COMPARATIVE ANALYSIS OF TECHNICAL SHOOTING TRAINING IN ELITE BIATHLETES

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ABSTRACT
The study aimed to conduct a comparative analysis of two different methodologies for improving shooting results in elite biathletes. The methods applied different exercises to enhance technical skills and improve shooting accuracy. Shooting as a component of competitive activity in biathlon plays a significant role in disciplines in which the penalty for missing a target is implemented by running an additional distance. The subjects studied were 10 elite Bulgarian and 8 Norwegian biathletes (men and women). To compare the results obtained, we used the following statistical methods: analysis of variance, the mean value, standard deviation, and the Welch t-test for independent samples were calculated, with $p < .05$ being accepted as statistical significance; a percentage analysis of shooting success was also used. From the results obtained in this way, it can be stated that there is a statistically significant difference only in the indicator ' Points standing' ($p = .039$). There are no statistically significant differences in all other indicators. Interestingly, despite the higher number of errors in the standing position, the Norwegian athletes compensated for this by scoring more points. The study reveals that, although there are no significant differences in most indicators, Norwegian biathletes have an advantage in the standing position, which can be a key factor in a competitive environment. The high overall accuracy of shooting in both groups shows that both the Bulgarian athletes and the Norwegians are at an extremely high level of preparation.

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INTRODUCTION

The rapid increase in world biathlon achievements requires a constant search for new, increasingly effective means and methods for organizing and conducting shooting training. Many experts in shooting training (Palakarski, 2016; Yuryev, 1973; Zubrilov, 2013) have described the key elements of shooting technique, which include: shooting position (prone and standing), breathing, aiming, and trigger control. However, the proper execution of these components requires specialized exercises. In this context, it is also necessary to consider additional factors, such as balance stability, coordination of technical elements, and related aspects, all of which contribute to the effective execution of technical motor tasks in shooting.

Groslambert et al. (1999) validated three simple tests to assess shooting abilities in biathlon: aiming time from the standing and prone positions, and a tremorometer test in the standing shooting position. Studies on postural balance during standing shooting have shown that postural stability is a key factor contributing to high shooting success rates in biathlon. (Aalto et al., 1990; Ball et al., 2003; Era et al., 1996; Mon et al., 2014; Mononen et al., 2007; Niinimaa et al., 1983) . Elite shooting athletes show greater body stability than non-elite athletes, clearly distinguishing high-level from low-level shooters. (Sattlecker et al., 2014; Sattlecker et al., 2017; Groslambert et al., 1999; Konttinen et al., 1999; Mononen et al., 2003; Nitzsche & Stolz, 1981; Viitasalo et al., 1999).

The problem posed in this way provoked us to investigate the technical skills of elite biathletes. The study aims to compare the technical shooting training of elite biathletes.

To achieve the goal, the following tasks were set:

- To compare the specialized shooting exercises in the two groups of subjects.
- To compare and analyze the results of the specialized shooting accuracy test in biathlon.

METHODS

Study organization

The study involved Bulgarian national biathlon team members (six men and four women) and Norwegian club elite biathlon competitors (four men and four women). Exercises to improve shooting accuracy were implemented within a single mesocycle (21 days). To assess shooting training at the end of the mesocycle, a test of the biathletes' shooting abilities was conducted (30 shots from a prone shooting position and 30 shots from a standing shooting position, without physical exertion - for accuracy). Both the hits on the target of each shot and the

number of points achieved were recorded. During the test, competitors were not allowed to receive information about the results achieved so far, nor were they permitted to make any adjustments to the aiming devices after firing the weapon. The tests were analyzed and compared between the two subject groups. All participants provided written informed consent, confirming their voluntary participation in the study. The consent form contained details about the goals, procedures, methodology, and nature of the test conducted, which was an assessment of shooting accuracy. Participants were explicitly informed of their right to withdraw from the study at any time, without any adverse consequences. The anonymity and confidentiality of the collected data were ensured, and all ethical standards related to the protection of personal data and the well-being of participants were strictly adhered to.

