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Trends in Shooting Results of Elite Biathletes

by

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The authors of this paper attempted to estimate the value and direction of biathlon shooting tendencies in particular events and shooting positions. Shooting results of 190 competitors who took part in World Cups, World Championships and Olympic Games from 1997/98 to 2003/04 seasons were analyzed statistically. The data indicates that shooting results during the analyzed period had a tendency to decrease. This is especially true in relay competition (annual decrease of specified variable is 0.9%, R^2=0.60) and in the prone shooting position (annual decrease of specified variable is 0.5-0.6%, R^2=0.51).

Keywords: *trends, shooting efficiency, biathlon*

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Introduction

The biathlon, an Olympic winter sport which combines free technique cross-country running and small-bore rifle marksmanship, has recently evolved very fast. Every year new rules related to competition and equipment are added. The biathlon becomes more spectacular and attractive to viewers. Everyone is especially interested in shooting results.

Analyses of individual cases do not allow drawing significant conclusions concerning shooting results in biathlon. It is necessary to take into account results of World Cups, World Championships and Olympic Games from several seasons.

Biathlon competition typically involves two to four periods of shooting which are preceded and followed by cross country running distances of 2.5 to 5km. Shooting alternates the prone and standing positions with each shooting period. In individual biathlon competitions five shots are allowed to hit the targets positioned 50 m from the firing line. A penalty lap or penalty time is added for each missed target and the lowest cumulative time wins.

The biathlete shoots under specific conditions. These conditions include limited time and fatigue from high running intensity, increased heart rate (HR), breath rate (DR) and nervous excitability (Hoffman and Street 1992; Klusiewicz 2000). It is evident that other factors influence open shooting range such us: weather conditions participation (wind, temperature) (Wasilewski 1977). Moreover the competitor should adapt to alternate shooting positions and conform to total time of being in the firing line (Shalayev and Hrisanfov 1999; Gerasimuk 2002).

It is clear that biathlon shooting is a very complex motor activity requiring good postural stability and rapid execution. However, it has been reported that there are significant differences in shooting strategies between shooters and biathletes. Shooters attempt to control body and rifle sway while biathletes use coincidence-anticipation strategies. It has been reported that the mean duration of the target appearance in the rifle ring prior to shooting is only 200ms for elite biathletes during standing shooting (Pöhlmann 1986).

Only few studies have been directed towards the shooting tasks in biathlon which mainly concern physiological factors, parameters observed at the moment of shot or motor skills. From a scientific point of view it is important to analyse statistically the results of shooting obtained during recent years of biathlon.

The aim of this study was to estimate tendencies in biathlon shooting in particular events and shooting positions of the most recent competitive seasons (1997-2004).

The following research questions were formed:

What is the value and direction of the trend in biathlon shooting efficiency during recent years?

Are there significant differences between trends in particular events and shooting positions?

Material and Methods

The data included results of the World Cups, World Championships and Olympic Games which took place from 1997 to 2004. The number of considered subjects was 190.

The results were analyzed statistically with a PC program "Statistica". Athletes that performed occasionally in the considered events were excluded from the analyses, especially if the total number of their shots was under 100 during one season. At first for each subject a percent of efficiency of shooting for each event (sprint, individual, mass start, pursuit and relay) and shooting position (prone and standing) was estimated. This procedure was followed for each competitive season. Then the analysis was conducted for 30 athletes who achieved the best efficiency of shooting for every variable. The weighted results were presented as means (x), variance (V), and standard deviation (SD). In order to estimate the tendency in biathlon shooting efficiency the following regression equation was applied:

$$y_t = a + b^* t$$

a- intercept, b- regression coefficient, t- time variable

The level of significance was set at $p<0,05$.

Results

The obtained results are presented in table 1.

From these results we conclude that the level of shooting efficiency of elite biathletes had a downwards tendency. To test the model's properness of fit standard error (Se) and coefficient of determination (R^2 close to 1.0 indicates that we have accounted for almost all of the variability with the variables specified in the model) were estimated. A significant value of the coefficient was obtained for regression which characterized tendency in shooting during relay competition: 0.60 and while shooting in prone position: 0.51.

Table 1

The analysis of regression result of shooting efficiency

Shooting position/ event	Intercept	Regression coefficient	***p*** value for regression coefficient	Se	R^2
Relay	**89.83**	**-0.91**	**0.0402**	**1.76**	**0.602**
Prone shooting	**92.37**	**-0.65**	**0.0706**	**1.51**	**0.512**
Standing shooting	87.54	-0.44	0.1920	1.56	0.313
Individual	90.32	-0.33	0.2823	1.46	0.225
Mass start	86.09	-0.19	0.4928	1.07	0.124
Pursuit	88.03	-0.18	0.4209	1.12	0.133
Sprint	88.46	-0.06	0.8545	1.52	0.007

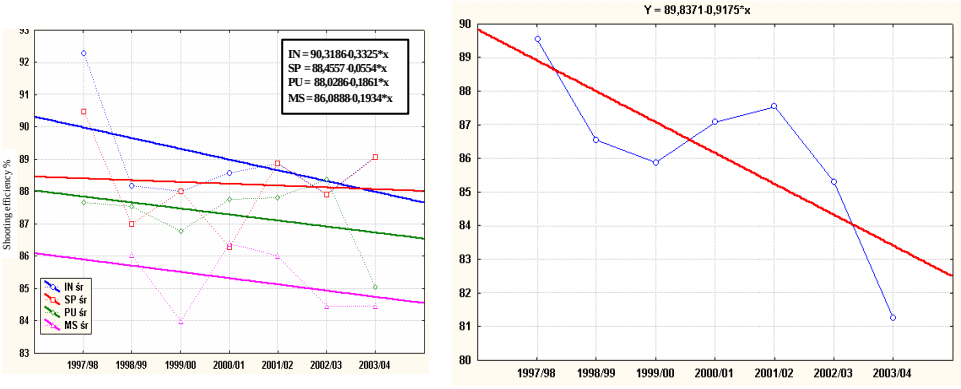

Fig. 1

Mean values for shooting efficiency level of top 30 results from 1997 to 2004. (IN-Individual, SP-Sprint, PU-Pursuit, MS-Mass Start, RL-Relay)

