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Convergent validation of training loads measurements in taekwondo athletes

Abstract

The purpose of this study was to analyze if both the Banister's TRIMP method and the Foster method are convergent to calculate the training loads in Taekwondo athletes. There was a total number of 8 Taekwondo athletes as participants, of which composed of 4 women and 4 men. Together, the participants performed a total number of 61 training sessions. The study also had a significant Pearson correlation found between the Banister's TRIMP and Foster's method ($r= 0.33$, $p < 0.01$), but according to Lin's Concordance Correlation Coefficient, the measurement was very low (Rc between 0.002 and 0.022). An individual correlation was also made through the Pearson Product-Moment between the two methods and through this it was discovered that only one participant had a significant association ($r=0.812$, $p<0.014$), but with Lin's Concordance Correlation Coefficient, the result was low (Rc between -0.004 and 0.037). In conclusion, both the Banister's TRIMP method and the Foster method are not convergent to measure the training loads in Taekwondo athletes.

Keywords: load training, martial arts, taekwondo, heart rate, Banister's TRIMP method, foster method

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Introduction

Sport planning in disciplines such as martial arts requires to understand a lot of physiological variables that are involved in processes like training and competition.[1,2] Moreover, some physiological aspects are needed in order to quantify the training loads (TL) that will evaluate and improve physical abilities (including technical and tactical qualities) in athletes.[3] Different studies have been published that involves determining the training Loads (TL). In one study, it shows that the heart rate (HR) has been used as an easy and reliable measurement to monitor the TL and the athletes' work of progress.[4–6] In sports like Taekwondo and Karate, they both share things in common. Both presents abrupt changes in HR, every time an attack or counter-attack technique was implemented,[7,8] and this happens also during fighting moments.[9–11] All these changes are produced when intermittent efforts happen with metabolic demands (alternative aerobic and anaerobic sequences) in sports. Researchers have used a vast diversity of procedures to calculate changes in HR and TL. One example, in Taekwondo, Haddad[1]did an investigation wherein 10 Taekwondo competitors trained for 10 weeks during pre-competitive period. The researchers used Edwards' Heart Rate–Based Method (Edwards' TL) and Banister's Training Impulse Method (Banister's TRIMP) to determine the LT of the athletes. They found that both methods were related, however, Borresen[12] mentioned that Banister's TRIMP technique was more reliable when it comes to measuring intensity training, and Edwards' TL was more reliable for TL. A group of researchers[13] designed a method for controlling TL based in the Rating of perceived exertion (RPE´s Borg). This method (RPE´s Borg) had also been evaluated in boxing;[14] karate;[15,16] diving;[17] football;[18] and finally, waterpolo.[19] Padulo[20] demonstrated that Foster method was reliable in develop load in trainings because it additionally takes physiological demands for each athlete. Nevertheless, it is important to understand that this method only works with Borg CR-10 scale because as some authors[21] proposed, the subjective perception scale of Borg effort, from 6 to 20 points, it is not a valid instrument to control intensity effort in training situations. The purpose of the study was to evaluate to recognize the effectiveness of the Banister's TRIMP and Foster methods to measure training load. Besides, it is of interest to know if both methods are convergent in determining load training for adult athletes (men or women) in Taekwondo.

Materials and methods

Participants

Eight Taekwondo participants, composed of 4 men and 4 women, participated in this study voluntarily. All of them came from the Taekwondo Representational Team from the University of Costa Rica. The participants were black belts (4) or red belts (4), with a minimum experience in Taekwondo practice of 5 years. In addition, all had participated in the last 2 years in kyrugui (combat) modality at least 3 times. Before beginning the study, participants were informed about the potential risks and benefits associated with their involvement. Finally, those who agreed signed a written informed consent. Participant characteristics are shown in Table 1.

