

## Combat Sports Special Issue

### Research article

# A PROFILE OF OLYMPIC TAEKWONDO COMPETITORS

Mohsen Kazemi ✉, Judith Waalen, Christopher Morgan and Anthony R. White

Canadian Memorial Chiropractic College and Ryerson University, Toronto, Ontario, Canada

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#### ABSTRACT

The purpose of this study was to identify the profile of the Olympic champions and the other competitors who were involved in the Games. The information on each of the athletes was obtained from the "Official Site of the Sydney 2000 Olympic Gamescom/eng/sports/TK" and included weight category, weight, height, age, points obtained, warnings, deduction point, defensive/offensive kicks and punches. One hundred and two athletes competed (54 males and 48 females) in the Games. The mean average age and BMI (Body Mass Index) of 16 male winners was  $24.4 \pm 3.3$  years and  $21.9 \pm 2.4$  respectively compared to  $25.2 \pm 4.3$  years and  $22.8 \pm 3.3$  for the 38 male non-winners. The mean average age and BMI of the 16 female winners was  $23.1 \pm 3.9$  years and  $20.8 \pm 2.3$  respectively compared to  $24.9 \pm 4.7$  years and  $21.3 \pm 2.7$  for the 32 female non-winners. For all four types of athletes, offensive kicks accounted for at least 52% of the techniques to score a point. Ninety-eight percent of all techniques used to score were kicks. Although not statistically significant, winners overall tended to be younger in age and taller with slightly lower BMI than their weight category average. Taking into account the literature cited in this article, future studies should be designed to examine the relationship between performance and functional variables such as muscle power, muscle endurance, reaction time and aerobic capacity.

**KEY WORDS:** Taekwondo, martial arts, body weight, body mass index, height, age.

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#### INTRODUCTION

The origins of the Korean martial art of Taekwondo go back 1500 years. Originally Taekwondo was taught for warfare, self-defence, and physical fitness. Over the centuries, the art form has spread throughout the world. Today, an estimated 75-120 million children and adults worldwide participate in martial arts with an estimated annual growth rate of 20-25% (Birrer, 1996). Taekwondo is practiced in over 140 countries around the world and 120 nations are official members of the sport's major organizing body, the World Taekwondo Federation (WTF). Taekwondo reached the Olympic stage as a demonstration sport in the 1988 Seoul Olympics and the 1992 Barcelona Olympics. It became an official Olympic sport in the 2000 Sydney Olympic Games.

Taekwondo, renowned for its high and fast kicks, was developed as a technique used by Korean peasants to dismount their attackers, who rode on horseback. In competition, kicks and punches score points when contact made to the torso (by punches and kicks) or head (only by kicks) is sufficient to produce a displacement of the body segment. A match can be won by a knockout or on points. While punching to the head is not permitted, kicks to the head and face are allowed. Research studies related to Taekwondo have tended to concentrate on injury rates (Beis et al., 2001; Chuang and Lieu, 1992; Philips et al., 2001; Pieter et al., 1995; 1998a; Pieter and Lufting, 1994; Pieter and Zemper, 1995; 1999; Serina and Lieu, 1991; Zemper and Pieter, 1989). Studies have been conducted on the epidemiology of trauma which is proposed to be related to skill level,

gender, weight, age, mechanism, body part, situation, and years of experience (Beis et al., 2001; Philips et al., 2001; Pieter et al., 1995; 1998b; Pieter and Lufting, 1994; Pieter and Zemper, 1995; 1999; Zemper and Pieter, 1989). However, very little research has been conducted in the area of performance in the martial arts, and how it might relate to anthropological variables such as body weight. Kules (1996) examined the impact of anthropometric variables on judo performance for female judokas. Kules (1996) established that body weight, the circumference of the extremities, skin folds on the upper arm, back and height were identified as important determinants of performance. In addition, Pieter et al. (1998b) described the somatotype of 19 elite Filipino female judo athletes, also comparing them to a sample of elite American female Taekwondo athletes. Pieter et al. (1998a) concluded that the Taekwondo athletes were leaner than the judo athletes. In a study of 30 elite Chinese male Taekwondo athletes, Gao (2001) demonstrated that the dominant somatotype was a well-proportioned stature, well-developed muscles and skeletons, and low subcutaneous fat.

