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Fighting and non-fighting time-motion in taekwondo cadet athletes

Análisis del tiempo de lucha y no lucha en taekwondistas cadetes

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Abstract

Fighting (F) and non-fighting (NF) relationship has been used to characterize the physical demands in taekwondo. The aim of this study is to analyze the time motion activity (F and NF) according to the weight category in taekwondo cadet competitors (12-14 years). Time motion phases (F and NF) of 47 bouts of the first Cadet World Championship according to the weight category (fin, fly, bantam, feather, light, welter, light-middle, middle, light-heavy and heavy) were analyzed. Kruskall-Wallis followed by Mann Whitney U tests were used to analyzed differences between groups ($p < 0.05$). There are differences in F and NF according to the weight category. In NF phase, heavy athletes (welter, light-heavy and heavy) had longer NF periods than lighter athletes (fin, fly, light and light-middle). In F phase, fin, light-middle and light-heavy performed shorter F phases than fly, bantam, feather, light, welter, middle and heavy. Eventually, trainings must be prepared to simulate competitive F and NF phases according to the weight category in the sample analyzed. Thus, coaches should propose to athletes F:NF ratios of activity similar to the real competition according to the weight category of each athlete in addition to the characteristics of each competitor.

Key Words

Time-motion; taekwondo; cadet; observational analysis.

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Resumen

La relación entre los tiempos de lucha (L) y no lucha (NL) ha sido utilizada para caracterizar las demandas físicas del taekwondo. El objetivo del presente estudio es analizar el tiempo de L y NL en función de la categoría de competición en taekwondistas cadetes (12-14 años). Se analizaron las fases del tiempo de movimiento (L y NL) de 47 combates del primer Campeonato del Mundo Cadete en función de la categoría de competición (minimosca, mosca, gallo, pluma, ligero, superligero, semimedio, medio, semipesado y pesado). Se utilizó el test Kruskal-Wallis seguido de las pruebas por pares de U de Mann Whitney para analizar las diferencias entre grupos ($p < 0,05$). Se encontraron diferencias significativas en función de la categoría de competición en las fases de NL y L. En la fase NL, los deportistas de mayor peso (superligero, semipesado y pesado) realizaron periodos más largos que los de menor peso (minimosca, mosca, pluma, ligero y semimedio). En cuanto a los periodos de L, los deportistas de minimosca, semimedio y semipesado realizaron periodos más cortos que mosca, gallo, pluma, ligero, superligero, medio y pesado. Como conclusión, se deberían preparar entrenamientos para que los tiempos de L y NL sean parecidos a los encontrados según la categoría de competición en la muestra analizada. Así, los entrenadores podrían proponer a los deportistas ratios de actuación L: NL similares a la realidad de cada categoría de competición y características de cada competidor.

Palabras clave

Tiempo de movimiento; taekwondo; cadete; análisis observacional.

Introduction

Taekwondo (TKD) is a combat sport that is known for fast and powerful kicks (Estevan, Falco, Freedman Silvernail, & Jandacka, 2015). The TKD competition system works by direct elimination according to weight category and gender (WTF, 2012). In this case, the elimination of the opponent by a knock out or points results in a bout victory (WTF, 2012). In TKD, victory by points is achieved by performing kicks and punches to the trunk, generating strength above a pre-established threshold or to the head (only kicks) with a simple contact, thus, achieving a score (Estevan et al., 2015; WTF, 2012).

Importantly, TKD bouts have an intermittent nature. After high intensity kicks and punches, there are lower intensity actions, where the athlete observes the opponent and prepares a new attack. This period is called skipping due to the movements that are performed

during it (Santos, Franchini, & Lima-Silva, 2011). Understanding the intermittent nature of the sport, in particular the relationship between kicks and the skipping time, allows coaches to know the physical demands of the competition and develop a specific conditioning program to meet these demands (Butios & Tasika, 2007).

Several studies (Matsushigue, Hartmann, & Franchini, 2009; Santos et al., 2011; Tornello, Capranica, Chiodo, Minganti, & Tessitore, 2013) have used the relationship between the fighting (F) and non-fighting (NF) time to characterize the physical demands of TKD. As mentioned above, TKD is an intermittent exercise, where the physiological response depends on the duration and intensity of the effort and pause (Glaister, 2005). A review of the current literature suggests that fewer studies have examined this relationship in TKD competition. Heller et al. (1998) showed that 17-18% of the bout total time corresponds to F actions, while 50-57% is corresponds to NF actions.

