BEHAVIOR ANALYSIS OF TAEKWONDO ATHLETES ACCORDING TO THE ROUNDS OF THE CHAMPIONSHIP

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The purpose of this study was to analyse the technical and tactical behaviour of taekwondo athletes in a university level taekwondo championship according to the round. A total of 169 matches, consisting of 1088 performances were videotaped. The results showed that athletes when compete in a final and semifinal round performed more direct actions, simultaneous counterattacks, linear kicks, actions to the chest, and with left leg than when competing in prior rounds, whose technical-tactical behavior is characterized by perform more anticipatory actions than competitors in the final and semifinals. This information serves to focus taekwondo training in direct attacks to the chest and perform simultaneous counterattacks, imitating the final round competitors' behavior.

KEY WORDS: taekwondo, university, championship, rounds.

INTRODUCTION: Performance analysis is defined as a combination of biomechanical and notational analysis (Barlett, 2001). Both could share some commonalties like the purpose of their analysis (improvement of sport performance), use of similar methodology (i.e. video analysis for measurement of the movement), emphasise feedback to coaches and use systematic techniques of observation and need the data validity and reliability. However, biomechanics and notational analysis have differences, biomechanics are based on mechanics and anatomy, analysing kinematic parameters while notational analysis is focusses on movement patterns, strategy and technico-tactical indicators. Thus, biomechanical analysis allows coaches to identify how sport techniques can be improved whereas notational analysis identifies the performance indicators that relate to good and bad individual performance (Barlett, 2001).

Taking into account these disciplines, in the field of combat sports, different authors have analyzed biomechanically the execution technique (by mechanical parameters) and the influence of external factors on kick performance (such as execution distance, the height of target) aiming to understand the mechanisms in which it is based on. Most of these studies carried out the analysis in a specific technique (i.e., the roundhouse kick) because as it has been pointed out is the most frequent action used in competition (Falco, Landeo, Menescardi, Bermejo, & Estevan, 2012; Menescardi et al., 2012). However, with the inclusion of electronic body protectors and video replay it seems that the linear action (i.e. axe kick in taekwondo) overtakes the circular action (i.e. roundhouse kick) as the most used technique in training and competition (Woo, Ho, Choi, Her, & O'Sullivan, 2013). It allows us to determine that there are key factor like the height of target, the execution distance, the type of action and technique performed.

Based on these biomechanical results, some studies have analyzed these parameters notationally (Falco et al., 2012 ; Iglesias, Gasset, Gonzalez, & Anguera, 2010; Kazemi, Casella, & Perri, 2009; Kazemi, Perri, & Soave, 2010; Kwon, 2012 ; Matsushigue, Hartmann, & Franchini, 2009; Menescardi et al., 2012; Santos et al., 2011).Taekwondo championships are conducted according to a single elimination tournament system, in which, winners of preliminary rounds of combats (three two-minute rounds) progress to successive rounds until the final combat of the championship. Being a combat sport characterized by fast and explosive actions. Taking into account that championships are generally carried out in a single day, several authors (i.e., Bouhlel et al., 2006; Iglesias et al., 2010) suggested that technical tactical behavior can be affected by the athlete's fatigue such as decreasing the frequency of use of some types of techniques. Nonetheless, there is a lack regarding the frequency of combat actions performed throughout the championship. Thus, the purpose of this study was to analyze the technico-tactical behavior of taekwondo athletes in a university

level taekwondo championship according to the round. Our study attempts to analyze what kind of combat actions (determined by type of attacks or counterattacks, type of techniques,, height, and laterality) are performed more often in each round of championship for researchers to make their trainings more real and adapted to competition characteristics.

METHODS: Participants: Two hundred and four university taekwondo athletes participated in the study. A total of 1088 performances corresponding to 169 combats from a National University Championship were analyzed. According to the Belmont Report, because the analyzed video tapes are in the public domain, no participant's informed consent was required.