Other sports have also conducted anthropological studies including gymnastics, volleyball, basketball, rock climbing, swimming, freestyle wrestling, and ten-pin bowling to mention a few (Callan et al., 2000; Cleassens et al., 1999; Khosla, 1984; Tan et al., 2000; Toriola et al., 1987; Watts et al., 1993; Yamamura, 1999). Studies have been conducted examining the links, if any, between anthropological variables and actual performance outcomes: These include physiological profiles of elite freestyle wrestlers; a comparison by age, height, weight and somatotype of the finalists at the Seoul Olympics, and physiological profiles of male and female Taekwondo (International Taekwondo Federation, ITF) black belts (Heller et al., 1998). The majority of these studies have found that, in each sport, the elite athletes fit a certain physical or anthropometric profile. One study concluded that lack of 'proper physique' (which was not defined by the authors) could hinder successful sport performance at the Olympic level (Toriola et al., 1987). Toriola et al. (1987) found that the differences they observed between their athletic groups were related to the morphological factors that influenced the basic components of competitive sports performance.

One study does give a hint at what somatotype may have a better chance at excelling in competition (Gao et al., 1998). The researchers found that the body fat percentage in five elite athletes was relatively low compared to average athletes (Gao et al., 1998). Gao et al. (1998) concluded that because aerobic ability in Taekwondo is very important,

decreasing body fat percentage and increasing lean body mass are needed to gain the highest possible  $VO_{2max}$ . In contrast, Melhim (2001) found no significant differences in either resting heart rate or aerobic power after training; however, significant differences were observed in anaerobic power and anaerobic capacity. Markovic et al. (2005) examined the differences between successful and less successful Croatian national Taekwondo champions and found that successful athletes achieved significantly higher maximum running speed, significantly higher ventilatory anaerobic threshold at significantly lower heart rate, significantly higher explosive power, anaerobic alactic power and lateral agility somewhat lower body fat (2.3%), and were slightly taller (by 5.8 cm) than less successful athletes. On the other hand, other researchers (Callan et al., 2000; Cleassens et al., 1999; Gao, 2001; Gao et al., 1998; Heller et al., 1998; Khosla, 1984; Tan et al., 2000; Toriola et al., 1987; Watts et al., 1993; Yamamura, 1999) agree that the possession of specific anthropometric qualities alone cannot guarantee a gold medal. Success in competition is indeed a combination of physical attributes, talent, skill, technique, determination, strategy and psychological preparedness. Many of these qualities have not been investigated in elite WTF Taekwondo athletes.

Work by Yujin and Zeng (1999) concluded that training should focus on offensive fighting as the major focus. Smith et al. (2000) examined the effect of a 3%-4% loss in body mass on a boxing-related task. They found that some participants were able to resist the deleterious effects of a rapid loss of body mass prior to competition and suggested the necessity of further research to find the mechanism. In a subsequent study, the effects of serial reductions in energy and fluid intake on two simulated boxing performances separated by two days recovery were assessed (Smith et al., 2001). Smith et al. (2001) concluded that energy and fluid restrictions in weight-governed sports do not always lead to a significant decrease in performance. However, they cautioned the readers to use these findings with care since their sample size was small and there were large variations in individual performances (Smith et al., 2001).

Fogelholm et al. (1993) studied the effects of gradual versus rapid weight loss in national wrestlers and judo athletes on nutrient intake, micronutrient status, and physical performance (sprint, jump height, and anaerobic performance). A 5% to 6% reduction in body weight was reported in the gradual and rapid loss groups. Nutrient intake was significantly decreased in both groups in vitamin B1 and B2, and  $K^+$ ,  $Ca^{+2}$ ,  $Mg^{+2}$ ,  $Fe^{+2}$ , and  $Zn^{+2}$  values, compared to baseline measures. Speed, vertical