Shooting Training Exercises

The exercises that were included in the shooting training of the Bulgarian biathletes were: dry shooting in a series of 5 minutes prone and 5 minutes standing; 10 times 1 shot (prone and standing); model shooting in the individual disciplines (individual, sprint, pursuit) and a model relay with additional cartridges - for time; 15 minutes of holding the target only from a standing position;

The exercises included in the shooting training of the Norwegian biathletes were: dry shooting in a series of 5 shots (prone and standing); 30 shots, each shot once (prone and standing); and 5 minutes of shooting, with one shot per minute (prone and standing).

METHODOLOGY

The following research methods were employed to address the tasks in the study: bibliographic analysis of specialized literature on the research problem, content analysis of test protocols to determine the level of accuracy in shooting, pedagogical observation, and testing. To compare the results obtained, we used the following statistical methods: analysis of variance, calculation of the mean, standard deviation, and Welch t-test for all indicators due to the different numbers of participants and varying standard deviations between the groups, as well as a percentage analysis of shooting success.

RESULTS

Table 1 presents the mean values, standard deviations, and *t*-test results for the 30-shot shooting accuracy test conducted from a prone shooting position and a standing shooting position.

Table 1. *Comparative analysis of the results of the 30-shot shooting test from the prone and standing positions between the Bulgarian Biathlon Team and the Norwegian Biathlon Club*

	Bulgarian Biathlon Team		**Norwegian Biathlon Club**				
Indicators	***M***	***SD***	***M***	***SD***	***t***	df	***p***
Mistake prone	1	1.24	0.75	1.16	0.441	15.5	.666
Points prone	277	9.24	265	24.88	1.295	8.55	.229
Mistakes standing	0.7	1.05	1.5	1.41	-1.336	12.65	.205
Points standings	200	16.03	213.75	9.49	**-2.262**	14.93	**.039**
Total Punishments	1.6	1.5	2.25	1.83	-0.810	13.51	.432
Total Points	476.7	23.49	478.75	29.76	0.229	4.54	.822
Percentage of hits on the target prone	97	3.74	97.5	3.88	0.225	16.65	.825
Percentage of hits on the target standing	96.6	4.08	95	4.72	0.687	15.71	.502
Percentage of hits on target Total	96.84	3.17	96.3	3.05	0.325	15.53	.749

In terms of errors and points from the prone position, the results showed that there was no statistically significant difference between the Bulgarian (M = 1.00, SD = 1.24) and Norwegian athletes (M = 0.75, SD = 1.16) in terms of the number of errors from the prone position (t = 0.441, df ≈ 15.5, p = .666). Similarly, the average points in this shooting position did not differ significantly between the Bulgarian and Norwegian biathletes (M = 277, SD = 9.24; M = 265, SD = 24.88; t = 1.295, df ≈ 8.55, p = .229). These results indicate that performance in the prone position was similar across both groups, with no apparent differences.

In terms of errors and standing points, Bulgarian competitors made fewer errors (M = 0.7, SD = 1.05) compared to Norwegian competitors (M = 1.5, SD = 1.41), but the difference was not statistically significant (t = -1.336, df = 12.65, p = .205). However, the Norwegian competitors showed a significantly higher score (M = 213.75, SD = 9.49) than the Bulgarian competitors (M = 200, SD = 16.03), with the difference being statistically significant (t = -2.262,

df ≈ 14.93, $p = .039$). This result is exciting because it highlights that the number of errors alone is not a sufficient indicator of the final performance. What seems to be more important is the quality of the successful hits and the ability to achieve a higher number of points despite a higher number of misses.
No significant differences were found in the total number of penalties (Bulgarians achieved $M = 1.6$, $SD = 1.5$; and Norwegians $M = 2.25$, $SD = 1.83$) and the total number of points (the values of Bulgarian biathletes are: $M = 476.7$, $SD = 23.49$; and Norwegians: $M = 478.75$, $SD = 29.76$), respectively ($p = .432$ and $p = .822$). This indicates that there is no statistically significant difference between the two groups at the standard $p > .05$ significance level, with the mean of Group 1 being lower than that of Group 2. This suggests that the overall performance of the two groups is almost identical, with no clear advantage in the shooting component.
Both teams had high and homogeneous hit rates. In the prone position, the Bulgarian athletes achieved an average of 97 % ($SD = 3.74$), and the Norwegian ones – 97.5 % ($SD = 3.88$). From the standing shooting position, the values were 96.6% ($SD = 4.08$) and 95% ($SD = 4.72$), respectively. The overall percentage of hits also showed no difference (96.84% vs. 96.3%). All comparisons were statistically insignificant ($p > .05$). This indicates that both groups have extremely high accuracy, with variations within normal limits.
In summary, it can be said that there is a statistically significant difference only in the Points standing indicator ($p = .039$). There are no statistically significant differences in all other indicators.

