Original Article

Impact of selected factors on performance in sporting shooting from air rifle in standing position

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Abstract

The paper deals with the analysis of the impact of increased heart rate and total shooting time on the resulting score value of shooting performance. These are factors that can adversely affect the performance of the shooter in the discipline 10m air rifle which consist of 60 competition shots in a standing position in time limit of 75 minutes. The group consisted of 8 sports shooters of the first and master class. We obtained data using a stopwatch, sport tester and special electronic target devices to evaluate the sportperformance of shooting activities. Intraindividual performance of shooters was evaluated by Spearman's correlation coefficient, by means of which we found a significant relationship between selected factors and sports performance.

Keywords: sport shooting, air rifle, heart rate, total shooting time, sport performance

Introduction

Sport shooting is one of our successful Olympic sports. Shooting performances at world level, however, are still increasing. Therefore, it is necessary to continuously acquire new information and knowledge in the training process, which would enable not only our coaches but also fans of sport shooting to learn and progress. Success in sport shooting disciplines depends on a number of factors whose interplay requires long-term preparation by ideomotor, shooting, technical, tactical and psychological training. The sport performance of air rifle disciplines are limited by accuracy of shooting, therefore sport performance is determined also by quality of sport equipment and accessories.

The shooter must be able to achieve subconscious repetition of mechanical and technical operations such as positioning and position control, loading, breathing and triggering, and consequently creating the dynamic stereotype of these activities. High concentration and attention are a must in order to maintain stability and adequate aiming in this sport's performance (Brych 2008). According to Cink (1979), to achieve high performance in sport shooting, it is necessary to meet the prerequisites such as: Maximum stability of the shooter - weapon system, perfect neuromuscular coordination of movements while working on the shot, automation of individual technical activities, and high level of concentration in shooting.

According to Reinkmeier, et al. (2009) the most important training and competition elements are: external and internal position, zero point, the hold, aiming, shot release, follow-through, breathing, shot rhythm, shooting rhythm, material equipment and shooting accessories.

Ihalainen et al. (2015) analyzed six main components in the air rifle shooting technique: target arrival time, stability of hold, aiming time, trigger cleanliness, aiming accuracy, and timing of triggering. Multiple analysis identified four of them: body stability, trigger cleanliness, aiming accuracy, and firing timing as the most important predictions of shooting performance, representing 81% of the range of shots and success in shooting. The direct effect of postural balance on performance was small, representing less than 1% of the shooting shots.

Despite the fact that some individuals condemn the shooting of firing because of the use of firearms, which were used mainly as a tool of war and killing in the past, at present we can observe in addition to the classic groups (rifle, pistol, shotgun) part of other kinds of sport or multiplayer. Our intention was to bring new information and knowledge and thus contribute to the development of shooting sport.

The goal

Determine the impact of selected factors such as heart rate and total shooting time on sport performance from an air rifle in the standing position.

Hypotheses

- We assume a significant correlation between the heart rate value and the total score value of the shooting performance.
- We assume a significant dependence between the total shooting time and the score value of the shooting performance.

Tasks

- Process and evaluate the data of selected factors.
- Determine the impact of selected factors on the sport shooting performance.

Methods

We used Ex post facto research. In the created research situation VS (8) (S1-S3) t0 there is a selection of probands (V8) in which we monitored the S1 load conditions during sport performance, S2 total shooting time and S3 sport performance at time t0 (RTC - 2018/2019), (Kampmiller, et al., 2010). The group consisted of 8 selected sports shooters of the first class and master class category aged over 19 - 27 years. All shooters have won at least one Slovak championship title during their minimum eight-year sports career (Table 1). We recorded data of selected factors of individual shooters in the record sheets. Then we processed them into tables and graphs.

Table 1 Basic statistical characteristics

	Body height[cm]	Body weight [kg]	Decimal age (years)	Sports ctivity(years)
Average	176	68.5	22.03	10
Maximum value	180	78	27.16	14
Minimum value	172	60	19.90	8
Standard deviation	2.928	7.483	2.232	2.204
Variation margin	8	18	7.26	6

Average values of basal heart rate and maximum heart rate (Table 2) were recorded by each proband themselves through a sport tester on the day of shooting competitions.