Experimental design: The official videotapes from all the matches at the championship were recorded onto DVD and analyzed using the Hoisan software (Hernandez-Mendo et al., 2012). Following standard procedures in combat sports analysis (Salvador, Suay, Martinez-Sanchis, Simon, & Brain, 1999; Santos, Franchini, & Lima-Silva, 2011), a trained investigator analyzed all videos to determine the pre-defined parameters.

It was considered as an observational unit a combat action in which one or both contestants try to score (Iglesias et al., 2010). In order to specify the combat action, a total of twelve kicking parameters were defined: direct attack, indirect attack, anticipatory counterattack, simultaneous counterattack, posterior counterattack, linear action, circular action, actions with previous spin, actions to the chest, and actions to the head, with right and left leg. The movement of the athlete, who started the sequence, was defined as an attacking action (Luk, Hong, & Chu, 2001). These can be direct or indirect (if any action precedes the kick) (Gonzalez, Iglesias, Mirallas, & Esparza, 2011). The movement of the athlete to defend against an opponent's attack was defined as a counterattacking action (Luk et al., 2001). These can be anticipatory, simultaneous or posterior to the opponent's kick. Also, the type of kick was categorized into three variables: linear (i.e., pushing), circular (i.e., roundhouse) and with a previous spin (i.e., back) (Serina & Lieu, 1991). The section of kicking was classified into chest and head, which are the only scoring areas in Taekwondo. Competitors can kick the opponent with right or left leg (WTF, 2012).

The reliability of the data (intra- and inter-observer, compared with an expert observer) was assessed by calculating Kappa coefficients, of five randomized matches (Salvador et al., 1999), with a result over 0.70 for all study variables, showing that scoring was highly reliable.

Statistical analysis: Using a Kolmogorov-Smirnov test data were found normally distributed, a one-way analysis of variance (ANOVA) was conducted, with 'round' as a factor (five levels: final, semifinal, quarterfinal, second and preliminary round) for the mentioned variables. Significant main factors and interaction effects were subsequently examined using the Bonferroni adjustment. Significant differences were obtained from post-hoc comparisons. Cohen's *d* score was quantified to analyze the effect of size of the comparisons; a *d* value > 0.8 indicated a large effect, 0.8–0.5 a moderate effect, 0.5–0.2 a small effect, and <0.2 a trivial effect (Cohen, 1988). The level of significance was set at $p < 0.05$.

RESULTS: As we can see in the table 1, a significant main effect was observed for 'round' in direct [$F_{(1083, 4)}= 9.53$; $p = 0.01$;], anticipatory [$F_{(1083, 4)}= 4.78$; $p = 0.01$], simultaneous [$F_{(1083, 4)}= 7.52$; $p = 0.01$], and linear actions [$F_{(1083, 4)}= 28.48$; $p = 0.01$], actions to the chest [$F_{(1083, 4)}= 7.52$; $p = 0.01$] and actions with left leg [$F_{(1083, 4)}= 3.69$; $p = 0.01$]. Pairwise comparisons showed that athletes when compete in final and semifinal round performed more direct actions ($p = 0.01$), simultaneous counterattacks ($p = 0.01$) and linear actions ($p = 0.01$) than athletes when compete in the preliminary, second and quarterfinal round. The normalized effect size of these differences (Cohen's *d* value) was higher than 0.5 and lower than 0.8 in all the cases. Also, athletes in the final and semifinal round performed more actions to the chest ($p = 0.01$) and athletes when compete in the final round performed more actions with left leg than competitors of the preliminary round ($p = 0.03$). The normalized effect size of these differences (Cohen's *d* value) was higher than 0.3 and lower than 0.5 in all the cases. In contrast, athletes competing in the final and semifinal round of this championship performed fewer anticipatory actions than athletes competing in the second round ($p = 0.04$;

p = 0.01, respectively). The normalized effect size of these differences (Cohen's d value) were higher than 0.3 and lower than 0.5.

