Project title:

The influence of balance training and mindfulness training on shooting performance in young biathletes

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Introduction

The project focuses on the evaluation of effectiveness of two alternative approaches to performance enhancement of biathletes. First is based on motor competence and is focused on postural balance and the second approach focuses on psychological competency and is built on the concept of mindfulness. Recent research suggests that in resting conditions and after physical exercise, rifle sway during aiming at the target in a standing shooting position seems to be coordinated with the postural sway of the biathlete's body. Thus, an increase in postural sway contributes to a greater sway and lesser stability of the rifle. With respect to the second approach, the core of mindfulness is a way of paying attention that entails intentionally being aware of the present moment and accepting things just as they are without judgment. Mindfulness-based approaches in sport, exercise, and performance psychology is a fast developing area of sport psychology. There are many athletes (and coaches) who know that mental factors such as concentrating, relaxing, and letting go of thoughts and feelings can aid performance, but have no idea how to actually do these things under the pressures of training and competition. Moreover, recent findings indicated that mindfulness facets were positively associated with shooting performance, with higher levels of Awareness, Refocusing, and Awareness being related to better shooting performance in competitions. The 6-week balance training program and a 6-week Mindfulness Sports Performance Enhancement (MSPE) program was implemented in parallel among youth biathlon athletes in order to elicit improvements in their performance and verify the effectiveness of these programs.

Aim

The aim of the project was to implement two types of training in biathlon athletes and verify their potential to improve shooting effectiveness.

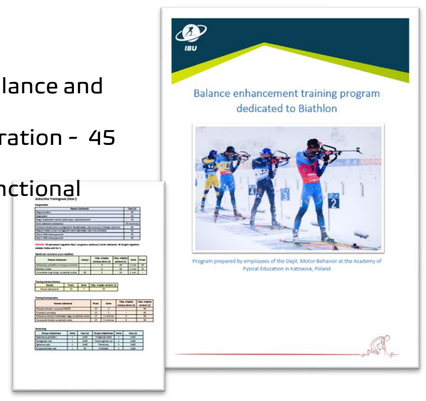
The first of the training programs focused on motor preparation and concerned the balance of the athlete's body. The second training program focused on mental preparation, specifically mindfulness.

Methods

The Motor Training

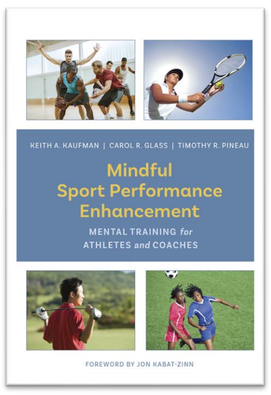
- Aimed at improving the parameters of balance.
- 3 phases, with progression of exercises, optimally stimulating balance and postural stability.
- 16 training units for a period of 6 weeks (2 times a week), unit duration - 45 minutes.
- 4 main implemented aspects (Core Stability, jumping training, functional training and Stretching) and has a fixed structure:

1. Short running warm-up,
2. Core Stability
3. Jumping exercises
4. Functional training with equipment,
5. Stretching exercises.



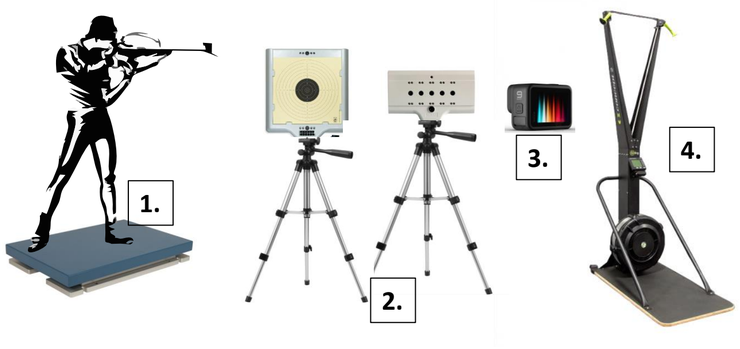
Mindful Sports Performance Enhancement training - (MSPE, Kaufman et al., 2018)

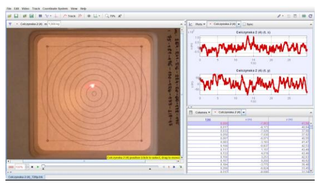
- A six-session group mindfulness program for athletes, rooted in a tradition of mindfulness-based stress reduction (MBSR, Kabat-Zinn, 1990) and mindfulness-based cognitive therapy (MBCT, Segal, Williams, & Teasdale, 2002).
- Training session: 60-90 minutes with elements of education, empirical, debatable and home practice.
- Exercises: body scanning, mindful breathing, sitting meditation, mindful yoga and walking meditation boosting mindful awareness and acceptance.
- Learned sequentially: from sedentary to mindfulness in motion, ending with a sport-specific exercise – transition of mindfulness techniques directly to basic skills in their sport.
- Recommended daily home practice and discussion in which athletes . Access to recordings of all mindfulness exercises of daily home practice was provided through the online platform



Measurement methods

1. Force plate (AMTI BP600900)
2. SCATT System
3. Video Camera
4. Ski Ergometer (SKiErg)
5. Video Tracker





Methods continued

Measurements (before and after the training):

1. **Force plate data from quiet standing and in shooting position with a rifle in anterio-posterior (AP) and mediolateral (ML) direction,**
2. **Scatt training system variables,**
3. **Laser tracker data (shooting aiming trajectory),**
4. **Mindfulness test and inventories (psychological tests).**
5. **CHORT test (computer test),**
6. **Y-Balance test Upper and Lower quarter.**

Results

Table 1. Correlation coefficients and corresponding p level between the shooting performance parameters and posturographic measures in the "Stability group" before the experiment

