2004 Olympic Tae Kwon Do Athlete Profile

Mohsen Kazemi RN, DC, FCCSS(C), FCCRS(C)*
Claudia Casella BSc (Hon)**
Giovanni Perri, BA (Hon)†

The purpose of this study is to identify the characteristics of Tae kwon do champions (gold, silver, and bronze medalists) who competed in the Athens 2004 Olympic Games (N = 124) and compare these characteristics to those who competed but did not earn medals. All the data for the study was obtained from the official website of the 2004 Olympic Games www.athens2004.com and the following information was collected: weight category, weight, height, age, country representation, total points from kicks per weight category, total points from punches per weight category, total penalties per weight category, and type of win. The following descriptive statistics were calculated for each athlete according to gender: age, height, weight, and body mass index (BMI). No statistically significant differences exist between winners and non-winners with respect to age, height, weight and gender. Overall, male winners versus non-winners were similar in age and female winners were younger than the average age in their respective weight category. Male and female winners had a taller average height compared to male and female non-winners. The average BMI of male and female winners was less than non-winners. Females were eight times more likely to win by superiority than males. Overall, 100% of techniques used to score were by kicks. Specifically, males and females used one-point offensive and defensive kicks more than two-point offensive kicks to score. Males had more average kyong-go (half point warning) and gam-jeom (full point deduction) warning deductions per match versus females, thus demonstrating a more aggressive style of combat. In addition, males had a total of four

L'objectif de la présente étude consiste à identifier les caractéristiques des champions du Tae kwon do (médailler d'or, d'argent et de bronze) qui ont participé aux Jeux olympiques d'Athènes (N = 124) et comparer les caractéristiques de ceux qui ont participé aux compétitions, mais qui n'ont pas gagné de médailles. Toutes les données de l'étude proviennent du site Web officiel des Jeux olympiques de 2004, www.athens2004.com; l'information suivante a été recueillie : catégorie par poids, grandeur, âge, pays, points totaux par coups par catégorie de poids, points totaux par coups par catégorie de poids, pénalités totales par catégories de poids, et type de victoire. Les statistiques descriptives suivantes ont été calculées pour chaque athlète selon leur genre : âge, grandeur, poids et indice de masse corporelle (IMC). Il n'existe pas de différence statistique importante entre les gagnants et les perdants en ce qui touche l'âge, la grandeur, le poids et le genre. Dans l'ensemble, les gagnants mâles par comparaison aux perdants appartenaient à la même catégorie d'âge par contre les gagnantes femelles étaient plus jeunes que la moyenne d'âge de leurs catégories respectives de poids. Les gagnants des deux sexes étaient en général plus grands par comparaison aux perdants des deux sexes. La moyenne d'IMC chez les hommes et les femmes gagnantes était inférieure à celle des perdants. Les femmes avaient huit fois plus de chance de gagner par leur supériorité que les hommes. Pour marquer des points, les mâles et les femelles ont utilisé, de façon spécifique, des attaques d'un point et des coups de défense plus fréquemment que les attaques de coups

  * Associate Professor, Canadian Memorial Chiropractic College, Toronto, Ontario, Canada. mkazemi@cmcc.ca
 ** Chiropractic Intern, Canadian Memorial Chiropractic College, Toronto, Ontario, Canada. ccasella@cmcc.ca
  † Chiropractic Intern, Canadian Memorial Chiropractic College, Toronto, Ontario, Canada. gperri@cmcc.ca
   Correspondence to: Dr. Mohsen Kazemi, Canadian Memorial Chiropractic College, 6100 Leslie Street, Toronto, Ontario, Canada, M2H 3J1.
   Tel: 416-482-2340, 416-385-0110.

knock downs during the entire competition, one in each weight category, whereas there were no knock downs among females, again suggesting a more aggressive fighting style among males.
(JCCA 2009; 53(2):144–152)

comptant pour deux points. Dans l'ensemble, 100 % des techniques utilisées pour marquer des points ont été les coups de pied. Les hommes ont reçu en moyenne plus souvent des kyong-go (avertissement de demi-point) et des gam-jeom (réduction d'un point) par match que les femmes, démontrant ainsi un style de combat plus agressif. De plus, les hommes ont eu un total de quatre mises à terre pendant la durée de la compétition, une dans chaque catégorie de poids, alors qu'il n'y a pas eu aucune chez les femmes, ce qui porte à croire encore une fois que le style de combat des hommes est plus agressif que chez les femmes.
(JACC 2009; 53(2):144–152)

