DE GRUYTER OPEN

Sport Science Review, vol. XXV, no. 5-6, 2016, 321 - 344
DOI: 10.1515/ssr-2016-0017

Maximal Isometric Handgrip Strength (HGS) in Greek Elite Male Judo and Karate Athletes

Georgios ZAGGELIDIS

The specificity of the technical performance in judo and karate demands from athletes to perform fast and powerful actions at a high level, therefore, much importance is given to the development and supporting motor system, in particular, HGS function. Research aim was to determine the characteristic of maximal isometric HGS in Greek elite male judo and karate kumite athletes that may be important for competitive success in the aspect of age and BMI and identify any differences between these two compact sports. The studies were carried out in the competitive period of 2015 training cycles. The subjects were male judokas with mean weight 84.24 ± 12.38 kg and karateka's 76.63 ± 10.46 kg. Average BMI (kg/m^2) for judokas 25.67± 3.60 and karateka's 23.03 ± 1.75. Research results showed that the HGS in dominant and nondominant hand in karateka's was 68.28 ± 7.3 kg and 63.28 ± 7.5 kg and in judokas 73.72 ± 7.85 kg and 71.34 ± 8.10 kg. karateka's had significant less stronger HGS compered to Judokas in dominant and nondominant hand, t^{32}= -2.089 and $p<0.05$ and t^{32}= -3.016 and $p<0.05$. Karateka's had significant higher differences between the two hands 4.94 ± 2.15 kg compered to judokas 2.38 ± 1.84 kg, t^{32}= 3.722 and $p<0.05$. The two groups had significant difference in BMI, t^{32}= -2,771 and $p<0.05$. Pearson correlation showed a significant correlation between HGS and BMI, $r=0.563$ and $p<0.05$. In conclusion judo and karate have different requirements and training methods due to the objectives and generally the technical training nature with judokas appearing stronger in the HGS compere to karateka's.

Keywords: hand dynamometry, Judo, karate, performance, grip, strength

ISSN: (print) 2066-8732/(online) 2069-7244

Introduction

Many studies have shown that practicing martial arts such as judo and karate provides various physiological benefits in strength, anaerobic capacity, balance, and flexibility as well as an overall improvement in cardiorespiratory fitness (Douris et al., 2004). Judo (J) is an intermittent grappling combat sport with high-intensity actions in which it is difficult to isolate which aspects can determine success in competition, considering the complexity and unpredictability of the techniques actions of combat (Miarka et al., 2012). Judo uses gripping and throwing techniques. Karate (K) is a martial art and modern combat sport very popular among boys and girls all over the world characterized by punches of both upper and lower limbs, incorporate straight line powerful blocking, kicking, and punching techniques as a major component (Pion, Fransen, Lenoir, & Segers, 2014).

Karate is divided into "kata" and "kumite". Kata is a set form in pre-established sequences of offensive and defensive techniques and movements such as a battle against an imaginary antagonist (Alesi et al., 2014). Kata performance judgement is essentially based on assessing the following: technique, rhythm, power, expressiveness of movement and "kime" (short isometric muscle contractions performed when a technique is finished with the transfer of explosive energy, Cohen, 2006). The last assessment category represents the most important criterion of proper kata execution. Kumite, in contrast, is a real match/combat between two competitors under strict rules; they are free to move, kick and punch in defensive and offensive manners (Chaabène, Hachana, Franchini, Mkaouer, & Chamari, 2012). Attacks in karate are normally made with hand or fist (punches) and foot (kick).

Muscular strength is the maximum force that a muscle group can exert over a brief Period. The HGS is the result of the maximum force that the subject is able to exert under normal biokinetic conditions through the voluntary flexion of all finger joints, thumbs, and wrists (Shyamal, K., & Yadav, 2009). HG is very important, although often underestimated strength component. However, the researches show that the HGS is very important component, especially in some sports: Climbing, Judo, Weightlifting, Wrestling, Tennis, Field hockey/s, Pin bowling, etc. (Ivanovic & Dopsaj, 2012). According to some researchers HGS is not always the same, along with gender and age it also depends on the specificity of the type of sports. In order of testing and measure upper limb strength is used and as a general judo (Zubitashvili, 2011) and karate (Keshishian, 2013) motor fitness test in many studies.

