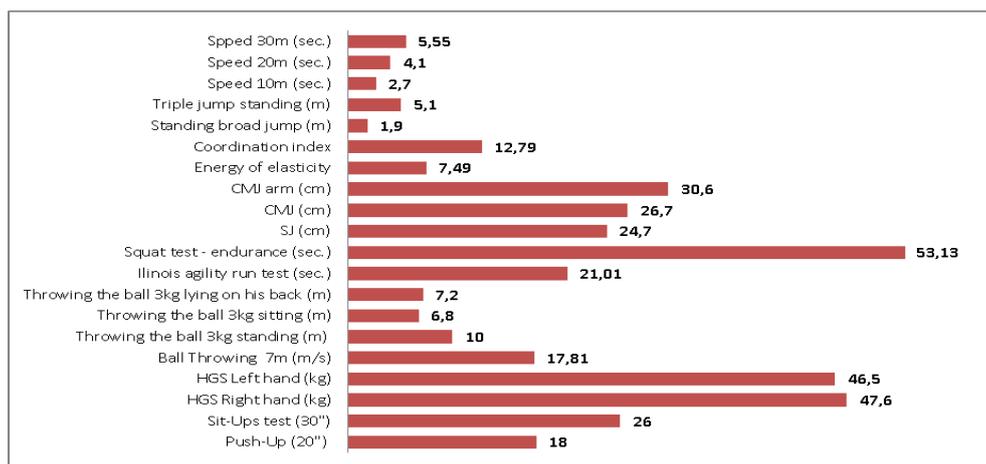
**Table 1: Fitness profile Jelena Arnautović**

S. No	Measured parameters	Value
1.	Push-Up for 20" (iter.)	18
2.	Sit-Ups test for 30" (iter.)	26
3.	HGS <sub>Right hand</sub> (kg)	46,6
4.	HGS <sub>Left hand</sub> (kg)	45,5
5.	Speed of throwing a handball ball with 7m (m/s)	17,87
6.	Throwing the ball 3kg standing (m)	10
7.	Throwing the ball 3kg sitting (m)	6,80
8.	Throwing the ball 3kg lying on his back (m)	7,20
9.	Ilinois agility run test (sec.)	19,87; Average 3,09m/s
10.	Squat test - endurance (sec.)	53,13
11.	SJ (cm)	24,7
12.	CMJ (cm)	26,7
13.	CMJ <sub>arm</sub> (cm)	30,6
14.	Energy of elasticity *	7,49
15.	Coordination index **	12,74
16.	Standing Broad Jump (cm)	190
17.	Triple Jump Standing (m)	5,10
18.	Speed 10m (sec.)	2,70
19.	Speed 20m (sec.)	4,10
20.	Speed 30m (sec.)	5,55
21.	SJ <sub>PAP</sub> (W)***	4816,87
22.	CMJ <sub>PAP</sub> (W)***	4938,27
23.	CMJ <sub>arm PAP</sub> (W)***	5175

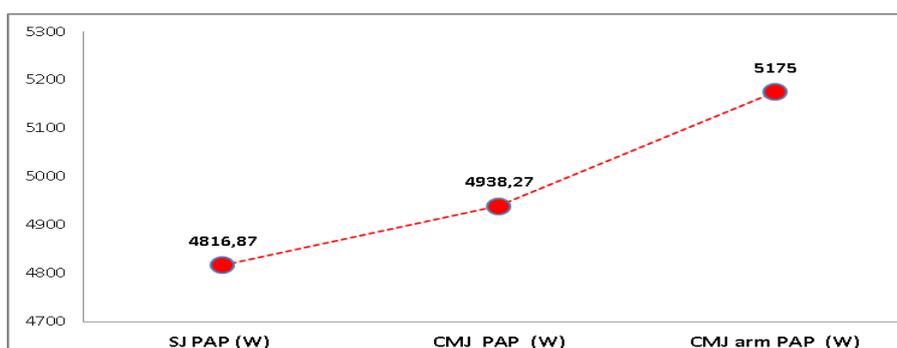
\*the formula is used  $((CMJ-SJ) / CMJ) \times 100$ ;

\*\*the formula is used  $((ABK-CMJ) / ABK) \times 100$

\*\*\*The Sayers Equation: Peak anaerobic power output-PAP (W) =  $(60.7 \times \text{jump height (cm)}) + (45.3 \times \text{body mass(kg)}) - 2055$



