# Performance and Success Factors in Biathlon

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Abstract: Biathlon is a combination of two completely different sports - Nordic skiing and archery. While cross-country skiing requires great physical effort, archery requires a clear head and a calm and relaxed body. The aim of this study was to determine the factors that affect the accuracy and shooting of targets in biathlon. Due to the reduced number of researches in this field, five papers were singled out in the period between 2011 and 2018. By reviewing the literature, we can conclude the great role of the postural status of every biathlete. Whether the shooting is performed from a lying or upright position, a special focus is on stabilizing the aiming point before the shot is fired. Better shooting results are significantly related to the smaller distance of the middle location of the target point.

Keywords - cross-country skiing, precision, balance, aiming, competition, shooting

# INTRODUCTION

Biathlon is a winter Olympic sport that combines cross-country skiing and small-caliber rifle shooting [1]. The result in this sport is determined by the speed of skiing, the accuracy of shooting as well as the time interval for which the target is hit [2]. In this sport we have two or four breaks within the race itself. In this framework, rifle shooting is performed in a standing or lying position [3]. The most important concentration during shooting is due to the intensity of cross-country skiing, which is at a very high level. As previously mentioned, target shooting is done with a small-caliber rifle. The targets are 50 meters away and each competitor has 5 bullets [4,5].

Today there are 6 different types of biathlon competitions, sprint (7.5 km for women and 10 km for men, shooting lying down (A) and standing (B); race (10 km for women and 12.5 km for men, A + A + B + B), mass start (12.5 km for women and 15 km for men, A + A + B + B), individual (15 km for women and 20 km for men, A + B + A + B relay (4 x 6 km for women and 4 x 7.5 km for men, 4 x A + B) and mixed relay (2 x 6 km for women + 2 x 7.5 km for men, 4 x A + B) [6,7].

Compared to standard shooting disciplines, previous research in biathlon has not been so detailed and studied. The result in this sport, more precisely the shooting part itself, is primarily determined by previous efforts during skiing, shooting time, changes in weather conditions and many specifics that are difficult to influence immediately before the race [8]. These specific conditions can include: the surface, the attitude on the skis, which is quite individually determined. Upright body balance is one of the most important factors for successful shooting [9]. Professional male and female shooters show less oscillations in body balance than shooters who practice this sport as amateurs [10]. High-intensity skiing before shooting affects the stability of the body in shooting from an upright (B) position and thus affects the oscillation of the body during shooting mainly in the anterior but also in the posterior direction. Impaired body balance is closely related to the stability of movements transmitted to the rifle, which has been shown to be closely related to shooting accuracy, as well as the reason why we distinguish shooters with good and bad accuracy results, ie. shooting [11,12].

# METHODS

# Literature search

The research was collected by searching electronic databases of scientific databases. Also, papers are collected from references of found papers on this and similar topics, which are fully available. The key words used in the search are: cross-country skiing, precision, balance, targeting, competition, shooting. The greatest attention is paid to the works published in the period from 2011 to 2018. The first condition for taking the papers into consideration was to determine what are the factors that negatively or positively affect precision in biathlon.

#### Theoretical consideration of the problem

The study includes five closely related studies. At the beginning of the search, 114 references were identified that met some of the criteria, but a large number of papers on other criteria were immediately eliminated based on the title (Figure 1). Each paper is presented according to the following parameters: Sample of respondents (number of respondents, age and sex of respondents) and program (duration and program, monitored parameters, results). Elimination and search of works is shown in Figure 1.



#### **RESULTS AND DISCUSSION**

The procedure and pre-defined criteria were met by five studies and they were included in the systematic review (Table 1). The total number of respondents included in this study was 104, of which 65 respondents were male and 30 female. In the paper Baca & Kornfeind (2012) [14] the gender of the respondents is not known.

Table 1. Review of papers included in the study

References	Subject	Method	Results
[ <b>13</b> ]Laaksonen et al., (2011)	n = 20, 13 Å, 7 $\bigcirc$ 20 yo	Testing hypotesis combined relaxation / specifically designed shooting training	Relaxation / specific hoting training - combined, shooting performance ↑
[ <b>14</b> ]Baca & Kornfeind (2012)	n = 9, 4 world c., 5 european c.	Analyze stability of aming / elite biathles	Video system revealed the top level athletes exhibited more stable horizontal / vertical motion of the muzle ↑
[15]Sattlecker et al. (2014)	$n = 36, 27^{3}, 9^{\circ}_{\uparrow}$ 21.6 yo	Biomechanics young / elite biathles shooting performance	Rifle and body stay were correlated with shooting score ↑
[16]Sattlecker et al. (2017)	$n = 22, 14^{3}, 8^{\circ}$ 20.6 yo	Factors discriminating high / from / low scoring biathles both / rest / under	With prone shooting, shoulder force in the resting condition and vertical rifle motion after intense roller skiing were the main discriminators between high and low scoring athletes ↑
[ <b>17</b> ]Ihalainen et al. (2018)	$n = 17, 11$ $\bigcirc, 6$ $\bigcirc$ 21.7 yo	Standing shooting performance rest / after exercise	Clean triggering / vertical stability exerted most influence on shooting performance both at rest / after exercise. Postural ability ↑