Other of the research studies correlated grip strength to various physical variables including nutritional status, rotator cuff weakness, fatigue, and overall physical function related to examinees age, health condition or training status (Alkurdi & Dweiri, 2010). Grip strength is also positively related to other muscle groups, including the legs; has long been thought of as a possible predictor for valid evaluation of overall body strength, ambidexterity (Čular, Miletić, & Miletić, 2010) and performance (Ortega, Ruiz, Castillo, & Sjöström, 2008; Ivanovic & Dopsaj, 2012).

Isometric HGS is essential for Judo sport performance in which the foundation of grip (combination of maximal strength and endurance) or "Kumi-Kata" is decisive for the outcome of a fight (Sánchez, Domínguez, Turpin, Tormo, & Llorca, 2011). During the bout, a judo athlete grips the opponent's uniform (judogi), which provides the basis for the execution of the throwing techniques (nage-waza) and non-standing combat (ne-waza), when a judoka wishes to apply a choke hold, an arm lock or other forms of immobilizing an opponent are incredibly important for successful J performance (Detanico, Arins, Pupo, & Santos, 2012).

The gripping method (kumi-kata) is the first contact between 2 judo athletes and basic support for the implementation of other techniques that may determine the result of the bout(Ache Dias et al., 2012). In this sense, the "Kumi-Kata" consists of a skill handgrip, in which the ability to generate force effectively through the hands and fingers is crucial to attack, defend and maintain balance (Margnes, & Paillard, 2011). In a combat situation, judo athletes consumes 51 ± 11% of the time during the struggle for grip and repeat this action at least 15 or 20 times per bout for a median time of almost 8 minutes that a combat can last (Bonitch-Góngora, Bonitch-Domínguez, Padial, & Feriche, 2012).

In K the main goal is to deliver the punch or kick with as much force as possible during sparring. Is characterized by rapid (ballistic actions) and fine control movements highly dependent on the athletes' ability to generate muscular force (for most muscle groups) and power (Gulledge & Dapena, 2008). The body parts must be moved rapidly and, therefore, muscle shortening must be achieved quickly. The use of speed and power is dictated by the purpose of the techniques (Keshishian, 2013). Maximal velocity and explosive strength represent the main determinant of the muscle mechanical factors involved in karate performance. Decisive actions during kumite karate (kick or punch) are mainly dependent on muscular explosive power, and karate match performance is exclusively influenced by higher levels of upper and lower limb power/speed production (Sbriccoli et al., 2010).

Some scientists have believed that useful parameters discriminating physical ability in combat sport athletes are maximal anaerobic power and aerobic capacity examined during leg cycling and arm cranking (Franchini, Miarka, Matheus, & del Vecchio, 2011). One of the most frequently used parameters is HGS determined by hand dynamometer (Obminski, Litwiniuk, Staniak, Zdanowicz, & Weimo, 2015).

It has been stated that the development of HGS do not differ between elite and non-elite judokas (Franchini, Takito, Kiss, & Sterkowicz, 2005), but it is also obvious that values are directly related to the quality of body working ability, being one of the most important conditions for success (Zubitashvili, 2011). Interestingly, there were no significant differences between the elite and novice karate participants for grip strength. However, it is also possible that grip strength itself and/or its less dynamic nature is not specific to K performance (Keshishian, 2013). In fact, Imamura, Yoshimura, Uchida, Nishimura, & Nakazawa, 1998 did report significant differences between elite and novice K participants in bench press strength and half squat strength. Maximal strength and muscular endurance are incredibly important for successful J performance (Monteiro, Massuça, García, Carratala, & Proença, 2011; Vecchio, Matsushigue, & Franchini, 2011). Considering the importance of bilaterality in J, these strength factors should be equally exhibited by both sides of the body. However, Bonitch-Góngora et al. (2012) found that maximal grip strength was significantly larger in the dominant rather than the non-dominant hand of judo athletes. The equal mastery of K techniques with both body sides is an important factor of K competition success (Grouios, Tsorbatzoudis, Alexandris, & Barkoukis 2000).

Studies comparing performance characteristics in multiple combat sports are limited and to our knowledge, no many studies have compared performance related characteristics in K and J specifically, such as static strength which was measured by the handgrip.

Methods

Participants

The subjects were 16 elite (with national, European and international participation) male judokas with mean weight 84.24 ± 12.38 kg and 18 elite kumite karateka's 76.63 ± 10.46 kg. and aged 24.25 ± 2.60 and 23.39 ± 2.81respectively.

