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Predictors of Judo Performance in Male Athletes

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Abstract
Main goal of this research was to identify and rank the predictors of athletic performance for male judo athletes. We have interviewed 18 top-level European judo coaches, and asked them to rank the importance of different general physical fitness, motor abilities and specific strength variables in the success of judo athletes for three weight groups: lightweight (< 66 kg), middleweight (67 – 90 kg), and heavyweight (> 90 kg) athletes. We have established coefficients of concordance to assess agreement among judo coaches about judo achievement predictors. To establish the differences among the three weight groups a nonparametric Z-test was done. Among the general factors, coaches ranked physical fitness and technical and tactical knowledge, as the most important factors for success in judo with no major differences in the hierarchical structures among weight categories. Heavyweight athletes benefit most from maximal strength, while motor-skill speed and power were judged as the most important factors in lightweighters. Muscular and cardiovascular endurance are significant predictors of judo success regardless of weight category.

Key words: **combat sport, questionnaire, motor abilities, weight categories**

Sažetak
Osnovni cilj ovog istraživanja bio je identificirati i rangirati prediktore uspješnosti judaša muškaraca. Anketiralo se 18 vrhunskih Evropskih judo trenera, koji su trebali rangirati po važnosti za uspjeh u judu općenito antropološke karakteristike, različite motoričke sposobnosti i specifične varijable snage za tri različite težinske skupine: niže težinske skupine (< 66 kg), srednje težinske skupine (67 – 90 kg) i više težinske skupine (> 90 kg). Da bi se utvrdio stupanj slaganja između anketiranih trenera izračunat je Kendall Tau koeficijent. Za utvrđivanje razlika u rezultatima između tri težinske skupine primijenjen je neparametrijski Z test. Promatrajući općenita obilježja, treneri su rangirali motoričke sposobnosti i tehničko-taktičko znanje kao najvažnije faktore uspješnosti u judu bez znatnih razlika u redoslijedu između težinskih skupina. Kod viših težinskih kategorija maksimalna snaga determinira uspješnost dok je kod nižih težinskih kategorija najvažnija brzina i eksplozivna snaga. Mišićna i kardiovaskularna izdržljivost je značajan prediktor uspješnosti u judu bez obzira na težinsku kategoriju.

Ključne riječi: **borilački sport, anketni upitnik, motoričke sposobnosti, težinske kategorije**

Introduction

For top results in the area of sport it is necessary to dispose with current scientific cognitions about the influence of anthropological characteristics on performance and success. Judo is a complex sport, involving a considerable number of dimensions (abilities, characteristics, and skills) that influence the final combat result. The volume and intensity of the judo combat classifies judo as an anaerobic-aerobic sport (Franchini et al. 2007, Almansba et al. 2007, Sbriccoli et al. 2007). Previous studies found stronger and mesomorphic judoists to have an advantage over their opponents of comparable technical skills (Krstulovic et al. 2005, Krstulovic et al. 2006, Franchini et al. 2005). Since judo basically consists of two fighters outsmarting each other, judo experts consider specific intellectual capabilities as highly important for a successful judo athlete (Filaire et al. 2001a, Filaire et al 2001b). Finally, athletes with a low level of the anxiety, and high ego and self-confidence are judged as potentially more successful (Filaire et al 2001b, Gimeno et al. 2007, Gernigon and Le Bars 2000). In defining the characteristic relationships among the physical, morphological, and/or personal characteristics of judoists as predictors and judo achievement criteria, some specific problems need to be addressed. First, the investigator has to observe a relatively large number of high-class (elite) subjects from each of seven weight categories and test them with great number of different tests. Second, to make certain that all athletes are observed in the same period of the competitive season and in a similar phase of the sport form, it is crucial to ensure the testing of all subjects involved during a relatively short testing period. Third, achievement in judo cannot be simply quantified as in some other sports like track and field, rowing, cross country skiing and/or swimming. Therefore, all previously mentioned studies investigated only the partial influence of a few dimensions potentially related to judo performance. In other words, we have found no recent study in which authors observed a wide spectrum of abilities and/or characteristics that could influence judo achievement. In this study, we have tried to avoid the aforementioned problems while using a relatively original approach in studying the influence of different dimensions on sport achievement and performance. The idea was to outline the hierarchy of the