**Figure 1: Fitness profile of Jelena Arnautović**



**Figure 2: Peak anaerobic power output - PAP (W)**

Judo is a sport where, in addition to good technical skills and tactical strategy, conditional (physical-fitness) abilities are necessary for a competitive result, because they determine performance only with an adequate morphological profile. It is a martial art with occasional catching and high-intensity movements in which it is difficult to isolate which aspects can determine success in competition, given the complexity and unpredictability of judo techniques (Miarka et al., 2012). In Judo fights are dominated by a dynamic environment that is constantly changing, whose nature imposes technical and tactical requirements that are applied during the fight and must be maximally improved and have the ability to quickly reorganize and continuously create new motor directions (Ali, Hanachi, & Nejad, 2010).

The body height of our competitor (186cm) with body weight (118.6kg) and BMI (34.3kg/m<sup>2</sup>) are good indicators of a pronounced endo-mesomorphic somatotype, which is primarily in the larger categories of women's judo, confirming the results of research with elite judokas (Smaruj et al., 2019). Compared with the research (Ceylan et al., 2018; Drapšin, et al., 2009; Quintero, Da Rosa, Orssatto, Pulgarin, & Follmer, 2019), the morphological parameters and the percentage of fat in our sample are of higher values, while the muscle component is slightly lower (Pavlović, 2021). The share of muscle mass in total body mass is 70.4 kg (59.35%), and adipose tissue saturates about 38% of total body mass, which corresponds to the leading endomorphic with the accompanying mesomorphic component. This relationship confirms the fact that adipose tissue has a positive impact on outcome success (Franchini et al., 2011). The percentage of water in the muscles is close to 48% and is an indicator of significant hydration and stable muscle function in the conditions of anaerobic regime, because judo consists of fast, intense movements of short duration. In terms of structure, judo belongs to the polystructural acyclic sports of intermittent intensity in which, in addition to good technique and tactics, physical abilities are necessary for competitive success. Some authors (Ali, Hanachi, & Nejad, 2010; Stradijot, Pittorru, & Pinna, 2012) confirm that physical abilities and morphological dimensions are prerequisites for high performance judo competition, which also requires the athlete to be in optimal physical condition as a prerequisite for achieving the expected result. The judo technique implies the synchronized action of muscle kinetic chains, with the maximum utilization of energy consumption. Structurally, judo techniques are manifested as throwing techniques (manual and foot technique, throwing over the hip), techniques in the ground (holding, lever, choking). During the fight, judokas show maximum physical (fitness) abilities, and the movements are strong and are performed in a short period of time, usually against the force of the opponent (Drapšin et al., 2009). In the first place, strength (explosive, repetitive, static), speed of individual movement, frequency of movement, agility, anaerobic endurance, etc. In addition to the technical aspect, hand techniques require a distinct strength of the arms (grip strength), flexors and shoulder girdle muscles in a short time interval. Leg technicians require speed, coordination, and explosiveness of the caudal extremities, with the activity of muscle kinetic chains at the maximum level with the involvement of the abdominal muscles, pelvic muscles and muscles of the caudal extremities.

The fitness profile of a judoka plays an important role in determining the potential for success in the fight on the ground floor, where the energy power, strength and economy of work are the main parameters of success. Often the first parameter is directly related to the physiological profile of the athlete, while the economy of work and strength defines mobility and efficiency in moving the body in space and is directly related to motor fitness and biomechanical profile of the athlete (Anderson, 1996). According to Pavlović (2021) motor fitness is defined as the relationship between the central nervous system and muscles, so it is often called neuromuscular coordination (neuromuscular component of fitness) which enables successful work in a certain motor skill, game or activity. Specific components of fitness include agility, balance, coordination, strength, reaction time and speed, and their integration is a confirmation of the expected success result. The analysis of the results of the

fitness tests of the current study confirms the role of the above, because it is about the senior champion of B&H and the Balkan champion. Insight into the numerical parameters of the contestant can conclude that it is an impressive morphological status and body composition that correspond to top judokas in the heavyweight category over 100kg, thus defining the endo-mesomorphic component, which confirms the research results (Franchini, Del Vecchio, Matsushigue, & Artioli, 2011). Although there may be increased body fat (37.5%) compared to muscle mass (about 61%), the current state of our competitor is such that with good synchronization of motor skills, good technique and tactics, this value has no negative impact, and given the overall placement, which confirms the findings of some studies (Casals et al., 2017). It can be concluded that body size is an advantage in certain matches when competing at the elite level, which is contrary to the results of research (Nakajima, Wakayama, Iida, & Matsumoto, 1998), which revealed the negative effect of excess fat on isometric strength, flexibility, balance and aerobic capacity in judokas.

