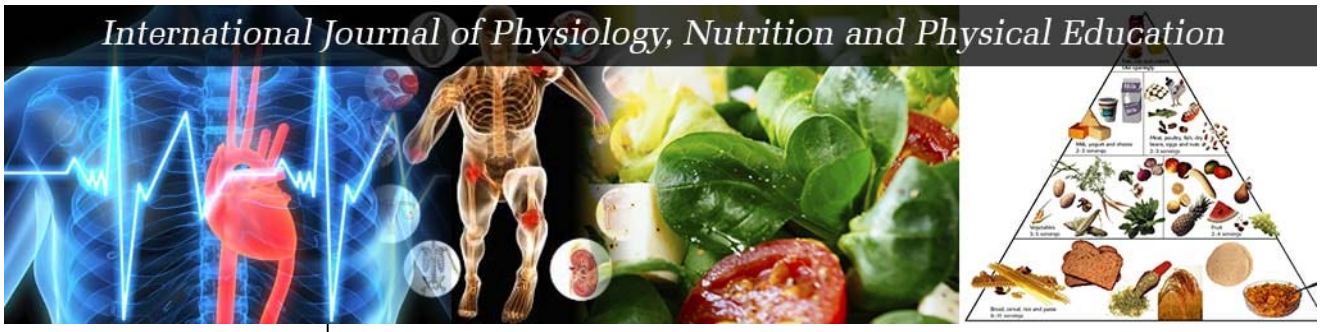

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Decrease in performance during repeated short sprint runs

Ľuboslav Šiška and Jaroslav Broďáni

Abstract
The aim of this work was to design a specific speed-endurance test with the duration of a competitive boxing match. The test consisted of repeated short 5 m sprints triggered by an acoustic signal. The time was recorded by photoelectric cells and the subject carried out 54 sprints divided into 3 rounds, separated by a 1 minute break. Regarding the inner response of the athlete's body, we monitored the heart rate and blood lactate level. The test criterion was time and the subsequent gradual decrease in performance during the test (index of fatigue). The average time in each round was 1.038 sec. in the first round, 1.076 sec. in the second round and 1.116 sec. in the third round. The t-test showed a statistically significant change between the first and second round and first and third round at 1%, and second and third round at a 5% significance level, whereby the effect size coefficient showed a marginal effect between the second and third round totaling 0.46 and significant effect between the first and second round and first and third round of 0.57 and 0.84 respectively. The fatigue index in the individual rounds totaled 16.15%, 16.76%, and 21.96%. The heart rate value in the individual rounds totaled 155-168, which was 88-95% of the maximum measured heart rate of the athlete. There was a 22 to 25 heartbeat rate decrease between the rounds. The blood lactate in the 4th minute after the load was 12.9 mmol and it dropped to 6 mmol in the 15th minute after the load. The average time increased with the repeated performance of the sprint run, and so did the fatigue index as an indicator of special endurance in each round, which is defined as one of the limiting performance factors in combat sports. The test can be used as a training and diagnostic tool – we propose to analyze it further in terms of intensification (increase in the number of short sprints) as well as the distance of the short sprint, and perform a subsequent comparison with a competitive or practice match.

Keywords: short sprint, test, fatigue index, heart rate, blood lactate

1. Introduction
Boxing is among those combat sports where endurance of explosive moves plays a major role in terms of the factor-structure. The sports performance is intermittent in the submaximum to maximum range, which should be accordingly taken into account in the management of training process [1, 2]. The energy intensity is at the level of 90% or more of the maximum heart rate and the blood lactate levels reaches up to 16mmol [3,4,5]. To develop special endurance, short-duration body movement programs are used extensively for the duration of a competitive match, which make use of either the mass of the athlete [6], additional load or special exercises [7,8]. Since it is important to assess the progress of the athlete, it is necessary to look for the means to quantify the diagnostics of trainability. When designing the program, we have to respect the kinematic and dynamic characteristics, and when discussing the explosive moves, many authors state that the short sprint is largely determined by the production of force mainly in the lower limbs[9,10,11], which is significant in boxing. In conjunction with statement that the force of the punch is determined by the strength of the rear limbs of the subject by almost 40% [12], the repeated maximum acceleration over a distance of 5 meters and the subsequent rapid deceleration into the basic position seems to be a suitable training and diagnostic means. In criterial terms, it can be determined very simply by measuring time, which can be used in the assessment of the declining performance (index of fatigue) as evidenced by the repeating values. The aim of our research is to design a test and assessment methodology for the diagnosis of speed-endurance abilities in combat sports.