abilities, characteristics, and skills important in the sport of judo by interviewing judo experts. Feltz and Lirgg (1998), Yeung et al. (2001) and Magyar et al. (2004) applied such approach for hockey, marathon, and rowing, respectively. However, in the literature we have found that only van Rossum et al. (1994, 1996) studied judo in the similar manner. However, in both Dutch studies, authors observed different sports while including a relatively small number of specific dimensions potentially related to success in one particular sport (e.g., dimensions potentially important only in judo). In this paper, we have studied the problem more specifically while analyzing the abilities and characteristics (factors) considered particularly important in judo. Therefore, the aim of the study was to identify and rank the predictors of athletic performance for male judo athletes observed in three weight groups.

Materials and Methods

Subjects: The sample of respondents (interviewed subjects) consisted of 18 top-level European coaches and national team managers from 14 countries. The subjects were 35 to 56 years of age, and coached and/or managed in judo for at least 11 years. Most of them were highly educated in the field of sport science.

Instruments: Although subjects were interviewed using a long questionnaire, in this paper we have analyzed only the responses on three hierarchically designed factors. In the first and most general factor, coaches were asked to rank the importance of five predictors: (1) physical fitness (motor abilities), (2) body constitution (body build), (3) technical-tactical readiness (motor skills and tactical knowledge), (4) psychic profile (competitiveness, persistence, etc.), and (5) sport-specific intelligence. The second factor was designed to rank physical fitness capacities potentially related to judo performance, and subjects were asked to rank the significance of (1) strength capacities, (2) judo specific endurance, (3) speed, (4) flexibility, (5) balance, and (6) coordination. In the third and most specific factor, subjects ranked three strength dimensions: (1) maximal strength, (2) muscular endurance, and (3) power (explosive strength).

Coaches were asked to assign rank 1 to the predictor judged most important, rank 2 to the second most important dimension, and so on. The assigning was done for each factor separately, and we accepted equal ranks for two dimensions within the each factor. It must be noted that respondents judged the importance of predictors separately for three weight groups: lightweight (<66 kg), middleweight (67–90 kg), and heavyweight group (>90 kg) of male judo athletes.

Statistical analysis: The coefficients of concordance (Kendall Tau coefficients) were calculated to assess agreement among respondents (judo coaches). Using descriptive statistics (means and standard deviations), we ranked the dimensions within each of the observed factors. Finally, to establish the differences among the three weight groups in terms of the mean score of each predictor within the three observed factors, a nonparametric Z-test was done. A level of significance of 95% was applied.

Results

Average Kendall Tau coefficient of 0.59 showed high agreement among coaches in their rankings of the factors influencing judo performance.

As presented in Table 1, within the most general dimensions in light weight and middle weight categories physical fitness capacities were ranked as most important, followed by TE-TA readiness, psychic profile, sport-specific intelligence, and body constitution. In heavy weight category TE-TA readiness is ranged as first, followed by physical fit-

Table 1.