Procedures

Preliminary Test. The subjects performed a training session with the grip test to familiarize themselves with the instrumentation and the maximal isometric HGS measurement protocol, for which we used a Jamar grip strength dynamometer (Hydraulic Hand Dynamometer, 5030J1). As recommended by Watanabe et al., (2005) the subjects made various attempts with both hands, noting the most comfortable distance to the handle when gripping the dynamometer and this distance was maintained during all subsequent tests. Each subject was instructed to obtain a maximal isometric contraction of HGS, alternately both hands was measured with the hand dynamometer. Contractions were made with each hand with both feet on the floor, the shoulder bent by 90º, and the elbow completely extended.

All subjects performed 3 trials, and the average of the two best performance in both hands was used. Basic demographic data and information about the athletes' individual's, year of birth, competition weight categories, the result obtained in the competition and lateral dominance of the competitor were collected. Hand dominance was determined by asking the subject which hand was used to hold a pencil and to throw a ball (Ager, Olivett, & Johnson, 1984).

Body weight and body height were measured to the nearest 0.1 kg and 0.5 cm, respectively. Body mass index (BMI) was calculated using the formula: BMI (kg/m^2).

Statistics

All values were reported as mean ±SD, and for all tests the significance level was set at $p<0.05$ and was two tailed method. An Independent Samples T-Test was used to investigate any differences between the two groups (karate athletes and Judo athletes) regarding the maximum isometric grip strength in the dominant and nondominant hand, the differences between the two hands as well as in the body mass index (BMI). In addition a paired samples T-Test was made to investigate differences between dominant and nondominant hand in both groups. In order to evaluate the relationship between the maximum isometric HGS and body mass index (BMI), Pearson's correlation was calculated.

Results

Mean data of weight, height, body mass index (BMI), dominant hand maximum isometric handgrip strength (HGS), nondominant hand maximum isometric handgrip strength (HGS) as well as the differences in measurements between the two hands in maximum isometric HGS are displayed in Table 1.

Table 1. Mean data of Weight, Height, BMI, and Dominant hand (HGS) and Nondominant hand (HGS) and between two hands (HGS) differences.

	Karate (n=18)	Judo (n=16)	t	p
Weight (kg)	76.63 ± 10.46	84.24 ± 12.38	-1.941	0.061
Height (m)	1.82 ± 0.8	1.81 ± 0.2	0.499	0.624
Age	23.39 ± 2.81	24.25 ± 2.60	-924	0.362
BMI (kg/m^2)	23.03 ± 1.75	25.67± 3.60	-2.771	0.009
Dominant HGS (kg)	68.28 ± 7.3	73.72 ± 7.85	-2.089	0.045
Nondominant HGS (kg)	63.28 ± 7.50	71.34 ± 8.10	-3.016	0.005
HGS differences (kg)	4.94 ± 2.15	2.38 ± 1.84	3.722	0.001

The Independent Samples T-Test analysis showed a significant differences in maximum isometric handgrip strength between the two groups in dominant hand 68.28 ± 7.3kg (Karate athletes) vs. 73.72 ± 7.85kg (Judoka athletes), t^{32}=-2.089 (Figure 1) and $p<0.05$ and nondominant hand 63.28 ± 7.50kg (Karate athletes) vs. 71.34 ± 8.10kg (Judoka athletes), t^{32}=-3.016 and $p<0.05$ (Figure 2).