2. Materials and methods

The research subject was a single athlete aged 37, height 172 cm, weight 70kg, max. HR 176 bpm. The athlete's total sports age is 30 years, and he won multiple medals at numerous Slovak athletic and kickboxing championships.

2.1 Description of the test

The photocells were placed at a distance of 5 m from each other. The athlete was standing in the basic position, with his hands lowered, and upon hearing the audio signal, he carried out a short sprint between the photocells, assumed the same position on the opposite side and waited for another audio signal (Fig. 1). The audio signals were repeated every 10 seconds for the duration of 3 minutes, which represents 18 signals. This is followed by a 1-minute break and another 18 signals. In this way, the athlete does 3 rounds of 54 short sprints. The time is recorded by the photocells with an accuracy to the hundredths of a second. Time and the subsequent decline in performance, expressed as a percentage, are the test criteria.

The internal response of the athlete (heart rate) was measured by a SUUNTO device and the blood lactate levels were measured by a LACTATE SCOUT device in the 4th and 15th minute after the load.

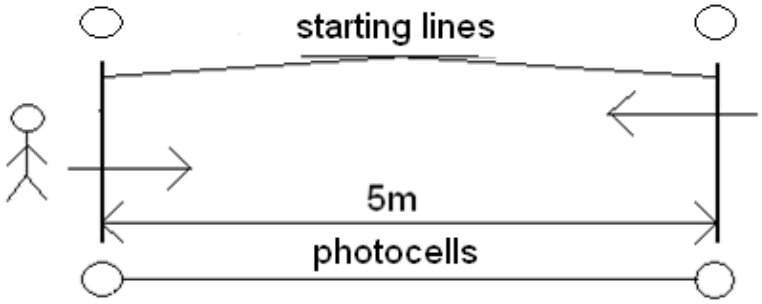

Fig 1: Visual representation of the test

2.2 Statistical analysis

The results captured in the test are expressed with elementary descriptive statistics using the average time value of practice in each of the rounds, standard deviation, minimum value, maximum value, and they are visualized in box charts. The statistically significant differences in the mean values between the rounds were expressed by the t-test at a 5% and 1% level of significance. The substantive significance was assessed with the Cohen's "d" effect size coefficient. The time value of each of the repetitions is displayed in a line chart and overlaid by a linear trend line. The decrease in performance (fatigue index) is expressed as a percentage of the difference of the maximum and minimum values on the linear trend line with regard to the minimum value, which is also represented by the decline of the trend line.

3. Results

Performance varied during the individual rounds in the test. The most consistent values with the smallest standard deviation were recorded in the second round. Compared to the first round, the average performance worsened by about 4 hundredths of a second. The best performance was observed in the first round, however, as it can be seen in the graphs, up to three extreme values were recorded (Fig. 2). The decrease in performance was most evident in the third round, which was reflected in the worst average performance and the highest standard deviation. We recorded the worst but paradoxically also the best performance at the beginning of the round (Tab. 1).

We identified statistically significant differences in the mean values and effect size coefficients "d" between:

I. and II. round $t(17) = 3.00$, $p < .01$, "d"= 0.57

I. and III. round $t(17) = 3.14$, $p < .01$, "d"= 0.84

II. and III. round $t(17) = 1.83$, $p < .05$, "d"= 0.46

Percentage of decrease in performance (fatigue index) in each round:

I. ROUND-16.15% II. ROUND – 16.76% III. ROUND – 21.96%

In terms of heart rate, we can see the highest values in the first round, with a maximum value of 168bpm. The heart rate subsequently decreased during the one-minute break by 22 pulses to 146. The heart rate during almost the entire second round was above 160, however, it did not reach this value in the third round, resulting in a decrease from 163 to 138 between the second and third round (fig. 4).