Table 1 Statistical descriptive of taekwondo performance in each round of championship.

	Final (n = 96)	Semifinal (n = 178)	Quarterfinal (n =306)	Second round (n = 382)	Preliminary round (n = 126)
	M±SD	*M±SD*	*M±SD*	*M±SD*	*M±SD*
Direct	6.16±3.12a	6.27±4.00bcd	4.84±3.65b	5.14±3.34c	4.17±3.29ad
Indirect	2.22±1.99	1.71±1.65	2.18±2.15	2.22±2.11	2.37±2.62
Anticipatory	0.32±0.65a	0.32±0.73b	0.53±0.91	0.62±0.99ab	0.62±1.01
Simultaneous	1.14±1.22abc	0.83±1.05	0.61±1.03a	0.59±0.93b	0.56±0.78c
Posterior	1.60±1.53	1.47±1.55	1.65±1.72	1.71±1.56	1.60±1.70
Linear	2.39±2.04abc	2.33±2.11def	1.23±1.80ad	0.98±1.53be	1.00±1.22cf
Circular	8.34±4.10	7.67±4.22	8.14±4.69	8.72±4.24	7.67±4.67
Spin	0.71±1.06	0.60±1.12	0.44±0.79	0.58±0.88	0.65±1.00
Head	1.19±1.19	1.03±1.33	1.30±1.48	1.35±1.46	1.43±1.57
Chest	10.25±4.46ab	9.57±4.71c	8.50±4.83a	8.93±4.11	7.90±4.56bc
Right	6.03±4.16	5.46±3.82	5.21±3.87	5.89±3.49	5.23±4.27
Left	5.4±3.31a	5.13±3.51	4.59±3.50	4.38±3.11	4.10±3.14a

Note: Similar letters to the right of the *M±SD* values mean statistical differences between rounds in the variable.

DISCUSSION: The aim of this study was to analyze the technical tactical behavior of taekwondo athletes in a university taekwondo level championship according to the round. Several studies have used notational methodology to analyze parameters related to the behavior of taekwondo athletes (Falco et al., 2012; Iglesias, Gasset, Gonzalez, & Anguera, 2010; Kazemi et al., 2009; Kazemi et al., 2010 ; Kwon, 2012 ; Matsushigue et al., 2009; Menescardi et al., 2012; Santos et al., 2011). However, there is a lack regarding the frequency of actions throughout the championship. In line with previous studies (Matsushigue et al., 2009; Santos et al., 2011), during final and semifinal rounds competitors behaved similar performance. That is, the results showed that in final and semifinal rounds, competitors performed more direct attacks, simultaneous counterattacks and linear actions to the chest with left leg than athletes when compete in the preliminary, second and quarterfinal rounds, whose technical-tactical behavior is characterized by performing more anticipatory actions than competitors in the final and semifinals. According to Cohen's d value, the effect of these differences is considered as moderate or small (Cohen, 1988), depending on the variables, the smaller the effect size, the more cautious we will be when consider the results when practical applications would pretend to be provided.

Another aspect that must be pointed out from our results is that when athletes competed in the previous rounds they tend to perform more indirect attacks, while when they arrive to semifinals and final rounds they perform more direct attacks and more kicks to the chest. It could be because athletes with lower success would not be able to control the distance from their opponent (athletes with higher success) and also direct attacks seem to be more difficult to defend (Kwon, 2012). The control of the distance appears to be a key factor from a tactical and technical point of view for success in competition (Falco et al., 2013). It seems that as athletes approach to the final they tend to use easier and more effective techniques.

CONCLUSION: It is important to know how vary the technico-tactical behavior in championship throughout the successive rounds because it could influence the coach's planning and competitor's training. Taking into account our results, coaches must focus taekwondo training to linear and direct attacks to the chest and simultaneous counterattacks to guide competitors who lag behind in the early rounds to the success, imitating the final and semifinal round competitors' behavior.