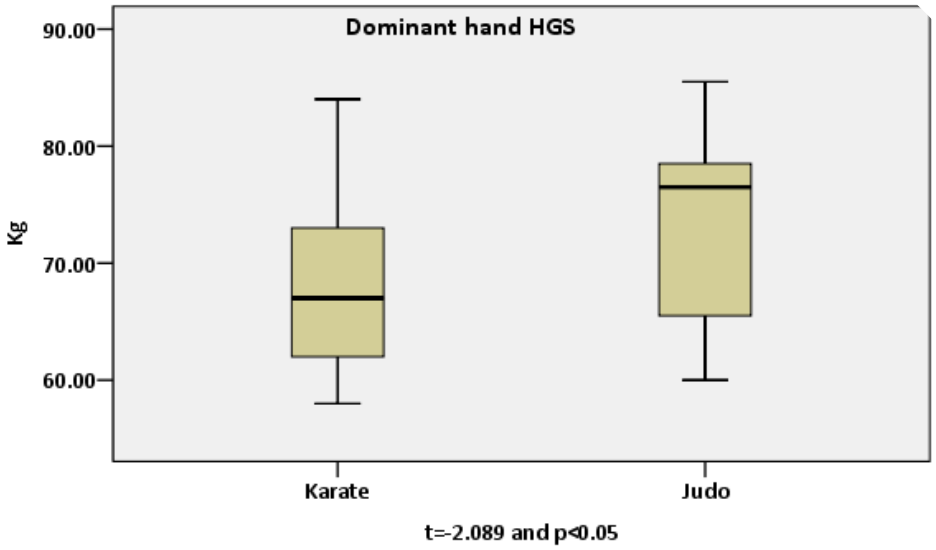

Figure 1. Dominant hand handgrip isometric strength.

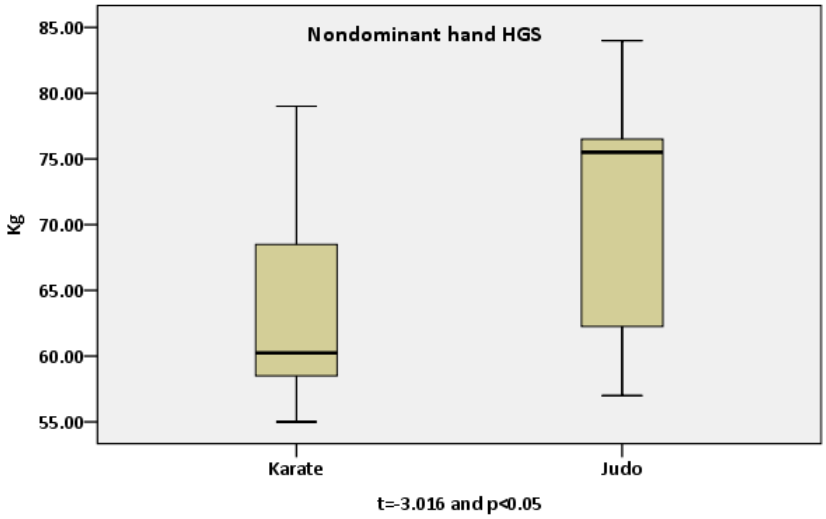

Figure 2. Nondominant hand handgrip isometric strength.

Both groups had significant differences in maximum isometric HGS comparing dominant and nondominant hand, $t^{17}=9.810$ and $p<0.05$ (karate athletes) and $t^{15}=5.165$ and $p<0.05$(judo athletes). Between dominant and nondominant hand, karate athletes demonstrate HGD differences 4.94 ± 2.15kg significantly bigger compared to Judo athletes 2.37 ± 1.84kg and $t^{32}=3.722$ and $p<0.05$. (Figure 3)

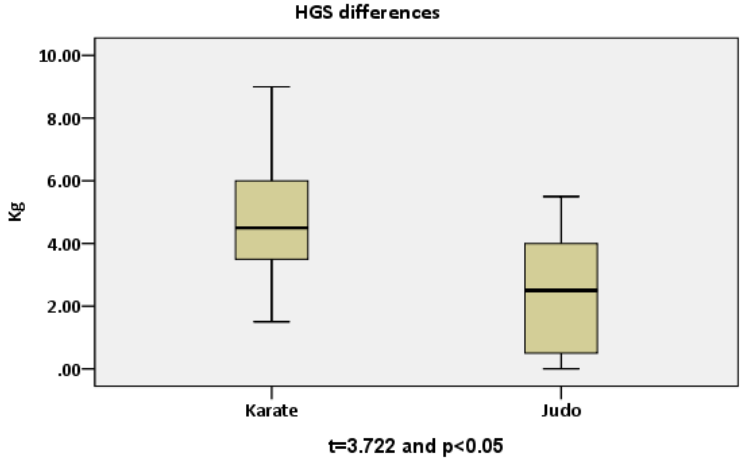

Figure 3. Differences between dominant and nondominant hand in HGS

Regarding the BMI the two groups (karate athletes and Judo athletes) had significant differences, 23.03 ± 1.75 kg/m^2 and 25.67 ± 3.60 kg/m^2 respectively, t^{32}=-2.771 and $p<0.05$. Concerning the Weight the two groups didn't show significant differences, 76.63 ± 10.46kg (Karate athletes) and 84.24 ± 12.38kg (Judo athletes), t^{32}=-1.941 and $p>0.05$. However the judo athletes were nearly 8 kg on average heavier than the karate athletes. Similarly both groups didn't show significant differences in height, t^{32}=0.472 and $p>0.05$ and age, t=-0.924 and $p>0.05$.

