Monitoring performance during high intensity interval training in International Taekwon-do Federation athletes.

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HIT training | Combat sport | Monitoring

Headline

High-intensity interval training (HIT) is a well-known, time-efficient training method for improving cardiorespiratory and metabolic function and, in turn, physical performance in athletes (1). While the literature is abundant with investigations on the benefits of HIT on aerobic and anaerobic capacity, many questions remain as to the most appropriate training format, modality and/or timecourse of neuromuscular recovery after different HIT protocols (1,2). Moreover to our knowledge there is paucity of data regards weekly changes in sport - specific HIT performance thus more longitudinal data could help develop more appropriate training programs and manage the training loads.

Aim. The aim of this study was to investigate the trend changes in specific HIT training performance in combat sport athletes. Understanding amplitude and diretion of changes of athletes' response helps the practitioners make informed decisions about the training loads.

Methods

Athletes. Twelve male taekwondo ITF (TKD) practitioners were recruited. All participants competed at the national and international level and had at least 5 years of training experience. (mean ± SD: age 24.9 ± 3.0 years, weight 71.63 ± 10.97 kg, height 177.60 ± 7.35 cm, VO2max 53.44 ± 2.06 $ml.kg^{-}1.minn^{-1}$). Written informed consent from participation was obtained. The study was conformed to the recommendations of the Helsinki Declaration (3).

Design. A within-group repeated measures design was used to examine the magnitude of change in HIT performance throughout 9-week period. The HIT protocol involved 30 s of maximal kicking drills (round middle kicks) separated by 90 s of rest (1:3 work/rest ratio) and was conducted twice per week. Performance was measured by the number of alternate left- and right-foot kicks making contact with a kicking pad held at waist level. Exercise was continued until volitional exhaustion or if the number of kicks performed in the 30 s bout decreased by a minimum of four kicks from the recorded maximum in the first kicking repetition. This marked the completion of the first set. The participant then rested for 20 minutes and returned to the above protocol of 30-s kicking repetitions until again the number of kicks decreased by a minimum of four from the recorded maximum or the participation refused to continue. Based on this protocol, the number of sets of kicking exercise was dependent on the participant's ability to maintain power output (the number of kicks in single 30 s period) in each subsequent repetition. A decrease in the number of kicks from the recorded maximum in this set signaled the end of the training session. HIT training was repeated every tuesday and thursday (48 hours apart). During monday, wednesday and friday athletes performed a typical 90-min TKD sessions involving traditional TKD methods and techniques. Saturday and sunday was a rest day.

Methodology. Trainings was performed under similar environmental conditions (105–115 m altitude, 20–25° C, 35–40% relative humidity) and at the same hour of the day as these athletes belongs to one training group. The round middle kick was adopted as it is one of the most basic and common kicks used in ITF-sanctioned TKD (Dollyo Chagi technique). During the training the bushi kicking pad was used (60 x 33 x 13 cm; height x width x depth, Bushi ltd, Poland) which is typically used during the typical TKD trainig sessions.

Statistical analysis. Data in the figures are presented as means and standard deviation (mean ± 90% CI). Changes in number of kicks performed were analysed using magnitue - based inferences. Traning 1, 6, 11 and 17 was chosen to analysis. Between-trainings standardized differences in the change in number of kicks were compared to the smallest worthwile change (SWC, 0.2 multiplied by the between-subject deviation of the 1st session number of kicks , based on Cohen's d principle) using magnitude based inferences. For all comparisons first training performance was used as a co-variable. These probabilities were used to make a qualitative probabilistic mechanistic inference about the true effect: if the probabilities of the effect being substantially positive and negative were both >5%, the effect was reported as unclear; the effect was otherwise clear and reported as the magnitude of the