Introduction

Tae kwon do, a form of Korean martial art originally designed for warfare and self-defense, has in recent times become a well-recognized sport and has become more popular since its official introduction into the 2000 Sydney Olympic Games. Tae kwon do requires skill, fitness, and high-energy, and is characterized by its swift kicking techniques, which distinguishes it from other forms of martial arts. This unique form of sport has gained popularity worldwide, and an estimated 120 million adults and children participate in some form of martial art, with an estimated growth rate of 25% annually.[1] Specifically, Tae kwon do is practiced worldwide with 184 nations as official members of the World Tae kwon do Federation (WTF).[2]

With the increase in popularity of Tae kwon do as a sport, there has been a growing interest in various areas of research, with injury rates being the most frequently investigated.[3–5] It is rationalized that the lower limb has the greatest length and power potential. Kicking generates the most powerful strikes while keeping the greatest distance from the opponent; therefore it is not surprising that the lower limb has been found to be the most commonly injured body segment.[1,6–9]

Recent research has focused on anthropometric variables of the competitors and how the physiological profile of the athlete correlates to their performance. Variables such as height, weight, body-mass index (BMI), and VO_2 max have been investigated in different sports. Defining physiological profiles has also been attempted in other sports, such as freestyle wresting and karate.[10–11] Heller et al.[12] determined that the physiological profile of male and female Tae kwon do black belts consisted of very low body fat percentages, a high lean body mass, and above average results for muscle strength, flexibility, and anaerobic and aerobic capacities. Toskovic et al.[13] compared the physiological profiles of male and female novice and experienced Tae kwon do athletes and found that more experienced males and females were more athletically fit in terms of greater lower-body strength, better aerobic capacity, and greater flexibility when compared to novice males and females, even though the experienced competitors were older in age.

In Tae kwon do, competitors must be able to move with high velocity, speed, and power. A surplus of body mass can hinder this ability especially if this excess mass is in the form of adipose tissue which is metabolically inactive when compared to muscle. When comparing different types of combative sports, it was found that elite female judoka athletes had a sum of six trunk skin folds measuring 76.00 mm. These values are greater in comparison to elite American Tae kwon do athletes whose sum of skin folds total 36.14 mm in males, and 54.81 in females.[7] The differences seen in these particular combative sports are based on the fact that judo athletes use throws and grapples more frequently in combat, therefore a larger body

size is advantageous. In contrast, Tae kwon do primarily uses kicking techniques, thus having a strong and lean core is more beneficial for successful competition. Combative sports where fast movements are required may mostly call for a low fat mass, which in turn enhances the weight-to-strength ratio.[14] In another study by Yun et al.,[15] it was found that male Tae kwon do athletes had significantly higher mean values for weight, body surface area, BMI, and body circumference when compared to female athletes. Mengli[16] assessed the differences in somatotype and body composition in female Tae kwon do athletes at different competitive levels and concluded that elite female athletes are more mesomorphic and have less fat than collegiate female athletes in Tae kwon do. Gao et al.[17] found that body fat percentages in five elite Tae kwon do competitors were much lower compared to average athletes. Similar findings of low body fat percentages along with increased lean body mass and high VO_2 max values have also been reported.[13,15] In contrast, no significant differences in either resting heart rate, or aerobic power after training were found. However, differences in anaerobic power and capacity were observed.[18]

Current research has focused on dietary alterations in order to reduce body fat while maintaining a lean body mass. It was found that dietary energy restriction improved anaerobic activity, but had no effect on skeletal muscle strength and endurance. Caloric restriction, however, resulted in an undesired amount of weight loss, particularly in the more beneficial lean body mass component.[19] In contrast, another study found anaerobic performance decrease after seven days of food restriction, along with decreases in body weight, plasma triglyceride and free fatty acid levels.[20] More recent research found the effects of short-term weight loss to be unfavorable for the athlete.[21] The decrease in weight and body fat percentage was accompanied by decreases in grip strength and isokinetic leg strength which proved to negatively affect performance in Tae kwon do athletes, thus advocating a long-term weight loss program as a more beneficial alternative.