DISCUSSION

The data analysis reveals that the only statistically significant difference between the Bulgarian and Norwegian competitors is in the standing shooting points, where the Norwegian biathletes outperform their Bulgarian counterparts. However, most of the other indicators show similar performance between the two groups.
Interestingly, despite the higher number of errors in the standing position, the Norwegian athletes compensated for this by scoring more points. This can be explained by several possible factors: Quality of hits – it is possible that the Norwegian biathletes registered shots in zones with a higher point value; Psychological resilience – the athletes from Norway may have demonstrated greater stability under pressure in the standing position; Tactical preparation – the training practices and methodologies of the Norwegian team probably put more emphasis on the standing position. The average points achieved by the biathletes in the study, across both shooting positions, were 478.75 points for the Norwegian biathletes and 476.7 points for the Bulgarian biathletes, and the average hit percentage was 96.3% and 96.8%, respectively. These results are consistent with previous studies that emphasize the need for individualized training programs to enhance shooting skills in various conditions (Schmidt & Lee, 2014; Konttinen et al., 2008). Klchorov et al. (2022) conducted a similar study with elite biathletes, with average points around 454.3 in both shooting positions and an average hit percentage ranging from 86.9% to 92.4%. They argue that "… in biathlon, the hit percentage is more important, but a higher number of points indicates better shooting capabilities, respectively, and better prerequisites for achieving a high success rate in competitions." Laaksonen et al (2011) claim that combined relaxation and specific shooting training (holding and routine maneuvers without ammunition) improves shooting results.
The lack of significant differences in total points and the percentage of hits indicates that, overall, the two groups have very similar shooting abilities. This emphasizes that international competition is extremely close, and that minor factors—such as technique, mental preparation, or tactical approach—can be decisive in the final result. In this regard, Vukov (2022) notes that "... in order to meet the modern requirements for conducting fast and accurate shooting, it is necessary for the biathlete to master impeccable shooting technique, allowing for quick aiming (leading) of the weapon at the target."

CONCLUSION

The study reveals that, although there are no significant differences in most indicators, Norwegian biathletes have an advantage in shooting from a standing position**,** which can be a key factor in a competitive environment. The high overall shooting accuracy of both groups shows that both Bulgarian and Norwegian athletes are at an extremely high level of preparation.
The practical conclusions from these results include the need for Bulgarian competitors to focus on optimizing their performance from the standing shooting position, as well as additional psychological and technical preparation to stabilize results under increased mental stress. Furthermore, an analysis of training methods is necessary to enable Norwegian biathletes to compensate for their mistakes and still achieve high results.

REFERENCES

Aalto, H., Pyykkö, I., Ilmarinen, R., Kähkönen, E., & Starck, J. (1990). Postural stability in shooters. *ORL Journal of Oto-Rhino-Laryngology and Its Related Specialties, 52* (4), 232–238. https://doi.org/10.1159/000276141

Ball, K., Best, R., & Wrigley, T. (2003). Body sway, aim point fluctuation, and performance in rifle shooters: Inter- and intra-individual analysis. *Journal of Sports Sciences, 21*(7), 559–566. https://doi.org/10.1080/0264041031000101881

Era, P., Konttinen, N., Mehto, P., Saarela, P., & Lyytinen, H. (1996). Postural stability and skilled performance: A study on top-level and naive rifle shooters. *Journal of Biomechanics, 29*(3), 301–306. https://doi.org/10.1016/0021-9290(95)00066-6