All five studies are close to the given topic and focused on the goal of the research. Shooting in biathlon is the core of this sport and its main characteristic. During the competitions themselves, it is as important as running on skis, because the one who does not shoot well and runs well, according to the results, is close to the one who shoots well and runs worse. The essence of shooting in biathlon is a little different from the essence of shooting in archery itself, and based on what has been shown, we can single out 2 items: Hit the target regardless of the point at which the bullet will end; Reduce shooting time to the minimum that will allow the biathlete to score the most goals [18]. This shooting time is always taken into account during the competition and the placement of the competitor and thus his team can very much depend on it [19]. Considering the essence of shooting in biathlon, it can be said that it is demanding in its own way, especially due to the fact that every shooting during the competition takes place after a certain length of track during which the competitor raises his pulse, tires and increases breathing cycles [20]. The size of the target for standing to repeat the diameter is 115 mm, which corresponds to the circle between the third and fourth rounds on a standard shooting target for shooting from MK rifles with 50 m, while the size of the target for lying is 45 mm in diameter and corresponds to the outer part 8 on the target . This chapter will discuss postures, lying down and standing, and gripping weapons, followed by breathing, aiming, and firing [21]. When adopting a position, a biathlete should not follow a pattern, as there is no universal recipe that would apply to all shooters equally. This is because each person has their own characteristics such as height, weight, body proportion and muscle development. A biathlete must be careful not to adopt the wrong attitude when training and coaching. This is necessary because once an incorrect attitude is introduced, it is difficult to change for the better. We can be convinced of that at big competitions, where some biathletes shoot with such an attitude that obviously deviates greatly from the general attitude and does not support the results. In order to adopt the most favorable variant of the attitude, the shooter needs to study, improve and practice it for a long time, almost constantly. In order not to wander and waste time on fruitless experiments, a biathlete should study shooting literature well, observe top shooters on the firing line, carefully study the shooting technique of these shooters and accept from them everything that is valuable and useful, but by no means to copy masters whose body proportions are different [22,23].

The lying position is much more stable in its characteristics than the standing position. This comes from the fact that in the supine position, the supporting surface is much larger than in the standing position, and the center of gravity of the body is the lowest. This gives the best balance to the 'shooter's body - rifle' system. The posture should provide: holding the rifle at the slightest strain on the muscular apparatus; keeping the biathlete's body in one position for as long as possible during shooting; such a position of the head that creates the most favorable conditions for the work of the eye during aiming [24]. Experience has shown that it is most suitable for shooting in a lying position if the body is slanted so that an angle of 30-400 is taken from the level of shooting. The legs should be spread effortlessly so that the right is parallel to the longitudinal axis of the rifle barrel and the left at an angle of 700 to 900. The left arm, which carries all the weight of the rifle, is bent at the elbow and should be thrown as far forward as possible. With such a position of the left hand, a very stable position is achieved, the flicker and movement of the rifle during shooting is reduced. The difference between standing and lying posture is that the tension of the muscular apparatus is significantly higher. This strain with its breaks does not allow the biathlete to calm down completely, but as a result he constantly sways. That is why shooting in a standing position is considered complex and difficult. Top biathletes do not spend more than half of their time in training and training aimed at improving shooting from a standing position [25]. The difficulties that a biathlete encounters when choosing an individual standing position for shooting consist in the fact that, in addition to straining the muscles to achieve stability and balance of the body, he should also control the weight of the rifle whose center of gravity is at a greater distance from the center of gravity of the body. To maintain the balance of the 'biathlon-rifle body' system, the biathlete should take such a body position that he will achieve a counterweight to the rifle. Of great importance for a stable posture is the degree of muscle tension and the ligaments that strengthen the knee joints. You should not intentionally loosen the joints in the knees and stand with slightly bent legs. Also, the muscular tension in the legs must not be uneven and one leg should be stretched and the other bent. Insufficiently fixed position of the knee joints entails unnecessary tension of certain groups of leg muscles, due to which the whole body moves (oscillates). Also, we must not artificially stretch and brake the joints of the legs and knees with excessive strain, since it weakens the stability during shooting that lasts longer [26]. This, in fact, disrupts the coordinated work of the muscles. The shooter's way of breathing is closely connected not only with firing each individual shot, but also with the successful shooting of all series in a certain discipline. It is generally known that one should not breathe during fine aiming and firing, because breathing is accompanied by rhythmic movement of the chest, abdomen, and entire wound girdle, which causes the weapon to move and swing, making it impossible to score accurately [27]. That is why we must not breathe and perform a shot at the same time, but we should stop breathing for a while. A biathlete should not observe the process of breathing only from the point of view of moving the chest and swinging the weapon associated with it. We should not forget that respiration is a process that consists of a set of physiological processes that take place continuously in the body,

and are associated with blood flow and gas exchange, metabolism (metabolism) and complex phenomena in the nervous system, which depend on general condition and vitality organism [28]. Therefore, the way of breathing is very important. As for aiming, the shooter must aim with his right eye through the diopter opening and place the black field of the target in the middle of the ring fly opening. Thanks to the sense of symmetry around the eye, the centering of the diopter opening with the fly and the target will be done almost automatically. If the shooter allows a certain inaccuracy in the centering of the diopter opening and the fly, the error will not be large, since the diopter opening is relatively small [29]. In order to ensure accurate and uniform aiming with the help of diopters, all attention should be focused mainly on the correct and evenly placed fly under the flat field on the target and to carefully maintain the distance - the same white line.

# CONCLUSION

Biathlon is a complex sport in which everything is connected and dependent on each other in its own way. In order for a biathlete competitor to adopt, improve and automate everything necessary in running and shooting, he must train a lot, correctly and regularly, while fulfilling all the requirements that every sport advocates. He must have a team to accompany him, he must have both material and natural conditions and he must be maximally dedicated to biathlon if he wants to achieve a world-class result, and above all he must have all the necessary attributes from morphological and anthropomotor to psychological. and sociological in order to succeed and achieve the desired top result. By reviewing the literature, we can conclude the great role of the postural status of every biathlete. Whether the shooting is performed from a lying or upright position, special focus is on stabilizing the aiming point before the shot is fired. Better shooting results are significantly related to the smaller distance of the middle location of the target point.

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