Determining the ideal body composition for any sport can be challenging. Studies have been performed in attempt to identify predictors of the ideal competitor. Our study attempts to find predictors of successful competitors in terms of their age, weight, height, and body-mass index (BMI). The purpose of this study was to identify the characteristics of the champions (gold, silver, and bronze me-

dalists) who competed in the Athens 2004 Olympic Games and compare these characteristics to those of unsuccessful competitors. We also compared the anthropometric characteristics of the champions of the Sydney 2000 Games to the Athens 2004 Games in order to identify whether similarities existed between the two groups of champions. The results of this study will identify anthropometrical predictors of successful Tae kwon do athletes in terms of their age, weight, height, body-mass index (BMI), and fighting style. In determining these ideal characteristics of Tae kwon do champions, they will serve to assist the athlete and the coaches in alternate strategies to achieve future success in the sport. Furthermore, this article allows the chiropractor to illustrate to the research community their vast diversity of knowledge in regards to the research performed by the profession. Although chiropractors have been viewed as mainly experts of the spine; in more recent years the profession has expanded its knowledge base into many other areas of research related to its chiropractic fellowship programs such as the sports sciences residency, clinical science residency, and radiology residency. These research efforts have proven to be successful, as more and more studies have been published proving that chiropractors are not just experts of the spine but are full body musculoskeletal specialists which have the ability to analyze the body from a functional perspective and apply it to any realm, whether it be an athlete, or a weekend warrior.

Methods

The data for this study was obtained from the "Official Site of the 2004 Olympic Games," www.athens2004.com (a public domain website). The information obtained included: the participants in each weight category, their weight, height, country of representation, total points from kicks per weight category, total points from punches per weight category, total penalties per weight category and type of win. The information was entered into an Excel spreadsheet and transferred to STATA for analysis. Variables were coded and labeled.

Results

Profile of Athletes

By performing a logistic regression model for the outcome variables (medal vs. no medal) with the independent var-

Table 1   *Demographic profiles of athletes (n = 124). Data are means (±SD)*

Characteristics	Males		Females	
	Winners (n = 12)	Others (n = 52)	Winners (n = 12)	Others (n = 48)
Age (yrs)	26.1 (4.6)	26.0 (4.3)	24.3 (4.9)	24.5 (4.7)
Height (m)	1.83 (0.11)	1.81 (0.08)	1.73 (0.06)	1.69 (0.07)
Weight (kg)	75.8 (16.1)	74.1 (13.0)	61.3 (10.5)	60.9 (9.4)
Body Mass Index	22.4 (2.3)	22.5 (2.5)	20.4 (2.5)	21.1 (2.2)

Table 2   *Number of successful outcome of matches by type*

Weight Category	Won by Knockout	Won by Points	Won by Superiority
Males			
<58 kg	0	16	0
<68 kg	1	17	0
<80 kg	0	17	1
>80 kg	1	19	0
Females			
<47 kg	0	16	2
<57 kg	0	17	2
<67 kg	0	15	2
>67 kg	0	17	2

iables height, weight, and gender, a weak relationship was found, but the regression coefficient for only the height variable was found to be statistically significant (p-value = 0.036). However, when a two sample t-test was conducted on the height variable, the resulting p-value of 0.252 suggests that there is no statistically significant difference in the mean heights of the winners versus the non-winners. An insufficient sample size prevents us from having the power to detect differences in mean height among the stratified weight classes and genders.

For both male and female athletes, a t-test was also performed to look for differences between winners and non-winners in terms of mean age, weight, and BMI. There were no statistically significant differences between winners and non-winners in terms of age (p-value = 0.859), height (p-value = 0.252), and weight (p = 0.166) (Table 1).

Type of Win

Comparing men versus women in the type of win, a Chi-squared test for independence was used, and an association between gender and type of win is present (p-value = 0.026). Women were eight times more likely to win by superiority than men (Table 2).