Descriptive statistics (M - Mean; SD – Standard Deviation), overall ranking (bracketed numbers), and Z-test significance of the differences between weight groups for general judo performance predictors

PREDICTOR	Light weight M ± SD	Middle weight M ± SD	Heavy weight M ± SD
Physical fitness (motor abilities) [c]	1.52±0.77 (1)	1.97±1.05 (1)	2.70±1.11 (2)
Body constitution (body build) [b]	4.52±1.06 (5)	4.59±0.70 (5)	3.80±1.50 (5)
Technical – tactical readiness	2.49±1.22 (2)	2.15±1.21 (2)	2.00±1.08 (1)
Psychic profile	3.19±1.06 (3)	3.04±1.00 (3)	3.33±1.28 (4)
Sport specific intelligence	3.28±1.20 (4)	3.30±1.20 (4)	3.28±1.36 (3)

LEGEND: [a] indicates significant difference between Light and Middle weight; [b] indicates significant difference between Middle and Heavy weight; [c] indicates significant difference between Light and Heavy weight

ness, sport specific intelligence, psychic profile and body constitution as the last factor. Significant differences in the mean scores for each dimension were found only for physical fitness when comparing their importance for lightweight and heavyweight athletes and body constitution, when comparing their importance for middleweight and heavyweight athletes. Briefly, body constitution received a relatively higher mean score in middleweight athletes, while coaches gave physical fitness a higher mean score for athletes in the lightweight category.

The hierarchy of specific physical fitness capacities in judo athletes is evidently different when comparing the three observed weight categories (Table 2). In lightweight judo athletes, coaches ranked speed as the most important fitness capacity, followed by judo specific endurance, coordination, strength, balance and flexibility. For middleweight athletes, endurance is ranked first and strength is placed as second, followed by speed, coordination, balance and flexibility. Strength is judged as the most important physical fitness dimension in heavyweight male athletes, followed by judo specific endurance, balance, speed, coordination and flexibility. Logically, such discrepancies in the relative importance of physical fitness dimensions for each weight category are followed by numerous significant differences in the mean scores for each dimension among weight categories.

The most interesting are the variations in the scores for strength capacities and speed (significantly different among weight categories in all comparisons). At the same time, the mean scores for flexibility balance and coordination did not differ significantly among weight categories.

The importance of explosive strength decreases with the weight of the athletes, while the value of maximum strength is more evident in heavyweight athletes (Table 3). Such trend is followed by significant differences in mean scores. Muscular endurance is a highly ranked strength dimension for middleweight judoists.

Table 2.

Descriptive statistics (M - Mean; SD – Standard Deviation), overall ranking (bracketed numbers), and Z-test significance of the differences between weight groups for physical fitness judo performance predictors

PREDICTOR	Light weight M ± SD	Middle weight M ± SD	Heavy weight M ± SD
Strength capacities a b c	3.79±1.39 (4)	2.78±1.30 (2)	1.10±0.25 (1)
Flexibility	4.79±1.23 (6)	5.28±0.95 (6)	5.41±0.98 (6)
Judo specific endurance a b	2.79±1.20 (2)	1.99±1.12 (1)	3.28±1.66 (2)
Speed a b c	1.45±0.80 (1)	2.91±1.32 (3)	3.81±1.05 (4)
Balance	4.67±1.29 (5)	4.24±1.11 (5)	3.62±1.22 (3)
Coordination	3.47±1.11 (3)	3.75±1.15 (4)	3.88±1.75 (5)

LEGEND: a indicates significant difference between Light and Middle weight; b indicates significant difference between Middle and Heavy weight; c indicates significant difference between Light and Heavy weight

Table 3.

Descriptive statistics (M - Mean; SD – Standard Deviation), overall ranking (bracketed numbers), and Z-test significance of the differences between weight groups for strength-type judo performance predictors

PREDICTOR	Light weight M ± SD	Middle weight M ± SD	Heavy weight M ± SD
Maximal strength b c	2.85±0.39 (3)	2.79±0.47 (3)	1.50±0.79 (1)
Muscular endurance a b	1.71±0.70 (2)	1.22±0.55 (1)	1.81±0.59 (2)
Power (explosive strength) a b c	1.32±0.61 (1)	2.06±0.54 (2)	2.60±0.44 (3)

LEGEND: a indicates significant difference between Light and Middle weight; b indicates significant difference between Middle and Heavy weight; c indicates significant difference between Light and Heavy weight