**Table 1.** Demographic profiles of athletes (n = 102). Data are means ( $\pm$ SD).

Characteristics	Males		Females	
	Winners (n = 16)	Others (n = 38)	Winners (n = 16)	Others (n = 32)
Age (yrs)	24.4 (3.3)	25.2 (4.3)	23.1 (3.9)	24.9 (4.7)
Height (m)	1.83 (.08)	1.79 (.08)	1.70 (.07)	1.69 (.08)
Weight (kg)	73.4 (12.1)	73.7 (14.3)	60.3 (9.1)	61.3 (10.9)
Body Mass Index	21.9 (2.4)	22.8 (3.3)	20.8 (2.3)	21.3 (2.7)

jump, and anaerobic performance were not impaired by either rapid or gradual weight loss (Fogelholm et al., 1993). In contrast, Filare et al. (2001) reported that all mean micronutrient intakes were below recommended values, while triglyceride levels and free fatty acids were increased in weight cycling judo athletes. Left hand grip values and 30-second jump test output were decreased after seven days of food restriction (Filare et al., 2001).

In examining the literature, some might argue that the evidence of health risks from weight cycling is equivocal. Even so, there are several possibilities that may help explain the lack of supporting data. One possibility is that there may be no effect. Waslen et al. (1993) found that the duration, frequency, and severity of food restriction among the judo athletes in their study may not have been sufficient to have an effect. Even with a lack of strong support to illustrate the ill effects of weight cycling, monitoring dietary habits of athletes in weight class sports is recommended. It is more prudent to assume that larger weight losses and more frequent dieting could potentially result in negative physiological and performance consequences. Widespread regulations need to be implemented to control weight cycling practices among weight class sports.

The purpose of this study was to identify the characteristics of the champions (Gold, Silver, and Bronze medalists) who competed in Sydney 2000 Olympic Games and to compare these characteristics to those who competed but did not earn medals.

## METHODS

The data for this study were obtained from the "Official Site of the Sydney 2000 Olympic Games, www.olympics.com/eng/sports/TK" (a public

domain web site). The information obtained included: The participants in each weight category, their weight, height, date of birth, country, round by round report, points obtained, warnings, deduction point, defensive kicks, offensive kicks, offensive/defensive punches, list of referee and judges with their country of origin. The information was entered into an Excel spreadsheet and then transferred to an SPSS file (Version 11.5). Variables were coded and labeled.

### Statistical analyses

Descriptive statistics were calculated for the age, weight, height and body mass index of the athletes by gender. Analyses of variance were used to compare differences between demographic characteristics and techniques used to score. The level of significance was set at  $p = 0.05$ . A variable (rank) was created based on performance outcome (1=gold, 2=silver, 3=bronze, 4=bronze 5=no medal) in order to examine relationships between the demographic and technique variables.

## RESULTS

### Profile of athletes

For both male and female athletes, there were no statistically significant differences between winners and non-winners in age, height, weight or body mass index (see Table 1).

### Scoring techniques

The male non-winners used offensive kicks more often when compared to male winners. Offensive kicks accounted for at least 52% of the techniques (see Table 2). Information on the type of kick used to score was not published on the web site.

In general, an offensive technique was used to

**Table 2.** Techniques used to score (n = 102).

Techniques	Males		Females	
	Winners% (n)	Others % (n)	Winners % (n)	Others % (n)
Offensive Kicks	54% (147)	63% (128)	53% (170)	52% (103)
Defensive Kicks	46% (126)	38% (78)	47% (149)	47% (93)
Punches	0% (1)	0% (2)	0% (0)	0% (1)
Total	100% (274)	101%* (204)	100% (319)	100% (197)

\* due to rounding.

**Table 3.** Score in each round.

Round	Males		Females	
	Winners % (n)	Others % (n)	Winners % (n)	Others % (n)
<b>Round 1</b>	43% (72)	65% (91)	19% (34)	59% (83)
<b>Round 2</b>	30% (51)	31% (43)	53% (94)	35% (50)
<b>Round 3</b>	27% (45)	4% (5)	28% (50)	6% (8)
<b>Total</b>	100% (168)	100% (139)	100% (178)	100% (141)

score slightly more often than the defensive one. However, male non-winners had the highest percentage of offensive kicks (63%). In terms of techniques used, female winners used 45 more techniques (or 8%) than male winners. In addition, the margin between female winners and female non-winners (122 techniques) was greater than between male winners and non-winners (70 points).