Table 1 Participant characteristics

	Men (n=4)	Women (n=4)
Age	23±3.92	21.75±4.19
Weight	64.43±7.40	52.58±3.92
Height	169.48 ± 5.93	151.93±3.39
Experience	8.50± 2.06	7.5±2.08

Instruments

The HR was measure using a monitor Polar FT7. It has shown validity and reliability evaluating HR during exercise.[1–22] The TL was estimated through Banister method applying the following formula:

$$TD=HR_R \times 0.64 \times e^{1,92 \times HR_R}$$

In the formula, TD means the effective training session duration expressed in minute, e = base of the Napierian logarithms, and HRR= heart rate reserve.[7–12] The Foster Method[13]is based in the modified

perceived effort Borg scale (CR-10). In this scale the score given by the participant was multiplied by the training time.[4]

Procedures

A structured training was taken for 8 weeks. Each training followed the same sequence, first, a feedback phase (5 minutes), warm up exercises phase (10 minutes), stretch phase (10 minutes), and a specific warming up with physical preparation emphasis (15 minutes). The main phase of each training had a 60 minutes duration. Participants executed aerobic continuous kicking exercises for 1 minute per series. Furthermore, anaerobic training was also applied in the session through interval mode. Interval mode uses pads to work either technical or tactical exercises, or directed combat with assistant, or simulated combat. All exercises in the interval mode modality were realized at maximum effort. At the end of each session, a 10-minute normalization stage was carried out. Training sessions were taken between 19:00 and 21:00. Each session lasted 90 to 120 minutes. The HR was assessed at the beginning, middle, and after each training session using a heart rate monitor mark Polar FT7, RS300x. Middle evaluation was only focus to control heart rate monitor functionality. Banister's Training Impulse Method (Banister's TRIMP) was used to measure TL. This method uses HR during training and HR at rest (it was measured at the first day of the procedure). Each participant evaluated TL individually in two different moments, first one at the end of each session, and the second one between 10 minutes to 30 minutes after the ending. They used Borg scale (from 1 to 10) to estimate the training perceived effort through this question "how was your training on a scale from 1 to 10?." Based in the answer gave by athletes, the CR-10 method (Borg Perceived Effort modified by Foster[13]) was calculated.

Data analysis

Statistical analyses were performed using the IMB SPSS for Windows version 18.0 (IBM Corporation, New York, USA). The results are presented as means ± SD. The Pearson product-moment correlation coefficient, Lin's concordance correlation coefficient, Mann–Whitney U test between gender, and Bland Altman plot.

Results

The TL was calculated at the end of 61 sessions. A significant Pearson correlation was found between Banister's TRIMP and Foster's methods (r=0.33, p<0.01), however, Lin's concordance correlation coefficient showed a very low relation between both methods (Rc=0.012; IC 95% de Lin =0.002-0.022). Group correlation is presented in Table 2. Individual correlations between both methods are shown in Table 3. This analysis included 8 sessions that each participant accomplished. Only one participant assisted to 5 sessions. After analyzed Pearson correlation, only one person had a significant association (r=0.812, p<0.014), nevertheless, Lin's concordance correlation coefficient showed a low relation (Rc=0.017; IC 95% de Lin=-0.004-0.037).In addition, two participants demonstrated an inverse correlation (r=-0.327, p<0.429; y r=-0.032, p<0.941). Related with Bland Altman graph, its function is to describe consistency between two quantitative measurements. In this case, a consistency lack was displayed comparing participants and methods. Neither data results nor methods were uniform. In case they were, a central horizontal trend line between all the data had to be demonstrated (Figure 1). As shown in Table 4, there was not significant difference between method (Banister's TRIMP or Foster's) used according to gender.