Previous studies have analyzed this relationship or F:NF ratio in different competitions. In high-level competition, for example, in Olympic Games or in World Championships, there are similar times of F - around one and a half seconds. However, the NF times vary throughout competitions, being inferior in Olympic Games (8.3 ± 3.2 s) than in World Championships (10.1 ± 4.5 s) (Santos et al., 2011). From this study, we could extract an F:NF ratio (synonym of ratio effort:pause; E:P) of 1:4 (Santos et al., 2011). On the other hand, in national competitions (Matsushigue et al., 2009), the F and NF times have been found to be around seven and half seconds, showing a ratio of 1:1 and 27 ± 13 actions per bout.

However, it appears that these athletes perform a greater number of actions. In this sense, Menescardi et al. (2012) found that the mean actions per bout were superior to those previously mentioned (31.52 ± 7.87 for male and 34.72 ± 12.81 for females). The most recent study was carried out by Santos et al. (2014), with World Championship competitors dividing the sample according to the gender and weight categories. This study showed ratios of 1:6, with F periods of around 1.5 s and NF period of around 13.6 s with 9.1 ± 2.3 actions per bout.

With regard to the weight category, it is shown that light males performed F times that were superior to heavies and lower NF times than the heavies.

All of the mentioned studies focus on the analysis of adult competitors (Matsushigue et al., 2009; Santos et al., 2011; Santos et al., 2014), suggesting a lack of studies in inferior categories. This is due to the generalized information that is obtained for cadet competitors, who have different competition rules (i.e., shorter duration of bout), which could be considered to be an error (Tornello et al., 2013). There is only one study with cadets that has shown a 1:2 ratio, with F times of three seconds and NF times of six seconds (Tornello et al., 2013). During this fighting time, the cadet competitors performed 5 ± 1 actions, 4 ± 1 technical interchanges with a duration of 0.6 ± 0.1 s (Tornello et al., 2013).

A taekwondoist's behavior differs according to their weight category - heavy competitors perform a fewer number of actions and need a higher NF time in order to rest (Santos et al., 2011; Santos et al., 2014). Thus, it is necessary to consider the peculiarities of each athlete and divide them into trainings according to their weight category. As reviewed, previous studies (Santos et al., 2011; Santos et al., 2014) have been conducted with adults, it is not possible to extrapolate these data to cadet competitors who compete under different competition rules (e.g., less bout time) (Tornello et al., 2013). Therefore, the objective of this study is to analyze the F and NF times depending on the weight category in taekwondo cadet athletes, since it is hypothesized that athletes with a greater weight could perform NF phases longer than athletes of lighter categories.

Method

Study design

The present study is framed into observational methodology (OM), with a diachronic, nomothetic and multidimensional observational design, placing it in the IV quadrant. The order and duration parameters that are related to the nature of the data in the observational designs allow us to establish four quadrants according to the type of data (event-based vs. time-based). The first quadrant corresponds with data type I (sequential and event-based), the second with type II data (concurrent and event-based), the third with type III data (sequential

and time-based) and, finally, the fourth, with type IV data (concurrent and time-based). Types I and II only require the order parameter in the register, whereas types III and IV have to be registered including the duration parameter (see Anguera, Blanco, Hernandez-Mendo, & Losada, 2011, for a further review of OM).

Sample

We analyzed 47 bouts (finals and semifinals) of the first World Cadet Championship of TKD (Baku, Azerbaijan) in 2014, both in boys (n = 22) and girls (n = 25), aged between 12 and 14 years (WTF, 2012). According to the *Belmont Report* (1978), as the videos are from a public domain, informed consent from the participants is not needed. The *Belmont Report* describes the basic ethical principles and lines of action concerning studies with human subjects. This study was approved by a university ethics committee.

Variables

The analysis of the bouts was carried out following the movement phases settled by Tornello et al. (2013) (F and NF). The F phase was considered as an active temporary phase in which the technical exchange (e.g., kicks, punches, blocks, etc.) between opponents is given, as well as movements (e.g., feints, guard and direction changing or steps) that could precede the attack in order to confuse or surprise the opponent and score (Tornello et al., 2013). Feints are considered to be a threat (i.e., displacement), made with the aim of confusing the adversary (Gonzalez Iglesias, Mirallas, & Esparza, 2011). The type of guard is categorized according to the position that is taken by the taekwondoists before starting the movement (on the ground). Thus, a change of guard is the change of the initial position of the movement, which is usually performed by a movement of skipping movement. Meanwhile, the NF phase was considered as an active temporary phase including tactics planning, observation and physical preparation for the attack (e.g., safety distance, guard changing, direction changing, feints or steps) (Tornello et al., 2013). The present analysis was descriptive and differential. As shown in Table 1, the sample was grouped based on the

weight category of the participants (fin, fly, bantam, feather, light, superlight, welter, semi-middle, middle, semi-heavy and heavy).

Table 1. Weights for each weight category according to the gender in cadet category.