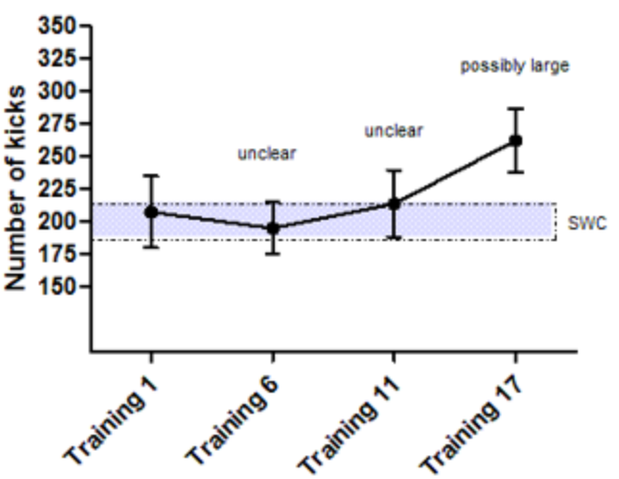

Figure 1.Changes in total number of kicks (mean ± 90% CI) during 1st set. Grey bar: smallest worthwile change.

Fig. 1.

observed value. Threshold values for standarized difeerences were >0.2 (small), >0.6 (moderate), >1.2 (large) (4).

Results

Total number of kicks during 1^{st} and 2^{nd} set are presented on figures 1 and 2. Figures 3 and 4 presents the average number of kicks performed during 30 s work periods in 1st and 2nd set, respectively. Smallest worthwile change was calculated based on the first training performance. Unfortunately we do not have reliability and reproducibility data thus we can not rule out the learning effects of the test/training performance and what is the extent of systematic error.

Discussion

Present study examined the trend changes of sport – specific HIT format which is often recommended in combat sport athletes conditioning (5). Iaia and Bangsbo (6) define this type of HIT as "speed endurance maintanance" (SEM) where the primary aim is to stimulate anaerobic energy production. Short bouts of SEM (5 – 90 s) with short recovery periods ($\leq$ 3 fold longer than exercise time) are resulting in progressive accumulation of fatigue and high ionic perturbations which may induce physiological adaptations that allow high work output despite homeostatic imbalance (6,7,8).

It could be suggested that enhanced ability to sustain exercise at high intensity (exercise tolerance) is presented by the increased total number of kicks performed in the set 1 and 2, until volitional exhaustion and/or decrease in power output occurs (fig. 1 and 2). It should be noted that in the 2nd set of training 6 there was moderate increase in total number of kicks, despite no improvements in single 30 s power output (fig. 4). Therefore it was clearly shown that improvments in the work capacity in this set was determined by the number of intervals maintained. Athletes were able to sustain high intensity exercise for a longer period of time which could be attributed to delayed fatigued development. Nevertheless this trend was not shown in set 1 (fig. 1) thus further research is required in order to investigate this pheomemenon. The fact that HIT bouts were performed at near maximal intensity may suggest that athletes' could also benefit from adaptations reserved for "speed endurance production" (SEP) training. It is believed that SEP, contrary to SEM, due to longer recovery periods (> 5 times exercise duration) maintains higher mechanical output, and in turn, is a potent stimulus for speed development during repeated sprint exercise (6). Even though the 1:3 work/rest ratio (SEM) was utilized in the present study, it can be assumed that by auto – regulating intensity of exercise (e.g. drop in the number of kicks), subjects were able to develop both anaerobic power and fatigue tolerance.

It should be emphasized that testing athletes performance only pre and post intervention may mask worthwile responses to stimulus during training intervention. For example if coach do a trend analysis for work capacity after first three weeks of training (training 1 vs training 6, fig. 2) he/she will notice most likely moderate changes. However if data between training 1 and 11 (after 6 weeks, fig. 2) are analysed only, coach would have came with unclear observations what can lead to different conclusions. Furthermore, during the 6th week moderate improvements in power output was recorded (fig. 4), however, unclear results were found when it comes to the total number of kicks in set 1 and 2 (fig. 3 and 4) Considering this, in some athletes we observed increased power output but