The blood lactate in the 4th minute after the load was 12.9 mmol and it dropped to 6mmol in the 15th minute after the load.

3.1 Tables and Figures

Table 1: Descriptive statistics

I. ROUND		*II. ROUND*		*III. ROUND*	
M	1,04	M	1,08	M	1,12
SD	0,07	SD	0,06	SD	0,11
Min	0,97	Min	0,98	Min	0,96
Max	1,20	Max	1,17	Max	1,32

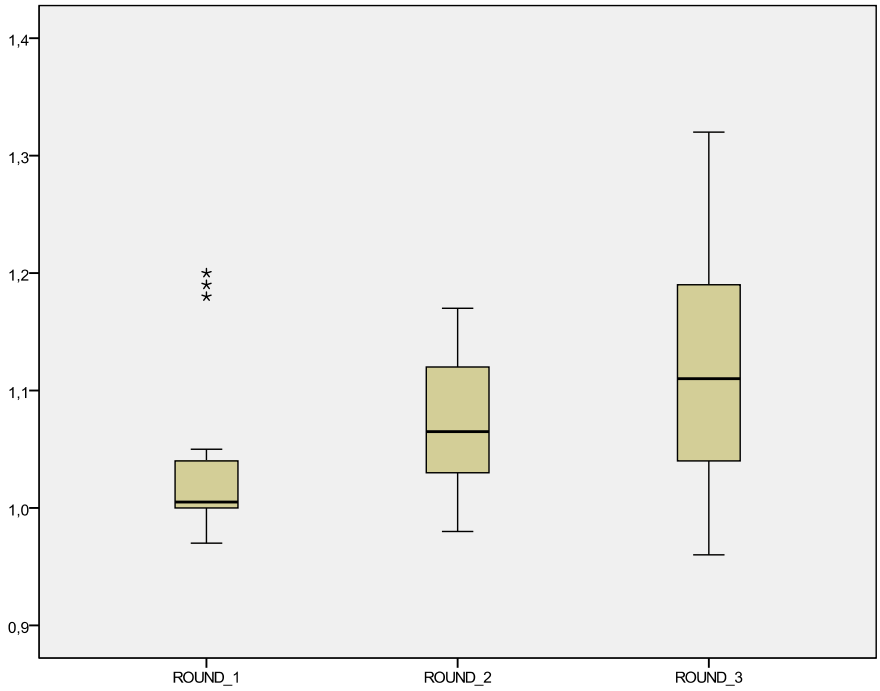

Fig 1: Box graphs with the measured values

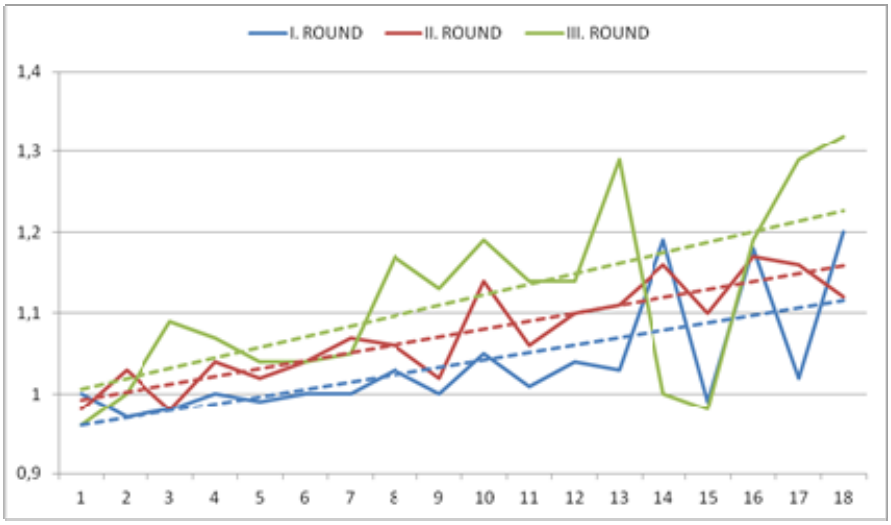

Fig. 3: Time values of the individual repetitions and their linear trending

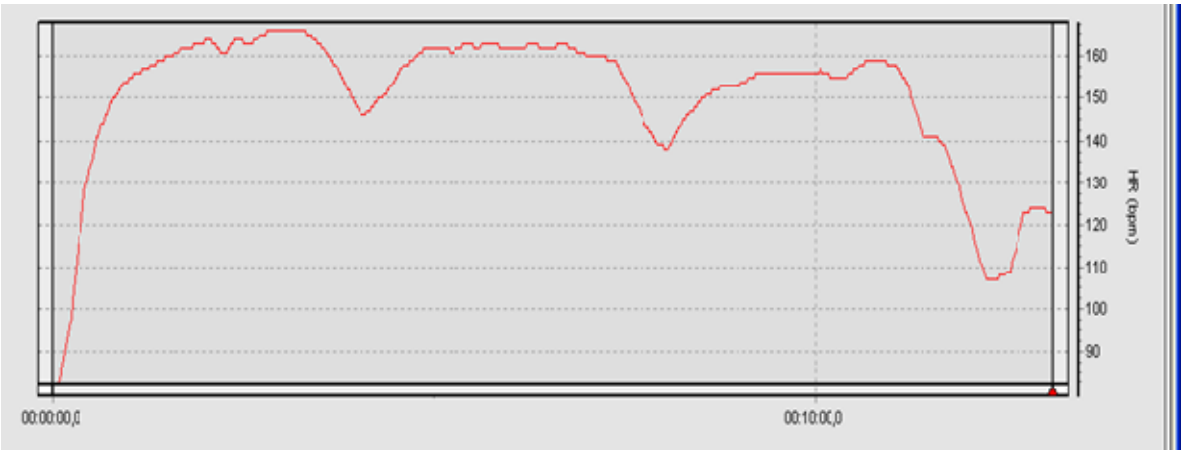

Fig. 4: Course of heart rate during exercise

4. Discussion

The creation of short physical programs for the development of endurance is a very current topic. The limiting factors of sports performance are quite accurately determined in terms of physical training, which makes us conclude that once we are able to produce power repeatedly and in the desired intensity, we have reached the basic prerequisite for success in a boxing match. Through our training tool, we triggered an internal response in the body at the lactate level of 12.9 mmol., the heart rate was within the range of 88 to 95% of the maximum heart rate, which is comparable with other works with the values from 11 to 16 mmol. and the heart rate band of around 90% both in the motion programs or training matches[3,4,5]. The 1-second duration of the short sprints corresponds to the existing values in a single execution[9,10,11], and it also shows a drop during repeated execution, which was the main hypothesis of our research; however, we have no data to compare this value with since we have not found any existing research studies in this field. In terms of subjective evaluation, fatigue was felt especially in the third round, and was demonstrated by the inability to "jumpstart" the motion in the maximum possible intensity, resulting in decreasing acceleration and worsening of the resulting time. It is interesting to note that in the third round the heart rate was at the lowest level due to the decline in performance, however, after mustering up in the end of the round and doing two demonstrably good runs, the heart rate increased in response. Similar behavior can sometimes be observed during a match where the boxer relaxes for a while by exhaling and lowers his intensity, and subsequently does a sequence of quality explosive combinations. Our program can be added to the short-stretch short-interval method, however, we defined a clear criterion and were able to quantify the entire program, which we assess as a contribution in the present field of observation.

5. Conclusions

We conclude that we managed to design a short exercise program that can be used as a training and a diagnostic tool for measuring the speed-endurance ability in combat sports. The decrease in performance (fatigue index), which is also obvious in real matches especially in the third round, was reproduced in our test. Its potentially better values may indicate the athlete's readiness to provide a quality athletic performance. We therefore recommend to submit the program for a deeper analysis in terms of intensification (increase or decrease in the number of signals), as well as the stretch distance and a subsequent comparison with a competition or practice match.

6. Acknowledgments

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