Table 2 Group correlation between Banister's TRIMP and Foster's Methods

Participants	Sessions number	R	P	Rc de Lin	IC 95% de Lin	
					Lower bound	Upper bound
8	61	0.33	0.01	0.012	0.002	0.022

Table 3 Individual correlation between Banister's TRIMP and Foster's methods

Participants	Sessions number	R	P	Rc de Lin	IC 95% de Lin	
					Lower bound	Upper bound
S1	8	0.469	0.241	0.008	-0.007	0.022
S2	5	0.775	0.124	0.009	-0.006	0.024
S3	8	0.121	0.776	0.002	-0.013	0.018
S4	8	0.812(*)	0.014	0.017	-0.004	0.037
S5	8	0.679	0.064	0.01	-0.004	0.023
S6	8	0.39	0.34	0.015	-0.018	0.048
S7	8	-0.327	0.429	-0.008	-0.028	0.012
S8	8	-0.032	0.941	0	-0.01	0.009

Table 4 Differences between Banister's TRIMP and Foster's methods according gender

	Banister´s TRIMP method	Foster´s method
U de Mann-Whitney	460,000	213,500

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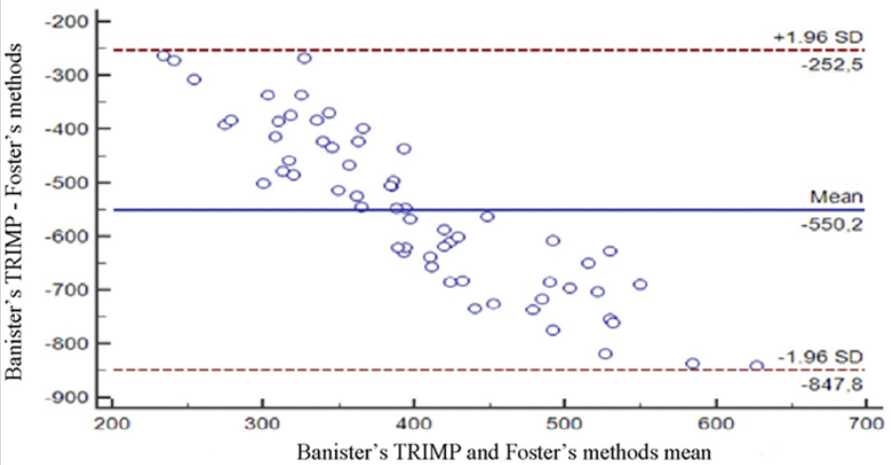

Figure 1 Comparison between Banister's TRIMP and Foster's methods.

Discussion

The purpose of this study was in recognized whether Banister's TRIMP and Foster's methods were similar to determine TL in Taekwondo adult athletes. There was not significant correlation between both methods. Haddad[1] showed that Banister's TRIMP and Edwards' TL had a high correlation among them and to evaluate TL too, nevertheless, results were obtained from young athlete participants. In some opportunities HR was overestimated. Moreover, when people get older HR_{max} trends to diminish.[23] The HR variability will be the mechanism which explains the relation among these two methods in young and adult people. Rodas[24] explained that a variety of factors affects HR. Some of them are age, physical training, body position, temperature, measurement time, and gender. All these characteristics were presented in this study. Tabben[6] proposed that HR is affected by age. When people are getting older, they reduce their maximum HR. This last fact could explain why different results for distinct competitor ages[5] were presented. Likewise, an investigation[25] established that in adult taekwondo athletes, perceived external effort is overestimated in relation to the internal effort. In addition, Tabben[6] showed that gender does not affect the percentages of HR. This might support the lack of significant differences between men and women. In summary both methods can be used to any gender. Taekwondo discipline is an acyclic and intermittent sport. It is characterized for abrupt changes in HR. This rapid changes in physical effort will be the reason for not finding any significance result, because it reduces the correlation among perceived effort and methods employed in this research.[19]

Conclusion

Banister's TRIMP and Foster methods are not convergent to calculate training loads in Taekwondo adult athletes, because a low correlation between both methods were found. However, Foster method seems reliable to evaluate the training intensities in Taekwondo. This method allows the athlete to show how vigorous the activity was. Banister's TRIMP is not an accurately technique to evaluate training loads.

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None.

Conflicts of interest

The authors declare no conflicts of interest.

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