In judo, great importance is attached to the development of strength, which is crucial for performing offensive and defensive actions during fights, while strength training enables the improvement of the body structure and general physical health of the competitors. The conclusions that top judokas are able to show significantly greater strength of extensors and flexors of the arms compared to lower-ranking competitors were confirmed. It is an obvious fact that fighting in the classic judo guard and maintaining the position of the body during the match, has a great stimulating effect on the strength of the arms, so it is not difficult to understand the importance of arm strength and shoulder girdle in judo. In our study, the strength of the muscle chains of the cranial extremities and the shoulder girdle of a judoka was estimated by the number of push-ups for 20sec. (=18), raising the hull for 30sec. (=26) are indicators of good fitness status of the competitor. The results in relation to the tabular values are in the category - Excellent (Mackenzie, 2005), which is in line with the results of studies (Franchini et al., 2005; Franchini, Del Vecchio, Matsushigue, & Artioli, 2011; Kim, Cho, Jung, & Yoon, 2011), where high arm muscle mass is associated with better performance in judo (Drid et al., 2015; Kubo et al., 2006), which is evident in our competitor.

Also, the grip strength, i.e. the optimal grip strength of the first is of exceptional importance in judo when holding the opponent during the fight (Bonitch-Gongora, Bonitch-Dominguez, Padial, & Feriche, 2012; Franchini, Miarka, Matheus, & Del Vecchio, 2011), and its evaluation by the dynamic test is very important. The grip strength of judokas is higher if their weight category is higher (Sanchez, Dominguez, Turpin, et al., 2011). Some research studies have linked grip strength to a variety of physical variables including nutritional status, rotator cuff weakness, fatigue, and overall physical function in relation to subject age, health status, or training status (Alkurdi, & Dweiri, 2010). Grip strength is positively correlated with other muscle groups, including the legs, because it is considered a possible predictor for a valid assessment of total physical strength. In the current study, hand grip strength was estimated by the dynamometry of the left hand (=45.5kg) and the right hand (=46.6kg), and the results show that hand strength records excellent values. The obtained results, in addition to strong abilities, can be partially correlated with the weight of the competitor, which is confirmed by the aforementioned research.

According to Katralli, Itagi, & Goudar, (2015) judo is an explosive power sport, which requires large reserves of anaerobic power and capacity, and yet functions within a well-developed aerobic system. The state of explosiveness and speed of individual movement of cranial extremities was assessed by throwing the ball (medic ball 3kg) from a standing position with both hands above the head (=10m), throwing from a sitting position with hands from the chest (=6.80m), throwing lying on the back with both hands above the head (=7.20m) and throwing a handball from a distance of 7m (=17.87m/s). The obtained results of the study are clear indicators of synchronous action of muscle kinetic chains of cranial extremities, which is an important factor in judo when performing manual techniques, where it is

necessary to perform adequate technique with strength, explosiveness and speed of individual movement and score over the opponent, which is in line with previous studies (Detanico, Budal Arins, Dal Pupo, & Dos Santos 2012; Miarka et al., 2012). In parallel with the explosiveness of the cranial extremities, during the fight, the effect of the explosiveness of the caudal extremities in the sagittal and frontal planes is evident. The explosiveness of the caudal extremities was assessed by tests: long jump from place (=190cm), triple jump from place (=5.10m), sprint 10m (=2.70sec.), sprint 20m (=4.10sec.). The obtained results confirm the relatively good state of explosiveness, which is manifested by performing leg techniques, especially if the body weight of the competitor (over 115kg) is taken into account, which is a disturbing factor in the manifestation of explosiveness. Therefore, our data may suggest that strength is generally a discriminatory factor in female judokas, i.e. often a decisive positive factor of result success, as in our case. Given the fact that the share of anaerobic strength and speed in certain parts of judo is evident, speed is extremely important, which is confirmed by the result of a sprint at 30m (=5.55sec.) which mobilizes phosphocreatine mechanisms for up to 8sec. (Table 1, Figure 1). This is an indicator that sprinting abilities are very present in judokas when fast muscle fibers are activated and they work in conditions of oxygen debt.