#### **Round scores**

In both male winners and non-winners, Round 1 had the highest percentage of scoring (43%, and 65% respectively). In females, winners scored only 19% of the total in Round 1 in contrast to female non-winners (59%) whereas in Round 2 female winners score more than half (53%) of their total points (see Table 3).

#### **Warnings received**

In both male and female winners, the number of warnings per match received was far higher than among non-winners (see Table 4).

#### **Country representation**

Korea was the most successful nation with two gold medals in the female division and a gold and silver medal in the male division. The Korean female gold medal winners and the male silver medallist used a defensive technique to score more frequently when compared to their weight category average. However, the Korean male gold medallist used a defensive technique to score less frequently when compared to the weight category average.

## **DISCUSSION**

Overall, both male and female winners tended to be somewhat younger than the average age in their respective weight category average. This may be a result of the inclusion of Taekwondo in the Olympic

Games which may have broadened its exposure to younger athletes. In addition, application of scientific training principles early in their development could be another reason for having younger winners.

In all weight categories, the average height of male winners is greater than the category average. This finding correlates with a longstanding Taekwondo coaching belief that taller athletes in their weight category maybe more successful due to longer reach, leaner body, and longer lever which helps them to cover larger distances expending less energy than their shorter counterparts.

In all weight categories except over 80 kg, the average weight of male winners was greater than the weight category average. In the heavy weight categories, for both male and female, the average weight of the winners was less than the category average. These findings are best explained through calculating Body Mass Index. Body Mass Index (BMI) is a reliable indicator of total body fat, which is related to the risk of disease and death. The BMI score is valid for both men and women; however, it may overestimate body fat in athletes and others who have a muscular build. It may also underestimate body fat in older persons and others who have lost muscle mass (Bickley and Szilagyi, 2003). The mean BMI ranged from 20.8 for female winners to 22.8 for male non-winner athletes. This is well with the normal range (18.5-24.9) and probably in the lower aspect of the normal range since this population comprised elite athletes who have higher muscle mass compared to general population (Bickley and Szilagyi, 2003). The average BMI of winners in general was lower than that of non-winners but did not achieve statistical significance. This may suggest that the winners had a leaner body than the non-winners and lower body fat content as supported by Gao (2001), who showed that the dominant somatotype was a well-proportioned

**Table 4.** Types of warnings received.

Warnings	Males		Females	
	Winners % (n)	Others % (n)	Winners % (n)	Others % (n)
<b>Kyong Go (half a point deduction warning)</b>	98% (91)	95% (59)	100% (60)	100% (34)
<b>Gam Jeon (one point deduction warning)</b>	2% (2)	5% (3)	0% (0)	0% (0)
<b>Total</b>	100% (93)	100% (62)	100% (60)	100% (34)