Discussion

It is interesting to note that, when van Rossum and associates (1994) studied judo predictors, they found only 0.36 concordance among judo experts. On the other hand, our analysis showed far better agreement (0.59) among respondents. Most probably, the higher expertise of the judges we have sampled led to the higher correlation in their evaluation of the judo predictors. Also, van Rossum and his associates (1994) studied judo in general, while we divided judo athletes into three weight groups. Almost certainly, such differentiation allowed judges to interpret the judo predictors in our study more specifically. We considered intriguing the fact that the results evidenced a similar hierarchy of the general dimensions (Table 1) potentially related to judo success in each weight category, especially when compared to dissimilarities in the hierarchy of physical fitness (Table 2) and strength dimensions (Table 3). Most probably, the hierarchy of the general dimensions differentiates judo athletes from participants in other sports and/or distinguish generally more successful judo athletes from their less successful peers, while physical fitness and strength factors define the judo performance predictors in the different weight categories of judo athletes. We discuss this more specifically in the following sections.

General hierarchy of factors potentially related to judo performance in females

Comparing gained results with the investigation of van Rossum et al. (1994), significant differences are noticeable in the importance of some factors on judo success. Briefly, the Dutch study ranked physical fitness as fourth and tactical ability as sixth most important out of eight explored factors, while the same dimensions emerged as the most important factors out of the five dimensions observed in our study. Since 1994 (the year the Dutch study was published) the rules of the judo match have changed significantly. The change is mainly related to the fact that modern judo directly "penalizes" passive fights. The logical consequence of such a ruling in judo is a high-intensity match, and accordingly, the requirement of a high level of (1) physical fitness and (2) tactical knowledge for the athletes. In the last decade, there is probably no published paper in which the importance of physical fitness in judo is not highlighted (Franchini et al. 2007, Krstulovic et al. 2005, Krstulovic et al. 2006, Franchini et al. 2005, Monteiro et al. 2007, Almansba et al. 2008) directly supporting our findings and previous discussion regarding physical fitness status. On the other hand, studies by Calmet and Ahmaidi (2004) and Franchini et al.(2008), in which judo athletes of high rankings were shown to be more technically and tactically skilled than their less successful rivals, validate our findings about the relative importance of technical-tactical skills in judo. Based on our results, body build does not influence judo performance considerably, which was already suggested in experimental studies in which body build was related to judo performance (Krstulovic et al. 2005, Krstulovic et al. 2006, Monteiro et al. 2007). However, this interpretation must not be oversimplified. Briefly, judo athletes are known to be among the most mesomorphic athletes (Gualdi-Russo and Graziani 1993, Krawczyk 1997). In other words, appropriate body build (athletic physique, mesomorphic build) is highly important in judo, but judo athletes do not differ within their competitive group in the body-build dimensions because: (1) the ranges of the weight categories are relatively narrow (6 to 10 kg, excluding an absolute category 100+ kg) and (2) each top-class athlete (practically judged by coaches in this study) tends to reach the highest possible body weight in a specific weight category. These two factors narrow the variance of body composition status in judo athletes, Hence, (1) correlation analysis did not show a significant relationship between body-build dimensions and judo performance and (2) the coaches can't recognize body-build measures as important factors in judo performance (here presented results).