A Pearson's correlation between body mass index (BMI) and the maximum isometric grip strength (HGS) showed a moderate correlation r=0.515 and $p<0.01$ (dominant hand) and t=0.563 and $p<0.05$ (nondominant hand).

Discussion

The optimum hand-grip strength during a judo match has become an important element for judo athletes (Sánchez et al., 2011). In J gripping is crucial as a means of controlling an opponent's focus of attention, posture, and balance (Nasri et al., 2013). The grip is used to transfer forces caused by actions performed during attack or defense to an opponent's body. The specific technical and tactical actions in a judo bout cause the athlete to adapt individual "Kumi-Kata"- hand grip on the clothes (Sterkowicz et al., 2016). Several studies showed high scores in maximum HGS among Combat Sport Athletes especially in Judo athletes (Sterkowicz et al., 2016; Zubitashvili, 2011; Prouteau, Ducher, Serbescu, Benhamou, & Courteix, 2007; Nasri et al., 2013; Torres-Luque, Hernández-García, Escobar-Molina, Garatachea, & Nikolaidis, 2016; Bonitch-Góngora et al., 2012). For example Zubitashvili, (2011) studied judoka's hand-grip strength in the aspect of age and weight categories, and showed that the average indices of hand-grip strength increase with age and weight category of judokas. In particular in the categories of 81-90 and 91-100, the 20 years old Judo athletes had an average of HGS 66.70kg and 70.7kg respectively. Similarly twenty-two male elite French Judo athletes were tested in maximum HGS by Prouteau et al. (2007) and their average were over 70kg. In the present study the Judo athletes with an average age of 24.25 years old in maximum isometric HGS had an average of 73.72kg.

Practitioners of soo bahk do (SBD) is a Korean martial art similar to karate) with mean age 46.7 years have shown HGS 48.05kg significant higher than the sedentary group (Douris et al., 2004). In other study 20 years old Taekwondo athletes demonstrate HGS an average of 56.57 ± 7,70Kg (Heller et al., 1998). The same phenomenon was established in highly trained female Karate athletes which are known to require significantly strong hand grip strength were

significantly stronger than untrained female counterparts (Ivanovic & Dopsaj, 2012). In this survey involved elite male Karate athletes aged 23.39 ± 2.81 years old and therefore achieved high performances in maximum isometric HGS, dominant hand 68.28 ± 7.3kg.

It is obvious that there aren't significant changes in relation to the overall force relations inside the area of athletes who practice martial arts. However, considering the nature of these sports differences must exist. Previous studies have shown that the wrestlers compered to karate athletes had stronger arm muscle strength and trunk muscle strength resulting from various competitive and training demands of these sports (Babiak, Strajnić, Sudarov, Vojinović, & Kalentić, 2011) measured Judo and Karate athletes with mean age 16.47 years old and they observed significant differences in both hands regarding maximum HGS, dominant hand 51.30 ± 9.01kg (Judo) vs. 46.60 ± 10.22kg (Karate) and nondominant hand 49.24 ± 9.17kg vs. 43.47 ± 9.75kg. In a study that participated martial arts athletes with mean age 11.6 years old no differences were found in maximum HGS between the Judo and karate athletes while in the same study with athletes aged 16 years old the judo athletes had significant higher scores in maximum HGS compared to Karate athletes (Pion et al., 2014). This difference may be due to the diversification of preparedness to address the specific needs of these two sports. Similarly results were found in this study between Judo and Karate athletes with Judo athletes demonstrating higher maximum isometric HGS in both hands against Karate athletes, dominant hand 73.72 ± 7.85kg vs. 68.28 ± 7.3kg and nondominant hand 71.34 ± 8.10kg vs. 63.28 ± 7.50Kg.