The importance of developing maximum muscle strength for improving athletic performance in most sports, including and judo, is generally accepted. During training and competition, the human body takes energy for activities depending on their intensity and duration, and most often the energy for muscle activity in judo comes from anaerobic sources-ATP (Katralli et al., 2015). High levels of anaerobic capacity, as well as superior strength parameters, are necessary for superior performance, and anaerobic capacity assessment is a standard procedure in judoka testing. Judo competitions define periods of maximum or submaximal intensity, intermittent high intensity (20-30sec.), requiring the manifestation of anaerobic strength. According to Pennington, (2014), anaerobic power is used in high-intensity exercise attacks lasting less than ten seconds, which is the upper time limit for depleting phosphocreatine reserves as the primary fuel source and is defined as Peak anaerobic power output (PAP). In this regard, numerical indicators of different variants of vertical jumps (SJ =24.7cm; CMJ= 26.7cm; CMJ<sub>arm</sub>=30,6cm) defined and confirmed a relatively good state of explosiveness of the muscular kinetic chains of the caudal extremities, which is a valid indicator that vertical explosiveness is also significant and represented in judo during the training and competition process. Also, Peak anaerobic power output (PAP) of our competitor is high value, SJ<sub>PAP</sub>=4816.87W; CMJ<sub>PAP</sub>=4938.27W and CMJ<sub>arm</sub><sub>PAP</sub>=5175W (Figure2) and are significantly higher than some PAP studies (Quintero, Da Rosa Orssatto, Pulgarin, & Follmer, 2019).

Also, judo fight is characterized by the movement of caudal extremities with fast entrances into the body of the opponent, the so-called jumps with the aim of making the best possible contact and disturbing his balance. An unavoidable segment of judoists' strength is the isometric strength of the caudal (lower) extremities, where elite judokas also have better results in semi-squats than lower-ranked ones. Research by Sbriccoli, Bazzucchi, Di Mario, et al. (2007) determined the outstanding parameters of isometric strength in elite Italian judokas, which is in line with the requirement for high strength required in judo wrestling. In our study, the isometric strength of the caudal extremities - Squat test endurance (=53.13sec.) Was estimated, which is in relation to the tabular values in the category - *Excellent* result (Mackenzie, 2005), which is in line with the findings of previous research (Imamura, Iteya, Hreljac, & Escamilla, 2007). As it is a polystructural acyclic movement, judo competitors are also characterized by having a high level of agility. The recently performed Illinois agility test (Illinois=19.87sec.) and average speed (3.27m/s) is an indicator that our competitor has above average developed agility, which is in line with the findings of previous studies (Stachoń et al., (2016), which to a large extent depends on the degree of development of the central nervous system. However, in this case, body weight can be a disruptive factor in the

realization of the test, while the Coordination Index proved to be an adequate value (CI=12.74), which corresponds to the morphological status of the competitor. However, this parameter is partly expected, as it is a competitor with well-developed explosiveness that correlates with agility during the performance of the appropriate technique. The state of the central nervous system is characterized by a variable that we defined as the energy of elasticity (EE=7.49) and corresponds to good neuromuscular adaptation. Elasticity plays a significant role in increasing strength in a variety of cyclical and acyclic movements including judo. Analysis of the results of Nurmekivi, Lemberg and Pääsuk (2016) shows that the development of muscle elasticity plays an important role in improving neuromuscular adaptation of athletes, where the brain as an organ is most related to motor power.

#### 4. CONCLUSION

This is the first realized research for a top judo competitor in Bosnia and Herzegovina. The results of the study will provide a better understanding of the importance of the fitness profile of heavy weight judokas female in achieving top results. It will be a kind of signpost for competitors and trainers to adjust the training process with the help of data on the physical condition of their competitors and possible fitness norms. The study is an indicator of the importance of the participation of most motor (physical) abilities in the resultant success of judokas female, confirming the thesis on the importance of high integration of segments of the anthropological space. The obtained results can serve as a model for comparison with some other competitors, of the same weight category and similar or different fitness abilities.

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