	Fin	Fly	Bantam	Feather	Light	Super Light	Semi middle	Middle	Semi heavy	Heavy
Boys	<33kg	<37kg	<41kg	<45kg	<49kg	<53kg	<57kg	<61kg	<65kg	≥65kg
Girls	<29kg	<33kg	<37kg	<41kg	<44kg	<47kg	<51kg	<55kg	<59kg	≥59kg

Procedure

Based on previous studies (Matsushigue et al., 2009; Santos et al., 2011; Santos et al., 2014; Tornello et al., 2013), the analysis of the official videos was made with an observational methodology of only one observer. To do this, the observer was formed for a period of 40 hours following the phases suggested by Anguera (2003). We used the HOISAN software for the video analysis (Hernandez-Mendo, Lopez-Lopez, Castellano, Pastrana, & Morales, 2012).

Data Analysis

Kolmogorov-Smirnov test was performed to test the normal distribution of the sample. As it does not follow a normal distribution, nonparametric tests were performed. Thus, Kruskal-Wallis test was carried out to determine the significant differences in the mean duration of each F and NF between different weight categories. Mann Whitney U test was used for pairwise comparisons. These were all performed with SPSS version 23.0 (Chicago, Inc.) license from the Catholic University of Valencia, with a significance level of $p < 0.05$.

Results

Significant differences were found according to the weight category in NF ($\chi^2_{(9)} = 61.026$; $p < 0.01$) and F ($\chi^2_{(9)} = 31.753$; $p < 0.01$) phases. Table 2 shows a descriptive analysis (mean and standard deviation) and differential of the variables analyzed.

In the NF phase, the semi-heavy and heavy competitors performed longer periods than fin ($p < 0.01$ in both comparatives), fly ($p < 0.01$ in both cases), feather ($p = 0.02$ and $p =$

0.04, respectively), light ($p < 0.01$ in both cases) and semi-middle ($p < 0.01$ in both cases). Moreover, differences were found in superlight competitors who performed longer NF phases than fin ($p < 0.01$), fly ($p = 0.04$), light ($p < 0.01$), semi-middle ($p < 0.01$) and middle ($p = 0.02$). In addition, the fin and fly weight categories performed shorter NF periods than bantam ($p < 0.01$ in both cases). Likewise, the differences between fin and feather were demonstrated, with fin performing shorter NF periods ($p = 0.03$). Other categories performed shorter NF periods as light and semi-middle with respect to bantam and feather ($p < 0.01$ in all comparatives).

Table 2. Descriptive analysis (mean ± standard deviation) and differential of competitors.

	Fin	Fly	Bantam	Feather	Light	Super Light	Semi middle	Middle	Semi heavy	Heavy
Non Fighting	2.88± 2.62 a,b,c,d,e	3.09± 2.03 f,g,h	3.52± 1.83 a,i,j	3.12± 1.74 k,l	2.70± 1.50 i,m,n,o	3.60± 2.37 b,f,m,q	2.79± 1.93 j,q,r,s,t	3.42± 2.96 c,n,r	3.82± 2.50 d,g,k,o,s	3.86± 2.74 e,h,l,p,t
Fighting	2.19± 1.39 a, b,c,d,e,f,g	2.98± 2.26 a,h,i	3.00± 2.65 b,j,k	2.81± 2.30 c,l	3.07± 2.50 d,m,n	2.73± 1.72 e,o	2.33± 1.34 h, j,l,m,o,p	2.81± 2.38 f,p	2.47± 1.69 i,k,n	2.68± 1.89 g

Note: similar letters in the right side of descriptive data shown differences between groups ($p < 0.05$).

With regard to F periods, fin, semi-middle and semi-heavy performed shorter periods than fly ($p = 0.01$ in all cases) and light ($p = 0.01$ in all cases). Additionally, fin performed shorter periods of F than bantam, feather, superlight, middle, semi-heavy and heavy ($p = 0.01$ in all cases). In the same line, semi-middle performed shorter periods than superlight ($p = 0.03$).

Discussion

The aim of the present study was to analyze the movement time of final and semifinal competitors of the World Cadet Championship of 2014 according to their weight category. To date, this is one of the first studies to analyze the movement time of cadet taekwondoists. The authors agree with Tornello et al. (2013) that the study should not extrapolate data obtained in adult athletes to the cadet category, since the latter have different competition rules according to their age (e.g., less bout duration). As it is shown in the introduction of the present work, different results were found in the F and NF phases according to the population

analyzed. In national championships, adult competitors perform F and NF periods of 7.5 ± 1.8 s and 7.5 ± 2.6 s, respectively (Matsushigue et al., 2009). Meanwhile, cadets perform phases with inferior duration, with F phases of 2.8 ± 1.0 s and NF of 6.5 ± 1.8 s (Tornello et al., 2013). The results obtained by Tornello et al. (2013) showed similar movement times between cadet athletes in a national championship, independent of the weight category. In our case, it is found that, in the NF phase, athletes with a higher weight (i.e., superlight, semi-heavy and heavy) performed longer periods than athletes with a lower weight (i.e., fin, fly, feather, light and semi-middle). This could be due to the higher corporal mass of the heavier athletes, who could expend more energy in actions to contact the opponent and, therefore, need more time to rest than the lighter athletes (Santos et al., 2011).