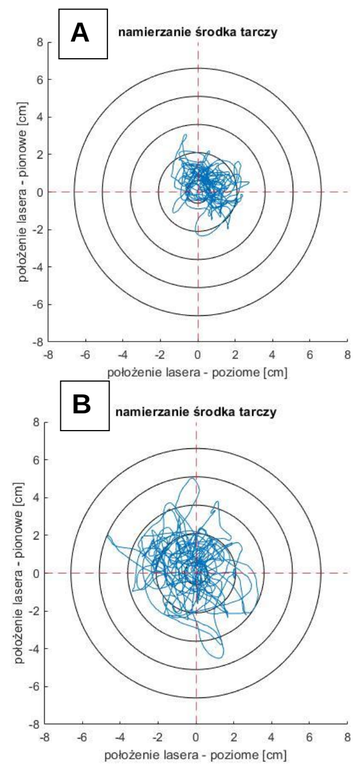
Variable	rhytm_stab	meanS	meanS_Horiz	meanS_Vert	score	score_indx
raCOP_ML	-,2163	-,1861	-,3201	-,0269	,5859	,7867
	p=,607	p=,659	p=,440	p=,950	p=,127	p=,021
stdCOP_ML	-,4136	-,1965	-,3053	-,0662	,7093	,8308
	p=,308	p=,641	p=,462	p=,876	p=,049	p=,011
rmsCOP_ML	-,4136	-,1965	-,3053	-,0662	,7093	,8308
	p=,308	p=,641	p=,462	p=,876	p=,049	p=,011
raRAMB_ML	-,1766	-,2691	-,4037	-,1027	,6166	,8019
	p=,676	p=,519	p=,321	p=,809	p=,103	p=,017
stdRAMB_ML	-,4207	-,2068	-,3159	-,0756	,7347	,8289
	p=,299	p=,623	p=,446	p=,859	p=,038	p=,011
rmsRAMB_ML	-,4207	-,2068	-,3159	-,0756	,7347	,8289
	p=,299	p=,623	p=,446	p=,859	p=,038	p=,011
sampEntr_ml	,2922	,1144	,3182	-,1245	-,7084	-,4429
	p=,482	p=,787	p=,442	p=,769	p=,049	p=,272

Table 2. Significant correlations in the Mindfulness group between shooting performance and Mindfulness inventories after the training ($p<0.05$)

Variable	Awareness	Distractions	CH_mean_rt	CH_long_rt
shooting score	,7150	-,7247	-,8240	-,7247
	p=,046	p=,042	p=,012	p=,042

Table 3. Pearson correlation coefficients and respective p level between Laser tracker data and posturographic parameters

Variable	s_Y		V_Y		s_Total		V_total	
	r	p	r	p	r	p	r	p
lenCOP_AP	0.74	0.035	0.74	0.035	0.5652	0.144	0.5652	0.144
vCOP_AP	0.74	0.035	0.74	0.035	0.5644	0.145	0.5644	0.145
stdTREMB_AP	0.74	0.037	0.74	0.037	0.6476	0.083	0.6476	0.083
lenTREMB_AP	0.77	0.027	0.77	0.027	0.6423	0.086	0.6423	0.086
vTREMB_AP	0.77	0.027	0.77	0.027	0.6418	0.086	0.6418	0.086
stdCOP_ML	0.82	0.013	0.82	0.013	0.7805	0.022	0.7805	0.022
raRAMB_ML	0.7	0.054	0.6987	0.054	0.7165	0.046	0.7165	0.046
stdRAMB_ML	0.82	0.013	0.82	0.013	0.7609	0.028	0.7609	0.028



Pic 1. Exemplary trajectory of the laser in Matlab **A**) before fatigue, **B**) after fatigue from the same athlete

Legend: area, range of COP (raCOP), standard deviation of COP (stdCOP), rmsCOP_AP, COP path length (lenCOP), COP velocity (vCOP), range of rambling (raRAMB), standard deviation of rambling (stdRAMB), rms of rambling (rmsRAMB), path length of rambling (lenRAMB), velocity of rambling (vRAMB), range of trembling (raTREMB), standard deviation of trembling (stdTREMB), rms of trembling (rmsTREMB), path length of trembling (lenTREMBD), velocity of trembling (vTREMB), sample entropy (sampEntr), range (rangX, rangy), standard deviation (std_X, std_Y), rms (rmsX,rmsY), path length (sX, `sY), velocity (vX, vY), total path length (s_total), total velocity (V_total), sample antropy (ent_X, ent_Y), shooting rhythm stability (%) (rhythm_stab), mean length of the aiming path (mm) (mean_S) (mm), mean horizontal length of the aiming path (mm) (mena_S_Horiz), mean vertical length of the aiming path (mm) (mena_S_Vert), shooting score number (score), index of shooting score (score_indx),Awareness, Not judgmental, Refocussing, Worring, Distractions, Emotional Control, Confidence, mean reaction time (CH_mean_rt), percent of errors (CH_%_errors), prolonged reactions (CH_long_rt), Composite Reach Distance (CRD)

Conclusions

- The body balance and the level of mindfulness can significantly contribute to the shooting accuracy.
- The training elicited significant changes of the posturographic parameters but not in the Mindfulness level estimated with the implemented tests.
- The individual statements of the participants were positive, especially with respect to the MSPE training. They reported that they were able to cope with the stress and to refocus much better with the use of the methods they were presented within the course of the project.
- The developed methodology of tracking of the aiming trajectory showed an interesting tendency in the results that suggest the training has led to better control of the rifle during aiming and resulted in a more focused tracing. This should be further explored in the future experiments.

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