Scoring Techniques

When comparing men versus women in the technique used to score, a Chi-squared test performed suggests that gender and technique used to score are independent of one another (p-value = 0.1372). Among men, we observed weight class versus the technique used to score and found that there is an association between the two variables (p-value = 0.044). In every weight category males used both one-point offensive kicks and defensive

Table 3   *Techniques used to score*

Weight Category	Technique					
	Offensive Kick 1-pt	Offensive Kick 2-pt	Defensive Kick	Offensive Punch	Defensive Punch	Knock Down
Males						
<58 kg	104	14	66	0	0	1
<68 kg	189	7	112	0	0	1
<80 kg	216	10	119	0	0	1
>80 kg	117	10	54	0	0	1
Total in 80 matches	626	41	351	0	0	4
Females						
<47 kg	67	5	24	0	0	0
<57 kg	85	13	57	0	0	0
<67 kg	101	3	80	0	0	0
>67 kg	139	3	107	0	0	0
Total in 75 matches	392	24	268	0	0	0

kicks more than two-point offensive kicks to score. Similar results were found when observing weight class versus technique used to score among female competitors (p-value < 0.001). The women competitors also used a greater number of one point offensive kicks and defensive kicks more than two point offensive kicks to score (Table 3).

Warnings
While testing for an association between gender and penalty type using a Chi-squared test, (Kyong-go and Gam-jeom), it is suggested that the two variables are independent of one another (p-value = 0.44). Looking at each gender individually and testing for independence between weight class and penalty type (Kyong-go and Gam-jeom), it was also found that there is no association (p-value = 0.9956). When observing the average number of penalties per match, males had 3.72 kyong-go versus females with 2.32 kyong-go; and an average of 1.41 gam-jeom per match for males versus 0.75 gam-jeom per match for females. In total, males were penalized more than females in both kyong-go and gam-jeom deduction warnings (Table 4).

Country Representation
Chinese Taipei was the most successful nation with a gold and silver medal in the male division and a gold medal in the female division.

Discussion
For both male and female athletes, there were no statistically significant differences between winners and non-winners in terms of age, height, weight and gender (Table 1). However, the following trends were observed.

Overall, the average age of male winners versus non-winners was similar; 26.1 years of age (standard deviation (SD) 4.6) for winners and 26 years (SD 4.3) for non-winners. Female winners were slightly younger than the average age in their respective weight category average versus non-winners, 24.3 years (SD 4.9) versus 24.5 years (SD 4.7) respectively. This trend is different than what was found by Kazemi et al.[3] in the 2000 Olympics. In the 2000 Olympic Games, both male and female winners tended to be younger than the average age in their respective weight category when compared to non-winners. Male and female winners had an average age of 24.4 and 23.1 years respectively, versus male and female

Table 4   *Types of Warnings Received*

Weight Category	Kyong-go (KG)		Gam-jeom (GJ)	
	# events	Average KG per match	# events	Average GJ per match
Males				
<58 kg	75	3.8	29	1.5
<68 kg	85	4.3	32	1.6
<80 kg	77	3.9	30	1.5
>80 kg	61	3.1	22	1.1
Total in 80 matches	298	3.72	113	1.41
Females				
<47 kg	32	1.8	9	0.5
<57 kg	42	2.2	14	0.7
<67 kg	51	2.7	16	0.8
>67 kg	49	2.6	17	0.9
Total in 75 matches	174	2.32	56	0.76

non-winners with an average age of 25.2 and 24.9 years respectively.[3] Also when comparing the differences between the 2000 and 2004 Games, not only were male and female winners younger than their weight category average in 2000, but the average of both the male and female winners in 2000 were younger than 2004 winners.