Table 2 Mean heart rate values of individual probands

Shooters	Basal HR	Maximum HR	Differences HR
S1	55	198	143
S2	67	207	140
S3	61	202	141
S4	48	198	150
S5	65	200	135
S6	70	190	120
S7	78	181	103
S8	52	194	142

Recording of other data took place in a time interval during a four-month training cycle (YTC 2018/2019) from November 30, 2018 to March 31, 2019. During this period the shooters participated in the 10m air rifle discipline of selected international competitions, individual rounds of extra league and championships Of the Slovak Republic and national competitions. Air rifle discipline which is fired in standing position has targets normally located at a distance of 10m from the firing line in accordance with international shooting rules ISSF (International Shooting Sport Federation). The shooter on the command "athletes to the firing line" takes up position with air rifle and other shooting accessories (shooting jacket, pants, shoes, gloves, belt and rifle tripods). The shooters has 15 minutes to take up position and at the same time they could perform simulation of individual shooting movements, stabilization of the body position and toning of individual muscle groups without firing. After the preparation time has elapsed, the sports shooter has an additional 15 minutes to "preparation and sighting". Within this time limit shooter has an unlimited number of firing shots that do not count towards the total score point of shooting performance. After these 30 minutes, the 10m air rifle discipline begins by command; "Start". After this command, the competition begins with a time limit of 75 minutes, during which the shooter fires at the target 60 competition shots. If the shooter fails to fire the specified number of shots within the time limit, he/she is awarded a score point value of the shooting performance he/she achieved during the firing of 60 competitions shots. The shooter is informed about the time course of the competition with the commands "10 minutes left", "5 minutes left". After performing sport-shooting activities within the principles and rules of safety on the handling of firearms, the shooter is obliged to discharge the weapon and subsequently secure it with protective nylons in the barrel. The Referee is obliged to check the security of all weapons at the shooting stations. The maximum value of the shooting performance can reach 654.0 points after the sum of all 60 competition shots (1 competition shot has a maximum value of 10.9 points), (www.issf-sports.org).

We used basic statistical characteristics to process and evaluate the results. We used a non-parametric Spearman correlation coefficient to calculate statistical significance and analyze the relationship between selected factors and point performance. The resulting statistical significance of the mean value differences was assessed at the level of statistical significance ($p \leq 0.05$) and ($p \leq 0.01$). The achieved results were subjected to logical analysis and synthesis and subsequently interpreted into the formulation of conclusions and results. To calculate the Spearman correlation coefficient we used program; Anaconda 2019.03-Python 3.7 version (Anaconda, Inc.:Austin,Texas : USA).

Results and discussion

The results from the data sheet monitoring are presented in Tables 1 - 6 and Figures 1 - 9. Analysis of the selected factors show relatively balanced performance of shooters. Table 2 shows the mean basal heart rate and maximum heart rate of each proband. Table 3 compares the average values of the individual shooters out of the 8 competitions recorded during the four-month training cycle (RTC 2018/2019). The maximum mean heart rate (HR) of probands after loading in shooting performance ranged from 64.9 (S4) to 110.9 (S7) pulses/min. The average total time that it took to shoot for target shots lasted from 52.5 min (S4) to 70.4 min (S2). The data shows that all shooters fit within the limit set by the ISSF rules. For sports performance after 8 competitions, probands received an average rating of 611.2 (S6) to 627.9 points (S1), (Table 3). As we found similar results in the group, we present a more detailed analysis of the shooting performance of three shooters out of a total of 8, namely the shooter 1 (S1), which scored the highest score in 8 competitions (627.9 pts). Shooter 6 (S6), who scored the lowest score (611.2 points) and Shooter 4 (S4), (Table 3).

Table 3 Mean values of selected factors in the sport shooting of shooters after 8 competitions in the air rifle discipline 60

Shooters	Heart rate (bpm)	Total shooting time [min]	Sport performance (points)
S1	77.4	58.0	627.9
S2	88.0	70.4	619.3
S3	77.8	67.0	619.0
S4	64.9	52.5	626.0
S5	89.0	67.5	615.2
S6	107.7	66.3	611.2
S7	110.9	62.3	618.0
S8	90.6	68.2	621.4

Evaluation of probation record sheets (S1, S4, S6) revealed data on individual factors (Tab. 4 - 6). S1 achieved the best performance score on average (627.9 pts) while monitoring 8 shooting competitions. He scored 16.7 points more than S6, which achieved the weakest rating of all shooters in the group (611.2 pts). This lowest power S6 (Fig. 3) is probably related to the largest missile scattering (13.4) and slower overall time (66.3 s). The maximum performance reached 629.8 points again on the S1. Compared to a minimum performance of 605.1 points (S6), it was 24.7 points higher (Tables 4, 6). The lowest load of 64.9 pulses/min and the lowest total firing time reached S4 (Table 5). However, both of these factors were not enough to earn the most points. He scored less than 2 points less than S1. He reached 626.0 points, ranking 2nd in the group of shooters.