Regarding the F periods, fin athletes (one of the categories with a lower weight), semi-middle (an intermediate category) and semi-heavy (one of the categories with higher weight) performed shorter periods than the rest of the athletes. These results contrast those obtained by Santos et al. (2011), who found a shorter F time in competitors with a higher weight, or Tornello et al. (2013), who did not find any differences between competitors according to their weight category. Such differences between studies could be attributed to the sample being grouped into four categories (Santos et al., 2011) or three weight categories (Tornello et al., 2013), meanwhile, in the present study, it is grouped into the 10 weight categories, which are assigned according to the age for the World TKD Federation (WTF).

Despite the heterogeneous distribution between previous studies, the differences in weight categories could be because athletes alter their technical and tactical behavior to surprise their opponent and try to score. This strategy would explain why athletes who do not usually attack (i.e., heavy athletes who, due to their larger body mass, are often characterized by a more static behavior [Santos et al., 2011]) would choose to initiate attacks (Chiodo et al., 2012; Menescardi, López-López, Falco, Hernández-Mendo, & Estevan, 2015), performing F phases longer than those who might initially have hypothesized this behavior (i.e., lighters). The results of this study can be applied in TKD training, for example, dividing taekwondo athletes according to their weight category.

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These results provide evidence that favor the practice and training of taekwondo cadets, respecting several pedagogical and biological principles of sports training (González-Ravé, Pablos, & Navarro, 2014). In taekwondo cadets, from the description of the F and NF times being close to three seconds in both cases, and in relation to the biological principle of modeling, as well as the pedagogical principle of individualization, it is suggested to coaches of young children to prepare trainings with F and NF times that similar to those found by their weight category. Specifically, during the training sessions, heavier children will require longer active rest times than lighter children (principle of individualization). In turn, tactical work proposals should reproduce the particularities of the competition, in the sense of incorporating their own parameters of the competition and adjusting the F and NF times that are proposed in this study (principle of modeling). This study should serve as a reference to forget traditional practices in sports field training, where training proposed to adults were applied to children. This is because the results show that the performance times of cadet athletes (12 - 14 years) differ considerably from those found in absolute national and international championships (≥ 18 years) (Matsushigue et al., 2009; Santos et al., 2011; Santos et al., 2014).

From the point of view of the suitability of the practice of TKD in children, different studies have shown how the practice of TKD improves the mood of its practitioners, decreases tension, depression, anger and fatigue (Toskovic, 2001), as well as anxiety, whilst showing an increase in self-esteem, self-confidence and optimism (Kurian, Caterino, & Kulhavy, 1993; Trulson, 1986). Lakes and Hoyt (2004) showed that it also improves the cognitive aspects of prosocial behavior, in addition to behavior and classroom performance (see Vertonghen & Theeboom, 2010 for a deeper review of the results of martial arts practice). In the physical field, it is proved that it improves the balance and flexibility of its practitioners (Cromwell, Meyers, Meyers, & Newton, 2006). Therefore, authors believe that taekwondo could be a suitable sport to be introduced in education, either in physical education lessons or as an extracurricular activity, due to the amount of benefits that it could bring to its practitioners.

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This study is the first to show the F and NF times in taekwondo cadets being adjusted to regulatory delimitations of the weight category. It also shows the relevance of these categories due to the different behavior shown between different weight categories. Among the limitations of the study, there is the inherent subjectivity of any observation or the unobservability periods that are found in the official videos (Santos et al., 2014). However, these periods did not exceed 10% of the same, and are within the acceptable limits (Anguera, 1990). Another limitation of the study is the biased analysis of the finals and semifinals of the championship. As such, the results may only be applicable to the taekwondo cadet population. However, future studies with all of the cadet competitors should be carried out in order to check whether the patterns that are shown in the present study are reproduced.

Conclusion

To conclude, the aim of this study was to analyze the time of F and NF in taekwondo cadets according to their weight category. From the results, it is concluded that, considering the taekwondo athletes analyzed, the heaviest weight categories performed longer NF and shorter F phases. Thus, for the analyzed sample, athletes (finalists and semifinalists) should prepare trainings with F and NF times that are similar to those found by each weight category. Finally, this study proposes that the performance of F:NF ratios that are similar to the reality of each weight category could allow coaches and athletes to achieve a preparation according to their characteristics, which could allow them to achieve their objectives.

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