stature, well-developed muscles and skeletons, and low subcutaneous fat. Heller et al. (1998) in their study of the Czech national Taekwondo (ITF) team reported low adiposity for their male and female athletes (BMI 21.9 and 22.0 kg·m<sup>-2</sup>, respectively). Gao et al. (1998) suggest that a certain somatotype (ecto-mesotype) may have a better chance at excelling in competition. These authors found that the body fat percentage in five elite athletes was relatively low compared to average athletes. Gao et al. (1998) also concluded that to gain the highest possible VO<sub>2</sub>max (aerobic ability) in Taekwondo, decreasing body fat percentage and increasing lean body mass are needed. Melhim (2001) examined nineteen Taekwondo male adolescent practitioners with regards to resting heart rate, aerobic power, anaerobic power and anaerobic capacity. He found no significant differences in either resting heart rate or aerobic power after training; however, significant differences were observed in anaerobic power and anaerobic capacity. The increases in anaerobic power and anaerobic capacity were 28% and 61.5% respectively. Markovic et al. (2005) assessed the differences in VO<sub>2</sub>max, explosive and elastic leg strength, maximal strength, muscular endurance, anaerobic alactic power, agility and flexibility of thirteen Croatian national Taekwondo champions divided in two groups according to their senior international competitive achievements. The successful athletes achieved significantly higher maximum running speed, significantly higher ventilatory anaerobic threshold at significantly lower heart rate than in the less successful athletes. These authors also reported significant differences in three tests of explosive power, anaerobic alactic power and lateral agility. They found that the successful athletes had somewhat lower body fat (2.3%) and were slightly taller (by 5.8 cm) than the less successful athletes. They concluded that the performance of Taekwondo female athletes primarily depends on the anaerobic alactic power, explosive power expressed in the stretch-shortening cycle movements, agility and aerobic power (Markovic et al., 2005). The nature of Taekwondo performance mainly requires bursts of sudden, fast and powerful kicks that lend itself to having a speed and power athlete profile and not an endurance athlete physiological profile suggested by Gao et al. (1998). In addition, there is no indication in the literature that a lower body fat and high lean body mass is required to gain the highest possible VO<sub>2</sub>max. An adequate VO<sub>2</sub>max enables the Taekwondo athlete to recover between rounds or burst of activity.

Toriola et al. (1987) observed that lack of proper physique could hinder successful sport performance at the Olympic level. Previous studies

have looked at anthropometric variables in terms of a potential indicator of athletic performance. Yamamura (1999) found no significant correlation between the performance scores of 16 well-trained synchronized swimmers and anthropometric variables. Claessens et al. (1999) and Zhao et al. (1999) found an association between decreasing athletic performance and increased subcutaneous fat among elite gymnasts and Taekwondo athletes respectively. The Claessens et al. (1999) study, however, concluded that the association was not strong enough to predict individual performance scores. However, Heller et al. (1998) found that among male ITF black belts, competitive performance was significantly related to maximum power output and upper limb reaction time only, whereas in females, performance was related to maximum power output and ventilatory threshold. In our study, for both males and females, the difference between winners and non-winners in terms of height, weight, and body mass index were not statistically significant. However, there is some evidence that lower BMI and taller athletes may have advantage to their counterparts in Taekwondo.

Overall, 98% of all techniques used to score were kicks. This was expected since major focus has been put on kicking skills in Taekwondo. However, one may use this fact to develop punching techniques to score since most Taekwondo athletes may not be trained sufficiently and may not have proper defensive techniques to counter. In addition, WTF Taekwondo rules and regulations at the time of Sydney Olympic Games did not encourage scoring with punches. At the time of these Games, the punches were used mainly as a closing technique to negate an attack. However, new WTF Taekwondo rules (see from URL: <http://www.wtf.org>) place greater emphasis on the scoring with punches by making wearing gloves mandatory. In addition, decreasing the duration of each round to two minutes from three minutes, decreasing the size of the competition area to 10m x 10m from 12m x 12m, win by 7-point gap, win by 12-point ceiling, and increasing the corner judges to four instead of three will encourage more intense bouts of fight with utilization of various techniques and possibly more accurate scoring. In general, an offensive technique was more commonly used to score, 57% in the men's competition and 53% in the women's. Although Yujin and Zeng (1999) concluded that training should focus on offensive fighting as the major focus, they did not provide any rationale. It is the first author's experience that using offensive techniques frequently during a match are viewed as an athlete's aggressiveness and being in control of the match since the athlete that retrieves often during the match may get warnings for not engaging.

In terms of total points scored, female winners scored 45 more points, 8% more than male winners. In addition, there is a greater point differential between female winners and female non-winners than between male winners and male non-winners, suggesting a greater gap between the top female Taekwondo athlete and the remainder of the field than between the top male athlete and the remainder of the male field. Taekwondo female athletes' participation in competitions and even in the sport started much later than the male athletes. In addition, the number of female Taekwondo athletes in the world is lower than that of the male athletes. Hence, the pool of female athletes is smaller than that of the males. In some countries, such as Iran, participation of female Taekwondo athletes in International competitions is banned due to religious belief. This may affect the degree of emphasis put on developing elite international female Taekwondo athletes in different countries, therefore, explaining the large difference in scoring between female winners and non-winners.