Fig. 1 Selected factors depending on sport performance of Shooter 1

Table 4 Individual Shooter 1 Factor Data

Shooter 1	Heart rate(bpm)	Total shooting time [min]	Sport performance(points)
X	77.4	58.0	627.9
S	0.983	1.644	1.800
Xmax	78.8	61.22	629.8
Xmin	76.2	55.4	623.9
Vr	2.6	5.82	5.9

Fig. 2 Selected factors depending on sport performance of Shooter 4

Table 5 Individual Shooter 4 Factor Data

Shooter 4	Heart rate (bpm)	Total shooting time [min]	Sport performance (points)
X	64.9	52.4	626.0
S	0.656	1.186	1.605
Xmax	65.7	54.08	629.1
Xmin	63.7	50.28	624.3
Vr	2.0	3.8	4.8

Fig. 3 Selected factors depending on sport performance of Shooter 6

Table 6 Individual Shooter 6 Factor Data

Shooter 6	Heart rate (bpm)	Total shooting time [min]	Sport performance(points)
X	107.7	66.3	611.2
S	2.584	4.454	4.690
Xmax	111.3	71.17	618.5
Xmin	104.3	59.45	605.1
Vr	7.0	11.72	13.4

Through an intra-individual evaluation of S1 shooter record sheets. we did not found that the significance of the relationship between selected factors and sport performance.

According to Chráska (2007) the S1 was classified in a weak correlation ($r_{S1}^{HR} = -0.228$) and moderate correlation strength ($r_{S1}^{ST} = -0.405$) however it has positively affect his sport performance (Fig. 4, 5).

Spearman correlation: -0.405

Fig. 4 Performance – time relationship – S1

Spearman correlation: -0.228

Fig. 5 Performance – heart rate relationship – S1

On the other hand we found a dependence between the two selected factors and the sport performance and it was classified in a very strong correlation strength ($rS4^{HR} = -0.929^{**}$; $p \leq 0.01$) and ($rS4^{ST} = -0.952^{**}$; $p \leq 0.01$) based on the size of the correlation coefficient (Fig. 6, 7).

Spearman correlation: -0.952

Fig. 6 Performance – time relationship – S4

Spearman correlation: -0.929

Fig. 7 Performance – heart rate relationship – S4

In shooter S6 we found a dependence on the relation of total shooting time and sport performance ($rS6^{ST} = -0.857^{*}$; $p \leq 0.05$) and on the relation of heart rate and sport performance ($rS6^{HR} = -0.952^{**}$; $p \leq 0.01$) (Fig. 8, 9).

Spearman correlation: -0.857

Fig. 8 Performance – time relationship – S6

Spearman correlation: -0.952

Fig. 9 Performance – heart rate relationship – S6

Conclusion

The aim of the paper was to find out the influence of selected factors such as heart rate during shooting and total shooting time on sport shooting performance in the 10m air rifle in the standing position. Our group consisted of 8 sport shooters (dec. Age 22.04 years) who meet the criteria of the first and master class. They have been actively involved in sports shooting for at least 8 years.

In hypothesis 1 we assumed a significant dependence between the heart rate value and the total score point value of the shooting performance and in hypothesis 2 the relationship between the total shooting time and the score point value of the shooting performance. Both hypotheses were confirmed in S1 and S4 shooters. Significance between observed variables and sports performance in S1 between heart rate ($rS1^{HR} = -0.228$) and total time ($rS1^{ST} = -0.405$) was positively reflected in the average highest score 627.9 points. In S4 ($rS4^{HR} = -0.929^{**}$, $rS4^{ST} = -0.952^{**}$) 2nd place in overall ranking with the average score of 626.0 points.

The weakest performance was apparent in the S6 shooter which could be due to various limiting and optimizing factors (mental, technical training, etc.) during the preparatory period and during the observed shooting competitions.

According to Chráska (2007) these values show a high dependence between the monitored factors. In the period under review the heart rate and overall shorter shooting time of both shooters brought significantly higher values of sport-shooting performance.

We are aware of the low number of shooters in our research group. Further research is needed to verify our claims.

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