Based on the results between dominant and nondominant hand, karate athletes demonstrate HGD differences between dominant and nondominant hand 4.94 ± 2.15kg significantly bigger compared to Judo athletes 2.37 ± 1.84kg. Judo is a compact sport with frequent grappling techniques, but also involves a combination of holds and throws in which participants frequently use isometric strength to submit an opponent, where it may be extremely important for success in competitions when both the left and the right techniques are used (Stachoń, Burdukiewicz, Pietraszewska, Andrzejewska, & Stefaniak, 2016). Similar differences showed in their study Obminski et al. (2015) where Judo participants aged 23-27 years old seemed that they had HGD differences between dominant and nondominant hand 3.6 kg. Gajevi, Ivanovi, & Badnjarevi, (2014) found in 16 year old athletes HGD differences, Judo 2.06 Kg, karate 3.13 kg and Taekwondo 4.47 kg. In combat sport athletes aged 17.1 the mean HGS difference was 3.5 kg. 22 year old Spanish national Judo athletes found to have 2.2 kg HGS differences between dominant and nondominant hand, 20 year old Cypriots competitive Judo athletes 4.5 Kg, adult French competitive Judo athletes 0.4 Kg. Athletes practicing Judo aged 19-26 years old found to have no

differences in HGS between dominant and nondominant hand 0.01 Kg, and Brazilian Jiu-jitsu 1.6 kg (Stachoń et al., 2015).

In the same study Stachoń et al. (2015) the mean BMI for the judo and jiu-jitsu athletes were similar (25.2 ± 2.4 kg/m^2 and 24.9 ± 2.3 kg/m^2, respectively. Mean BMI for Brazilian professional Judo athletes was 25.5 kg/m^2, Cypriots competitive 25.3 kg/m^2, Koreans collegiate 26.0 kg/m^2 and French national 26.5 kg/m^2 (Torres-Luque, et al. (2016). Aziz, Tan, and Teh, (2002) showed in members of the "silat" team (an Indonesian martial art incorporating strikes, grappling and throwing) average BMI 24.03 kg/m^2. Karate athletes 16 yrs. found with BMI 19.5 kg/m^2 and Judo athletes 21.9 kg/m^2 (Pion et al., 2014). Regarding the BMI the two groups (karate athletes and Judo athletes) in the present study had significant differences, 23.03 ± 1.75 kg/m^2 and 25.67 ± 3.60 kg/m^2 respectively. The two groups hadn't significant differences in weight 76.63 kg (karate athletes) and 84.24 kg (Judo athletes) and $p>0.05$ however the judo athletes in average were almost 8 kg heavier and it was notable that HGS correlated significantly with BMI, $r=0.563$, similar with Obminski et al. (2015) who showed significant correlation between BMI and HGS, $r=0.879$.

In conclusion judo and karate have different requirements and training methods due to the objectives and generally the technical training nature of both these combat sports regarding the overall intensity, dimension and type of explosive and strength training during the training process. The basis of the differentiated results in judo and karate athletes is in their physical characteristics with the judokas appearing stronger in the trunk and upper limbs and on an average higher in BMI scores mainly due to muscle overgrowth and not to increased body fat. The above results may be useful to trainers for the planning and outline of the training session regarding these sports.

References

Ache Dias, J., Wentz, M., Külkamp, W., Mattos, D., Goethel, M., & Borges Júnior, N. (2012). Is the handgrip strength performance better in judokas than in non-judokas? Science and Sports, 27(3), 9–14. doi:10.1016/j.scispo.2011.10.005

Ager, C. L., Olivett, B. L., & Johnson, C. L. (1984). Grasp and pinch strength in children 5 to 12 years old. American journal of occupational therapy 38(2), 107–113. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=6711662

Alesi, M., Bianco, A., Padulo, J., Vella, F. P., Petrucci, M., Paoli, A., … Pepi, A. (2014). Motor and cognitive development: The role of karate. Muscles, Ligaments and Tendons Journal, 4(2), 114–120. doi:10.11138/mltj/2014.4.2.114

Alkurdi, Z. D., & Dweiri, Y. M. (2010). A biomechanical assessment of isometric handgrip force and fatigue at different anatomical positions. Journal of Applied Biomechanics, 26(2), 123–133.

Aziz, A. R., Tan, B., & Teh, K. C. (2002). Physiological responses during matches and profile of elite pencak silat exponents. Journal of Sports Science and Medicine, 1(4), 147–155.

Babiak, J., Strajnić, B., Sudarov, N., Vojinović, J., & Kalentić, Ž. (2011). Muscle force harmonic canon of top karate athletes and Wrestlers. Proceedings of the 6th International Scientific Conference on Kinesiology, (pp. 138–140). Opatija, Croatia.