In both male winners and non-winners, Round 1 had the highest percentage of scoring (43%, and 65% respectively). However, male winners scored less than non-winners in Round 1. Among females, winners scored only 19% of the total in Round 1 in contrast to female non-winners (59%) whereas in Round 2 female winners score more than half (53%) of their total points. It is the principle author's opinion that these findings may be due to the fact that winners might have used the first round to evaluate their opponent moves and conserve energy. In both male and female winners, the number of warnings per match received was far higher than among non-winners. This may be due to the winners' aggressiveness and lack of fear of receiving warnings.

Korea was the most successful nation with two gold medals in the female division and a gold and silver medals in the male division. Taekwondo is Korea's National sport; therefore, Koreans have a huge pool of players that can be pushed as hard as possible. In our study, the Korean athletes, in general, used a defensive technique to score more frequently when compared to their weight category average. The Korean Taekwondo coaches might have studied the trend of scoring and worked on scoring with defensive techniques rather than offensive ones. It is the first author's opinion that the most important factor in scoring with an offensive or defensive technique is the timing, which is execution of a technique at the right time to surprise the opponent and score. Developing the proper timing requires development of speed, reaction time and understanding of the various sparring situations. Development of defensive techniques may even

requires further skills, timing, speed and practice since one has to decide what technique to use and be fast and effective to counteract and score.

## CONCLUSIONS

This study examined 102 athletes who competed in the Sydney 2000 Olympic Games. The findings suggest that the winners tended to be younger in age and taller with slightly lower BMI than their weight category average. In general, an offensive technique was used to score slightly more often than a defensive one. The majority of all techniques used to score were kicks. In both male and female winners, the number of warning per match received was far higher than among non-winners. Comparing the findings from subsequent Olympic events is needed to determine if the trends observed in this study are the same. In addition, it is recommended that future studies be conducted to examine the relationship between performance and functional variables such as muscle power, muscle endurance, reaction time and aerobic capacity (identified in other studies) in addition to the variables used in this study.

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### KEY POINTS

- Winners tended to be younger in age and taller with slightly lower BMI than their weight category average.
- An offensive technique was used to score slightly more often than a defensive one.
- Overall, 98% of all techniques used to score were kicks.

**AUTHORS BIOGRAPHY**

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**Mohsen KAZEMI****Employment**

Sports and rehabilitation specialist, and acupuncturist. Assoc. Prof. and Sports Sciences Residency program coordinator at Canadian Memorial Chiropractic College.

**Degree**

RN, DC, FCCSS(C), DACRB, FCCRS(C)

**Research interests**

Epidemiology, sports physiology and trauma in Taekwondo and Chiropractic.

**E-mail:** mkazemi@cmcc.ca  
drkazemi@sportdoc.biz

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**Judith WAALEN****Employment**

Professor Emeritus, Department of Psychology, Ryerson University Toronto, Ontario Canada.

**Degree**

PhD

**Research interests**

Validation of instruments used in measurement of disability, psychomotor skills, and quality of life; evaluation of technology-enabled education.

**E-mail:** jwaalen@ryerson.ca

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**Christopher J. MORGAN****Employment**

Chiropractic sports specialist and Fellow with the College of Chiropractic Sports Sciences, Canada.

**Degrees**

BSc., DC, FCCSS

**Research interests**

The conservative management of sports related injuries.

**E-mail:** mcw4life@rogers.com

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**Anthony R. WHITE****Employment**

Doctor of Chiropractic, Paulding County Chiropractic, 55 East Paulding Dr Suite 146, Dallas, Georgia 30157

**Degrees**

BSc., DC

**Research interests**

Chiropractic.

**E-mail:** drawhite@bellsouth.net

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✉ **Dr. Mohsen Kazemi**

Canadian Memorial Chiropractic College, 6100 Leslie Street, Toronto, Ontario, Canada M2H 3J1