Relative importance of physical fitness factors in judo athletes

Based on our observations, the hierarchy of physical fitness variables potentially related to judo performance differs significantly among weight groups. However, the judo specific endurance is recognized as very important in each weight group (ranked as the first or second physical fitness factor in all three weight groups). Although in the questionnaire we have used there was no distinction between aerobic and anaerobic endurance, we have no doubt that coaches practically considered *anaerobic endurance* in their rankings. This is mostly attributed to the fact that recent studies performed on judo athletes noted relatively low levels of aerobic endurance capacities (less than 50 ml/kg – Franchini et al. 2007, Sbriccoli et al. 2007) and high levels of anaerobic endurance capacities in judo athletes (12 to 17 W/kg; 273 - 320 J/kg – Almansba et al. 2007, Sbriccoli et al. 2007). Additionally, these findings probably support our views regarding the high intensity of the judo match (see the first section of Discussion). The importance of motor-skill speed is widely accepted in lightweight judo. Lightweight athletes are mostly relatively shorter and, consequently, quicker than their colleagues competing in the higher weight categories (Almansba et al. 2008). Since quickness ensures a proper and efficient technique not only in the attack but also in the counterattack, coaches perceive motor-skill speed as essential in lightweight athletes. At the same time, strength evidently prevails as a more important physical fitness dimension in heavyweight categories. The main reason for recognizing strength as the most distinctive physical fitness dimension in heavier athletes, which is most probably correct, can be found in biomechanical and functional theories. Briefly, experiments demonstrated that human strength scales allometrically to the body weight of the subjects (Markovic and Sekulic 2006). Although this is a complex theory, in judo it practically means that heavier athletes vary in their

strength capacities more than their "lighter" colleagues do. Also, judo performance in higher weight categories is more static, accentuating strength capacities more significantly in heavier than in lighter athletes. Therefore, it is logical that coaches considered strength as more important in the middleweight and heavyweight categories than in lightweight judo. Coaches do not consider balance (stability) as an important parameter in judo, although judo is generally known as a "balance sport". Briefly, a judo combat practically consists of constant attempts to disrupt the opponent's balance, which allows for the efficient application of throwing techniques (Krstulovic et al. 2006). The explanation for the low ranking of this physical fitness variable is probably very much the same as that for the previously discussed low hierarchical position of body build in the first (general) factor. In short, studies demonstrated a strong positive influence of judo on the balance status (Perrin et al. 2002), but variations in balance among judo athletes are relatively small and, therefore, probably not related to judo performance. We are of the opinion that the same logic of explanation should be followed as well for coordination.

Strength in judo athletes

Previous studies demonstrated strong relationships between muscular endurance and anaerobic endurance in athletes. Such interrelationships are essentially physiologically explained and relate to the fact that both capabilities depend of the same energetic process – anaerobic glycolisis (Willmore and Costill 2002). It did not surprise us that the interviewed coaches considered muscular endurance as a highly important strength factor in all weight categories. Basically, even if they did not have knowledge of the complex physiological and biochemical background of the relation between these two variables, coaches would surely be familiar with the fact that successful judo athletes are simultaneously dominant in both muscular and cardiovascular endurance. As in the case of endurance capacities (see previous paragraph), the high ranking of explosive strength in lightweight judoists is also physiologically described. In the Discussion section, we have explained the importance of speed in lightweight athletes. Both explosive strength (power) and speed are directly related to the quantity (proportion) of fast twitch muscle fibers of each athlete (Willmore and Costill 2002). Therefore, the quickness of lightweight athletes simultaneously means a high level of explosive strength (power). Both of these fitness capacities allow athletes to apply efficient techniques and to perform better. In support of our discussion in the previous section, in which we emphasized the allometrical relationship between human body weight and strength, the highest ranking of maximal strength exclusively in heavyweight athletes should be considered as an expected result.

Conclusion

The following can be concluded: (1) Observation of three separate weight groups proved to be justified because hierarchies of specific physical fitness capacities and strength capacities in judo athletes differ significantly when comparing the three observed weight categories; (2) Among the general factors, coaches ranked physical fitness and technical and tactical knowledge as the most important factor of success in judo; (3) Strength capacities, judo specific endurance and speed fall into a category of more important abilities, and balance, coordination and flexibility less important abilities for success in judo; (4) motor-skill speed and power are significant predictors of sport success in lighter judo athletes, while maximal strength is more closely related to performance in heavier judo athletes, while muscular and cardiovascular endurance is recognized as very important in each weight group.

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