Bonitch-Góngora, J. G., Bonitch-Domínguez, J. G., Padial, P., & Feriche, B. (2012). The effect of lactate concentration on the handgrip strength during judo bouts. The Journal of Strength & Conditioning Research, 26(7), 1863–1871.

Chaabène, M. H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and Physiological Profile of Elite Karate Athletes. Sports Medicine, 42(10), 829–843. doi:10.2165/11633050-000000000-00000

Cohen, E. B.-O. (2006). Kime and the Moving Body: Somatic Codes in Japanese Martial Arts. Body & Society, 12(4), 73–93. doi:10.1177/1357034X06070885

Čular, D., Miletić, Đ., & Miletić, A. (2010). Influence of Dominant and Non-Dominant Body Side on Specific Performance in Taekwondo. Kinesiology, 42(2), 184–193. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=58771230&lang=pt-br&site=ehost-live

Detanico, D., Arins, F. B., Pupo, J. D., & Santos, S. G. D. (2012). Strength Parameters in Judo Athletes: an Approach using Hand Dominance and Weight Categories. Human Movement, 13(4), 330–336. doi:10.2478/v10038-012-0038-x

Douris, P., Chinan, A., Gomez, M., Aw, A., Steffens, D., & Weiss, S. (2004). Fitness levels of middle aged martial art practitioners. British Journal of Sports Medicine, 38(2), 143–147. doi:10.1136/bjsm.2002.001768

Franchini, E., Miarka, B., Matheus, L., & del Vecchio, F. B. (2011). Endurance in judogi grip strength tests: Comparison between elite and non-elite judo players. Archives of Budo, 7(1), 1–4.

Franchini, E., Takito, M. Y., Kiss, M. A P. D. M., & Sterkowicz, S. (2005). Physical Fitness and Anthropometrical Differences. Biology of Sport, 22(4) 315–328.

Gajevi, A., Ivanovi, J., & Badnjarevi, N. (2014). The influence of athletic background on muscle force production. Proceedings of the 7th international scientific conference on kinesiology (pp. 137–141). Opatija, Croatia.

Grouios, G., Tsorbatzoudis, H., Alexandris, K., & Barkoukis B. (2000). Do left-handed competitors have an innate superiority in sports? Perceptual and Motor Skills, 90(3), 1273–1282.

Gulledge, J. K., & Dapena, J. (2008). A comparison of the reverse and power punches in oriental martial arts. Journal of Sports Sciences, 26(2), 189–196. doi:10.1080/02640410701429816

Heller, J., Peric, T., Dlouhá, R., Kohlíková, E., Melichna, J., & Nováková, H. (1998). Physiological profiles of male and female taekwon-do (ITF) black belts. Journal of Sports Sciences, 16(3), 243–249. doi:10.1080/026404198366768

Imamura, H., Yoshimura, Y., Uchida, K., Nishimura, S., & Nakazawa, a T. (1998). Maximal oxygen uptake, body composition and strength of highly competitive and novice karate practitioners. Applied Human Science : Journal of Physiological Anthropology, 17(5), 215–218. doi:10.2114/jpa.17.215

Ivanovic, J., & Dopsaj, M. (2012). Functional Dimorphism and Characteristics of Maximal Hand Grip Force in Top Level Female Athletes. Collegium Antropologicum, 36(4), 1231–1240.

Keshishian, H. (2013). Motor Fitness Profiling of Elite and Novice Karate Practitioners. (Master thesis). Catholic University, Australia.

Margnes, E., & Paillard, T. (2011). Teaching balance for judo practitioners. 11, 42-46. Ido Movement for Culture. Journal of Martial Arts Anthropology, 11(1), 42–46.