REFERENCES:

Barlett, R. (2001). Performance analysis: is it the bringing together of biomechanics and notational analysis or an illusion? In: *Proceedings of the 19th International Symposium on Biomechanics in Sports*. California, USA, University of San Francisco, pp 328-331.

Bouhlel, E., Jouini, A., Gmada, N., Nefzi, A., Abdallah, K. B., & Tabka, Z. (2006). Heart rate and blood lactate responses during taekwondo training and competition. *Science Sports, 21,* 285-290.

Cohen, A. (1988). Statistical power analysis for the behavioural sciences (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Gonzalez, C., Iglesias, X., Mirallas, J., & Esparza, G. (2011). Systematization of tactical action in high-level competition taekwondo [Spanish]. *Apunts. Educación Física y Deportes, 103,* 56-67.

Falco, C., Landeo, R., Menescardi, C., Bermejo, J. L., & Estevan, I. (2012). Match analysis in a University Taekwondo Championship. *Advances in Physical Education, 2*(1), 28-31.

Falco, C., Molina-Garcia, J., Alvarez, O., & Estevan, I. (2013). Effects of target distance on select biomechanical parameters in taekwondo roundhouse kick. *Sports Biomechanics, 12*, 324-333.

Hernandez-Mendo, A., Lopez, J.A., Castellano, J., Morales, V., & Pastrana, J.L. (2012) IT Program for Use in Methodology Observational [Spanish]. *Cuadernos de Psicología del Deporte, 12*, 55-78.

Iglesias, X., Gasset, A., Gonzalez, C., & Anguera, M.T. (2010). Competitive interaction and environmental pressure in combat sports: Application of Methodology Observational [Spanish]. *Revista Iberoamericana de Psicología del Ejercicio y el Deporte, 5,* 267-282.

Kazemi, M., Casella, C., & Perri, G. (2009). 2004 Olympic Tae Kwon Do Athlete Profile. *The Journal of the Canadian Chiropractic Association, 53*(2), 144-152.

Kazemi, M., Perri, G., & Soave, D. (2010). 2008 Olympic Tae Kwon Do Athlete Profile. *The Journal of the Canadian Chiropractic Association, 54*(4), 243-249.

Kwon, H. (2012). Discrepancies in fighting strategies between Taekwondo medalists and non-medalists. *Journal of Human Sport Exercise, 7,* 806-814.

Luk, T.Z., Hong, Y., & Chu, D.P.K. (2001). Analysis of strategy used in taekwondo competition. In: *Proceedings of the 19th International Symposium on Biomechanics in Sports*. California, USA, University of San Francisco, pp 166-169.

Matsushigue, K., Hartmann, K., & Franchini, E. (2009), Taekwondo: physiological responses and match analysis. *Journal of Strength and Conditioning Research, 23,* 1112-1117.

Menescardi, C., Bermejo, J.L, Herrero, C., Estevan, I., Landeo, R., & Falco, C. (2012). Technical-tactical differences among university level taekwondo competitors by gender and weight division [Spanish]. *Revista de Artes Marciales Asiáticas, 7,* 1-11.

Salvador, A., Suay, F., Martinez-Sanchis, S., Simon, V. M., & Brain, P. F. (1999). Correlating testosterone and fighting in male participants in judo contests. *Physiological Behaviour, 68*, 205–209.

Santos, V., Franchini, E., & Lima-Silva, A. (2011). Relationship between attack and skipping in taekwondo contests. *Journal of Strength and Conditioning Research, 25(*6), 1743-1751.

Serina, E., & Lieu, D. K. (1991). Thoracic injury potential of basic competition taekwondo kicks. *Journal of biomechanics, 24*(10), 951-960.

Woo J., Ko J., Choi E., Her J., & O'Sullivan D. (2013). Development and evaluation of a novel taekwondo chest protector to improve mobility when performing axe kicks. *Biology of Sport, 30*, 51-55.

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