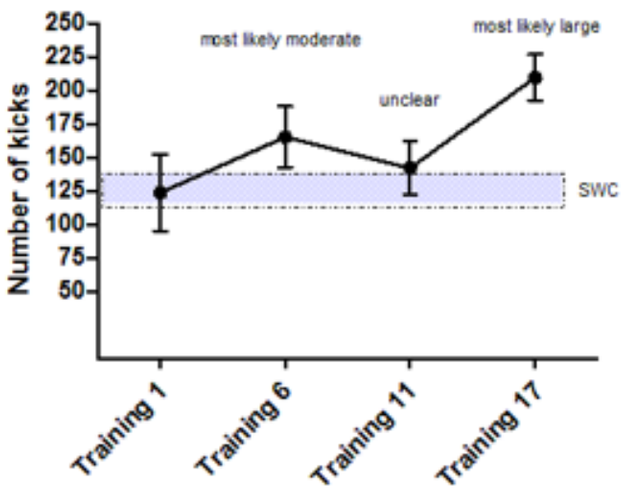

Figure 2. Changes in total number of kicks (mean ± 90% CI) during 2nd set. Grey bar: smallest worthwile change.

Fig. 2.

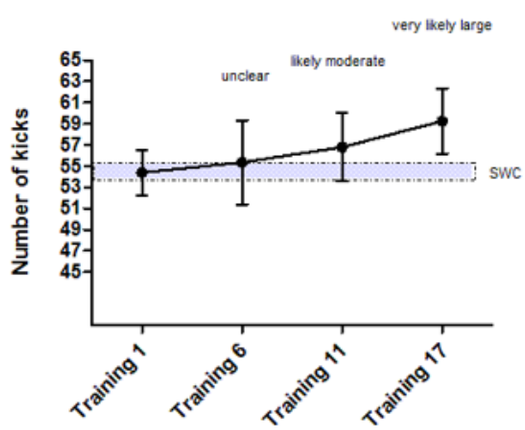

Figure 3. Changes in average number of kicks during 30 - s work period (mean ± 90% CI) in 1st set. Grey bar: smallest worthwile change.

Fig. 3.

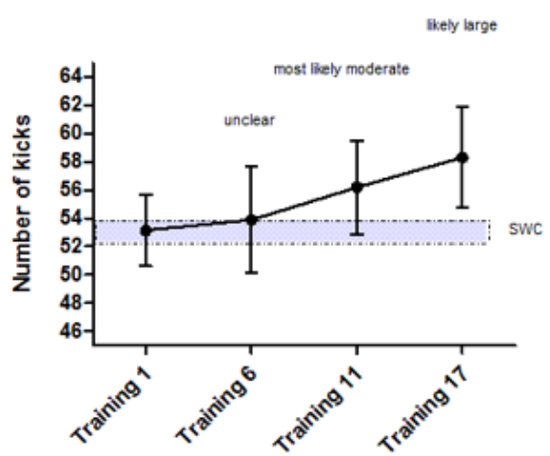

Figure 4. Changes in average number of kicks during 30 - s work period (mean ± 90% CI) in 2nd set. Grey bar: smallest worthwile change.

Fig. 4.

at the expense of work capacity. This paradox needs further studies in appropriate interpreting such results at the individual level.

In conclusion, present data show that magnitude of changes in HIT performance after 9 weeks are from possibly to most likely large, however not all variables present linear trend what should be taken into account during monitoring process.

Practical Applications

- HIT format and modality presented in this paper can be used by the coaches to develop anaerobic power and work capacity in trained combat sport athletes
- Practitioners should be catious in interpreting pre – post data in different window - times as they could not be sensitive enough to identify worthwile changes during training program.
- Basing the process on very regularly repeated training sessions may allow monitoring progress with high resolution and is sport – specific in contrast to the ocassional snapshots provided by typical laboratory testing.

Limitations

- Arbitrally selected trainings (weeks) for trend-line analysis may influence reported outcomes
- No internal training load were collected which might provide more information about the cardiovascular/metabolic response, and in turn, help coaches to prescribe loads more precisely
- SWC was obtained from first training performance which might be influenced by the daily readiness/fatigue state and by body mass variability as athletes competes in different weight categories.
- Athletes from different weight categories may present different physiological response and neuromuslar strain. Therefore further studies should asses performance changes comparing athletes from the same weight class in order individualize training loads.
- Repeated closed-loop exercise tests allow for adjustments in pace that may impact overall performance. We cannot rule out that results are influenced by learning (habituation) effects as training was the same as testing procedure.

Dataset

Dataset available on SportPerfSci.com

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