Miarka, B., Panissa, V. L. G., Julio, U. F., Del Vecchio, F. B., Calmet, M., & Franchini, E. (2012). A comparison of time-motion performance between age groups in judo matches. Journal of Sports Sciences, 30(9), 899–905. doi: 10.1080/02640414.2012.679675

Monteiro, L. F., Massuça, L. M., García, J. G., Carratala, V., & Proença, J. (2011). Plyometric muscular action tests in judo- and non-judo athletes. Isokinetics and Exercise Science, 19, 287–293. doi:10.3233/IES-2011-0429

Nasri, R., Hassen Zrour, S., Rebai, H., Fadhel Najjar, M., Neffeti, F., Bergaoui, N., … Tabka, Z. (2013). Grip Strength is a Predictor of Bone Mineral Density Among Adolescent Combat Sport Athletes. Journal of Clinical Densitometry, 16(1), 92–97. doi:10.1016/j.jocd.2012.07.011

Obminski, Z., Litwiniuk, A., Staniak, Z., Zdanowicz, R., & Weimo, Z. (2015). Intensive specific maximal judo drills improve psycho-motor ability but may impair hand grip isometric strength. Ido Movement for Culture. Journal of Martial Arts Anthropology, 15(2), 52–58. doi:10.14589/ido.15.2.8

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. International Journal of Obesity, 32(1), 1–11. doi:10.1038/sj.ijo.0803774

Pion, J., Fransen, J., Lenoir, M., & Segers, V. (2014). The value of non-sport-specific characteristics for talent orientation in young male judo, karate and taekwondo athletes. Archives of Budo, 10, 147–154.

Prouteau, S., Ducher, G., Serbescu, C., Benhamou, L., & Courteix, D. (2007). Gender Differences in Response To Weight Cycling in elite judoist, 24(2), 91–103.

Sánchez, Á. G., Domínguez, A. S., Turpin, J. A. P., Tormo, J. M. C., & Llorca, C. S. (2011). Importance of hand-grip strength as an indicator for predicting the results of competitions of young judokas. Archives of Budo, 7(3), 167–172.

Sbriccoli, P., Camomilla, V., Di Mario, A., Quinzi, F., Figura, F., & Felici, F. (2010). Neuromuscular control adaptations in elite athletes: The case of top level karateka. European Journal of Applied Physiology, 108(6), 1269–1280. doi:10.1007/s00421-009-1338-5

Shyamal, K., & Yadav, K. M. (2009). An Association of Hand Grip Strength With Some Anthropometric Variables in Indian Cricket Players. Facta Universitatis:Series Physical Education and Sport, 7(2), 113–123. doi:10.1127/0003-5548/2009/0003

Stachoń, A., Burdukiewicz, A., Pietraszewska, J., Andrzejewska, J., & Stefaniak, T. (2016). Improving body composition and strength in athletes through a 4-month combined martial arts and strength training program. Journal of Education, Health and Sport, 6(6), 445–458.

Sterkowicz, S., Jaworski, J., Lech, G., Pałka, T., Sterkowicz-Przybycień, K., Bujas, P., … Mościński, Z. (2016). Effect of Acute Effort on Isometric Strength and Body Balance: Trained vs. Untrained Paradigm. Plos One, 11(5), e0155985. doi:10.1371/journal.pone.0155985

Torres-Luque, G., Hernández-García, R., Escobar-Molina, R., Garatachea, N., & Nikolaidis, P. T. (2016). Physical and Physiological Characteristics of Judo Athletes : An Update. Sports, 4(1), 1–12. doi:10.3390/sports4010020

Vecchio, B. Del, Matsushigue, K. A., & Franchini, E. (2011). Physiological Profiles of Elite Judo Athletes, 41(2), 147–166.

Watanabe, T., Owashi, K., Kanauchi, Y., Mura, N., Takahara, M., & Ogino, T. (2005). The short-term reliability of grip strength measurement and the effects of posture and grip span. Journal of Hand Surgery, 30(3), 603–609. doi:10.1016/j.jhsa.2004.12.007

Zubitashvili, G. (2011). Adjusting the Training Process in Judo According to Physical and Functional Parameters. Kūno Kultūra Sportas, 82(3), 68–75. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=69691354&lang=es&site=ehost-live

Georgios ZAGGELIDIS, Ph.D. is an Assistant Professor of the Faculty of Physical Education & Sport Sciences, Aristotle University of Thessaloniki (Hellas), is specialized in judo, karate and Ju jitsu. He received a Ph.D in Pedagogy (Sport), from University of Bucharest (Faculty of History-philosophy), Romania. His research interests involve Sport Pedagogy, coaching and combat sports. He has published as author or co-author numerous papers.

Corresponding address:
Georgios Zaggelidis
School of Physical Education and Sport Sciences,
Aristotle University of Thessaloniki,
57001 Thermi
Thessaloniki, Greece
Phone: +30 2310 992172 or mobile: +30 6977 022064
E-mail: gzangel@phed.auth.gr