Male and female winners had a taller average height compared to male and female non-winners. The average height of male winners was 1.83 m (SD 0.11) versus 1.81 m (SD 0.08) for non-winners. Female winners had an average height of 1.73 m (SD 0.06) versus 1.69 m (SD 0.07) for non-winners. The same trend was found by Kazemi et al.[3] regarding the 2000 Olympic games; male winners had an average height of 1.83 m (SD 0.08) versus 1.79 m (SD 0.08) of non-winners; female winners had an average height of 1.70 m (SD 0.07) versus 1.69 m (SD 0.08) of non-winners. This finding may relate to the fact that the difference in height for winners gave them a significant biomechanical advantage over their shorter competitors. Taller athletes have longer upper and lower limbs, which translates into longer levers providing them with greater ability to cover a larger area with less energy. It has been suggested that a certain somatotype (specifically, an ecto-mesotype) may have a better chance at excelling in competition.[6]

The average weight of male and female winners was greater versus non-winners. The average weight for male winners was 75.8 kg (SD 16.1) versus male non-winners average weight of 74.1 kg (SD 13.0). The average weight for female winners was 61.3 kg (SD 10.5), versus non-winners average weight of 60.9 kg (SD 9.4). This was also a different trend than what was observed in the 2000 Olympics by Kazemi et al.[3] where the average weight of male winners was 73.4 kg (SD 12.1) versus 73.7 kg (SD 14.3) for non-winners and the average weight of female winners was 60.3 kg (SD 9.1) versus 61.3 kg (SD 10.9) for non-winners.

Body mass index (BMI) is a reliable indicator of calculating total body fat percentage related to morbidity and mortality.[22] Estimating body fat percentage by utilizing the calculated BMI has some disadvantages, as it may overestimate body fat in individuals who are of large muscular build, such as athletes. It may also underestimate body fat percentage in individuals who have lost muscle mass, such as the elderly.[22] The data from this study suggests that both male and female winners had lower average BMI's in comparison to non-winners. In general, these findings mirror those of Heller [12] who found that male and female Tae kwon do black belts demonstrated extremely low estimated body fat percent-

ages, and increased amounts of lean body mass. Elite female Tae kwon do athletes were found to be more mesomorphic with less fat than collegiate female Tae kwon do athletes.[17] Heller et al.[12] reported low adiposity for their male and female athletes. In the present study, the average BMI of male and female winners was slightly less than non-winners. Male winners had an average BMI of 22.4 (SD 2.3) versus male non-winners with an average BMI of 22.5 (SD 2.5); female winners had an average BMI of 20.4 (SD 2.5) versus female non-winners with an average BMI of 21.1 (SD 2.2). This trend was also found by Kazemi et al.[3] in the 2000 Olympics, where both male and female winners had a lower average BMI versus non-winners.

Another accurate indicator of body-fat composition is to calculate the height-weight ratio. This method is more accurate in terms of taking into account the muscular build of an athlete. Future studies may find it beneficial to incorporate this measure of body-fat composition, as it may provide further insight into the somatotype of successful athletes in competition. This study chose to use the BMI measure in order to demonstrate a clearer comparison with the author's previous study.[3]

Melhim investigated nineteen post-pubertal males in regards to their resting heart rate, aerobic power, anaerobic power, and anaerobic capacity and found no significant differences in either resting heart rate or aerobic power after training.[18] However, significant differences were found in anaerobic power and anaerobic capacity, a 28% and 61.5% increase respectively, after sport-specific training. Tae kwon do competition consists of sudden bursts of explosive and very powerful movements within a very short time period with short recovery periods, which stresses the body's anaerobic system. The effect of "living high-training low" was evaluated at a simulated altitude of 2500m on anaerobic capacity among Tae kwon do athletes.[23] Thirteen female Chinese national Tae kwon do athletes were studied and results showed that, at the tenth and twenty-eighth day of training, significant results using the Wingate test were found. The Wingate fatigue index declined ($p < 0.05$), therefore illustrating that living in high altitudes while training at low altitudes was an effective means to increase anaerobic capacity. It was reported that twelve weeks of two days per week of resistance exercises with elastic bands in adolescent male Tae kwon do athletes increased peak torque during hip adduction from

17% pre-test to post-test measurements (pre 136.58, SD 132.93%) and (post 160.08, SD 40.80%), with a significant increase in isokinetic hip average adduction power from pre-test (30.55, SD 8.11 Watts) to mid-test (40.43, SD 8.20 Watts).[24]

When evaluating the method of successful match outcomes, females were eight times more likely to win by superiority than males (Table 2). Winning by superiority is possible by two ways. One method is termed "point gap," meaning if an opponent leads a match by a seven-point gap, the match is terminated and the leader wins by superiority. The second method of winning by superiority is by "point ceiling." Point ceiling is defined as the competitor who first reaches a score of twelve points wins by superiority. The fact that females were found to be eight times more likely to win by superiority may be due to differences in skill set between males and females. The skill set and technique between male competitors is more similar, thus not leaving a large enough gap in points in order to ultimately win by superiority. Conversely, the skill set and technique between female competitors is less similar. A larger discrepancy in skill set and technique exists between female competitors, therefore allowing greater gaps in points obtained and more opportunity to conquer their opponents by superiority (Table 2).