Groslambert, A., Candau, R., Hoffman, M., Bardy, B., & Rouillon, J.-D. (1999). Validation of simple tests of biathlon shooting ability. *International Journal of Sports Medicine, 20*(3), 179–182. https://doi.org/10.1055/s-1999-970286

Klechorov, M., Vukov, V., & Haralampieva, A. (2022). Methodology for improving the technical skills of shooting in biathlon. In *International Scientific Congress "Applied Sports Sciences"* (Vol. 1, pp. 89–93). NSA Press. https://doi.org/10.37393/ICASS2022/15

Konttinen, N., Lyytinen, H., & Era, P. (1999). Brain slow potentials and postural sway behavior during sharpshooting performance. *Journal of Motor Behavior, 31*(1), 11–20. https://doi.org/10.1080/00222899909601888

Konttinen, N., Konttinen, H., & Lyytinen, H. (2008). Brain mechanisms in sports performance. In G. Tenenbaum & RC Eklund (Eds.), *Handbook of sport psychology* (3rd ed., pp. 188–209). Wiley.

Laaksonen, MS, Ainegren, M., & Lisspers, J. (2011). Evidence of improved shooting precision in biathlon after 10 weeks of combined relaxation and specific shooting training. *Cognitive Behavior Therapy, 40*(4), 237–250. https://doi.org/10.1080/16506073.2011.616217

Mononen, K., Viitasalo, JT, Era, P., & Konttinen, N. (2003). Optoelectronic measures in the analysis of running target shooting. *Scandinavian Journal of Medicine & Science in Sports, 13*(3), 200–207. https://doi.org/10.1034/j.1600-0838.2003.00130.x

Mononen, K., Konttinen, N., Viitasalo, J., & Era, P. (2007). Relationships between postural balance, rifle stability, and shooting accuracy among novice rifle shooters. *Scandinavian Journal of Medicine & Science in Sports, 17*(2), 180–185. https://doi.org/10.1111/j.1600-0838.2006.00549.x

Niinimaa, V., & McAvoy, T. (1983). Influence of exercise on body sway in the standing rifle shooting position. *Canadian Journal of Applied Sport Sciences, 8*(1), 30–33.

Nitzsche, K., & Stolz, G. (1981). Objektivierung und Vervollkommnung der Schießtechnik im Biathlon [Measurement and enhancement of the shooting skills in biathlon]. Leipzig: University Press. [In German].

Palakarski, GI (2016). *Biathlon, shooting preparation – monograph*. Sofia: NSA Press.

Sattlecker, G., Buchecker, M., Müller, E., & Lindinger, S. (2014). Postural balance and rifle stability during standing shooting on an indoor gun range without physical stress in different groups of biathletes. *International Journal of Sports Science & Coaching, 9*(1), 171–184. https://doi.org/10.1260/1747-9541.9.1.171

Sattlecker, G., Buchecker, M., Gressenbauer, C., Müller, E., & Lindinger, S. J. (2017). Factors discriminating high from low score performance in biathlon shooting. *International Journal of Sports Physiology and Performance, 12*(3), 377–384. https://doi.org/10.1123/ijspp.2016-0195

Schmidt, R., & Lee, T. D. (2014). *Motor learning and performance: From principles to application* (5th ed.). Human Kinetics.

Viitasalo, JT, Era, P., Konttinen, N., Mononen, H., Mononen, K., & Norvapalo, K. (1999). The posture steadiness of running target shooters of different skill levels. *Kinesiology, 31*(1), 18–28.

Vukov, V. (2022). Sequence (coordination) of elements of the shooting technique in biathlon. *Godishnik na NSA, 2* , 246–252. Sofia: NSA Press.

Yuryev, AA (1973). *Pulevaya sportivnaya strelyba* [Rifle sport shooting] (3rd rev. ed.). Moskva: Fizkultura i sport.

Zubrilov, RA (2013). Stanovlenie, razvitie i sovershenstvovanie tehniki strelybyi v biatlone [*Formation, development and improvement of shooting technique in biathlon] (2nd ed.).* Moscow: Soviet sport.

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