Despite the individual event the analysis of the distribution of shooting efficiency indicate decreasing of variance in every variable (Fig. 2). The results of shooting become similar what is confirmed by small values of standard deviation and variation.

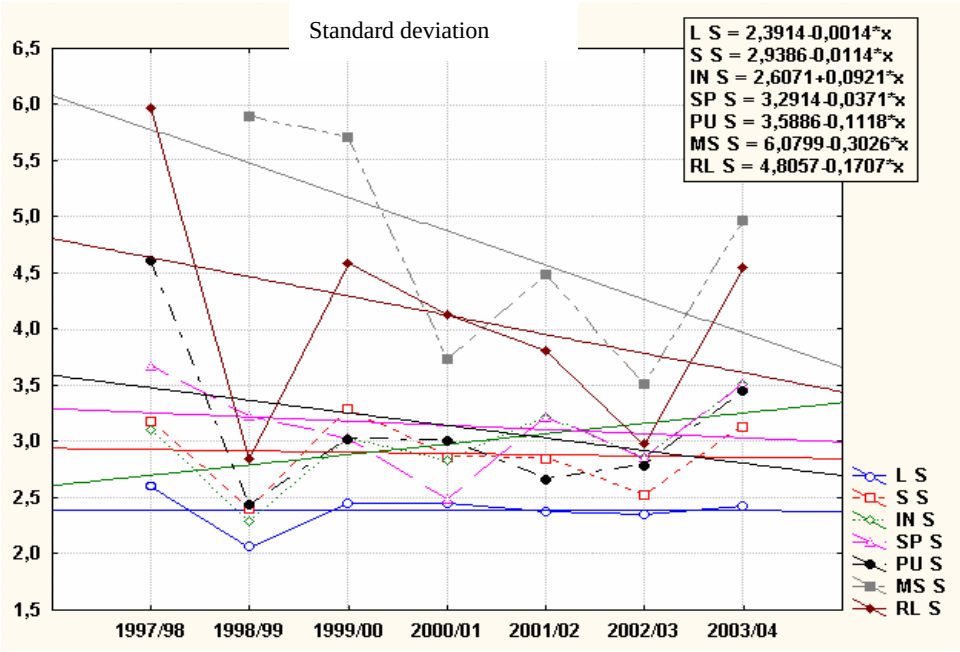

Fig. 2

Standard deviation of shooting results (L-shooting in prone position, S-shooting in standing position)

Discussion

The obtained results clearly indicate a decrease in the level of shooting in the biathlon. Recently a significant increase in training loads of biathletes has been observed. They are mainly directed at aerobic power what allows for the improvement of running time as the main factor affecting the final result (Manfredini *et al.* 2002).

Research confirms a higher influence of running time on the final result in comparison to shooting efficiency. Pustovrh *et al.* (1999) in analyzing the results of World Championships stated on the basis of results of factor analysis that the factor related to shooting had the highest projections with the variables shooting time and shooting precision explaining the phenomena in 14.3% while running time in 39.3%.

Similar results were obtained by Cholewa *et al.* (2005). Analyzing the effects of particular variables of the biathlon on the final result on the basis of results of the entire season they calculated correlation coefficients of shooting efficiency,

shooting time and running time on the final result. The value of these coefficients in the sprints ranged for shooting from 0.47 to 0.16. The correlation for running time with the final result ranged from 0.58 to 0.82.

The obtained above relationships clearly indicate a greater role of running time on final results in the biathlon of elite athletes in this sport discipline. Improving variables, especially those related to aerobic power leads to better results in the biathlon. Rundell and Bacharach (1995) on the basis of results of top American biathletes reached a significant relationship between sport results and $V0_{2max.}$ Klusiewicz *et al.* (2004) confirmed the influence of upper body strength, aerobic and anaerobic power on sport results in the biathlon and cross country running through the decrease of local fatigue in the upper limbs.

Shooting demands placed upon the biathlete are significantly, different from those that athletes face competing in shooting only. During the ability to maintain a stable prone shooting position is the main objective of both competitive shooters and biathletes. The difference lies in the strategy (Larue *et al.* 1989). Shooters attempt to control body and gun vibrations whole biathletes use the coincidence-anticipation strategy. Shooting abilities require a precise control of body stability with a short visual reaction time. Several scientists reported a negative influence of intensive physical effort on body stability (Hoffman *et al.* 1992) and visual reaction time (Malomsoki, Smodis 1970).

Conclusions

1. The level of shooting efficiency of elite biathletes is tending downwards during the most recent competitive seasons (1997-2004).
2. The most significant decreasing of efficiency in shooting was observed during relay competition: 0.9% every year and while shooting in prone position: 0.6% every year.
3. Despite of individual event the analysis of the distribution of shooting efficiency indicate decreasing of variance in sprint, mass start, pursuit and relay of elite biathletes.

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