Overall in our study, 100% of all techniques used to score were kicks. This was expected due to the emphasis on kicking in Tae kwon do, and is a similar finding of previous studies. Specifically, a total of 626 points was achieved using one-point kicks for males and a total of 392 points using one-point kicks for females. Defensive kicks were used to score 351 points for males and 268 points for females, making it the second highest technique used to score. In 2003, rule changes introduced an increase in point value of head contacts in adult competition to 2-points, compared to a standard 1-point value for kicks to the torso, plus an additional point for an eight-count knockdown.[2] Two-point offensive kicks were used the least to score, 41 total points for males and 24 total points for females. This may suggest that the males were more aggressive in their fighting style than females. It was found that during the 2000 Olympic Games, 98% of all techniques used to score were kicks.[3] However, in the 2000 Olympic Games there was no two-point kick category, therefore, no comparison can be made regarding this observation. In the 2000 Olympic Games, punching

was not encouraged as a technique used to score points; instead it was used as a technique to close an attack or to defend an attack. In the 2004 Olympics, the inclusion of gloves encouraged the use of punches to score points. Although these changes were implemented, this had no effect on the competitor's decision to use punches during combat, possibly due to the fact that the athletes were not as accustomed to use punches since training focuses more on kicking techniques to score. With the addition of protective hand gear, it would be interesting to look at hand injuries pre- and post-introduction of the gloves. The implementation of gloves may have been more of a protective measure as opposed to encouraging the use of punches as a technique used to score.

Other changes made for the 2004 Olympic Games compared to the 2000 Olympic Games included reducing the duration of each round from three minutes to two minutes, reducing the size of the competition area, and an increase in number of corner judges from three to four. This has encouraged more intense bouts of aggressive fighting. Males had a total of 298 kyong-go deduction points and 113 gam-jeom deduction points, in comparison to a total of 174 kyong-go deduction points and 56 gam-jeom deduction points for females. Males had on average 3.7 kyong-go and 1.41 gam-jeom deductions per match versus females who had on average 2.32 kyong-go and 0.75 gam-jeom deductions per match (Table 4). In comparison, there were a total of 244 Kyong-go (150 for males and 94 for females) and 5 gam-jeom (all for males and none for females) recorded for the 2000 Olympic Games.[3] Hence, there is a significant increase in the number of warnings obtained by competitors from the 2000 Olympic Games to the 2004 Olympic Games. This may suggest that the rule changes may have been successful in increasing aggression. Furthermore, a total of four knock downs were obtained by the males, one each per weight category versus no knock downs by the female competitors (Table 3). Two of these knock downs resulted in winning by knock out (male under 68 kg and over 80 kg categories). The number of knock downs and knock outs by males compared to none by the females may suggest the more aggressive nature of fighting style in males as compared to females.

Conclusions

This study examined 124 Tae kwon do athletes who com-peted in the 2004 Olympic Games. The findings from this study suggest that winners were slightly taller and had a slightly lower BMI than non-winners; however, these were not statistically significant. Overall, kicking was the only technique used to score points during competition. Specifically, for both male and females one-point offensive kicks were used to score the most points, followed by defensive kicks, and offensive two-point kicks. There was a significant increase in the number of kyong-go (half point deduction warning) and gam-jeom (one point deduction warning) in the 2004 Olympic Games compared to that in 2000 Olympic Games, which may suggest more aggressive fighting style in the 2004 Olympic Games.

Competing Interests

None.

References

1 Birrer RB, Halbrook SP. Martial arts injuries: The results of a five year national survey. Am J Sports Med. 1988; 16(4):408–410.

2 World Tae kwon do Federation [Online]. 2007 August 16 [cited 2008 May 15]. Available from: URL:http://www.wtf.org.2007

3 Kazemi M, Waalen J, Morgan C, White AR. A profile of Olympic Taekwondo competitors. J Sports Sci Med. 2006; CSSI:114–121.

4 Kazemi M, Pieter W. Injuries at a Canadian National Taekwondo Championships: a prospective study. BMC Musculoskeletal Disorders. 2004; 5:22.

5 Pieter W, Kazemi M. Competition injuries in young Canadian Taekwondo athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 197–206.

6 de Oliveira FCL. Injuries in the taekwondo athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 167–186.

7 Pieter W. Performance characteristics of elite taekwondo athletes. Korean J Sport Sci. 1991; 3:94–117.

8 Beis K, Abatzides G. Injuries of the taekwondo athletes in the official championships of the Greek taekwondo federation. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 229–237.

9 Phillips JS, Frantz JM, Amosun SL, Weitz W. (2001) Injury surveillance in taekwondo and judo during physiotherapy coverage of the seventh All Africa Games. South African J Physio. 2001; 57:32–34.

10 Callen SD, Brunner DM, Devolve KL, Mulligan SE, Hesson J, Wilber RL, Kearney JT. Physiological profiles of elite freestyle wrestlers. J Strength Conditioning Res. 2000; 14(2):162–169.

11 Giampietro M, Pujia A, Bertini I. Anthropometric features and body composition of young athletes practicing karate at a high and medium competitive level. Acta Diabetologia. 2003; 40:S145–S148.

12 Heller J, Peric T, Dlouha R, Kohlikova E, Melichna J, Novakova H. Physiological profiles of male and female taekwon-do (ITF) black belts. J Sports Sci. 1998; 16:243–249.

13 Toskovic NN, Blessing D, Williford HN. Physiologic profile of recreational male and female novice and experienced Tae Kwon Do practitioners. J Sports Med Phys Fitness. 2004; 44:164–172.

14 Pieter W, Bercades LT, Kim GD. Relative total body fat and skinfold patterning in Filipino national combat sport athletes. J Sports Sci Med. 2006; CSSI:35–41.

15 Yun C, Lee JH, Xiaolin G, Liren C, Xiudong L, Ruifang G, Wenyuan S. Comparison of Physique, Body Composition and Anaerobic Capacity Between Male and Female Taekwondo Athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 59–64.

16 Mengli. Difference in somatotype and body composition in female taekwondo athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 227–228.

17 Gao B, Zhao Q. Liu B. Measurement and evaluation on body composition and figure of taekwondo athlete. J Xi'an Institute Phys Educ. 1998; 15:29–33.

18 Melhim AF. Aerobic and anaerobic power responses to the practice of Taekwondo. Br J Sports Med. 2001; 35:231–235.

19 Zachwieja JJ, Ezell DM, Cline AD, Ricketts JC, Vicknair PC, Schorle SM, Ryan DH. Short-term dietary energy restriction reduces lean body mass but not performance in physically active men and women. Int J Sports Med. 2001; 22:310–316.

20 Filaire E, Maso F, Degoutte F, Jouanel P, Lac G. Food restriction performance, psychological state and lipid values in Judo athletes. Int J Sports Med. 2001; 22:454–459.

21 Lee MG, Kim YG. Effects of short-term weight loss on physical fitness, isokinetic leg strength, and blood variables in male high school Taekwondo players. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 47–57.

22 Bickley LF, Szilagy PG. (2003) Bates' Guide to Physical Examination and History Taking. 8th edition. Philadelphia: Lippincott Williams & Wilkins. 59–62.

23 Dong-sen Liu, Qi Gao, Ye Tien. Effect of "Living High – Training Low" On Anaerobic Capacity In Chinese National Female Taekwondo Athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 225–226.

24 Teng Mei Woo, Keong Chee Chen, Ghosh Kumar Asok, Thimurayan Vishvanaphan. Effects of exercises with elastic band on isokinetic strength of adolescent male Taekwondo athletes. The 1st International Symposium for Taekwondo Studies; 2007 May 16–17; Beijing, China. p. 73–81.