BODY SWAY IN BIATHLON SHOOTING

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INTRODUCTION

In the 7.5 km sprint biathlon event each competitor skis 7.5 kilometres, stopping two times during the race to fire shots into a target. A miss means handicap circuit added to the distance charged to the skier while completing the distance of competition. The race is capable to test the strength, endurance and skill of competitors.

In biathlon shooting, two positional rules apply. They are standing and prone (lying flat on the ground). Before the shooting, the cross-country racing loads extremely the cardio-respiratory and neuro-muscular systems. In shooting, the oscillation amplitudes of body segments depend on the degree of optimalization in diminishing running velocity, immediately before the shooting, without significant loss of time.

The aim of the present preliminary study is the investigation of body sway in model-situation, and during shooting in competition-like circumstances.

SUBJECTS AND METHODS

Twenty junior and adult biathlon competitors, 12 men and 8 women, were included in the study. The first group of subjects was represented by 8 males and 5 females. Their ages ranged from 10 to 18 years. The other group was formed by members of the Hungarian selected team.

A completely computerised system has been used for the investigations. The equipment includes Adam type force platform, Psycho 8 differential measurement device, ADDON microcomputer and personal computer.

Two measuring programs have been used.

1.1. Electronic realisation of the traditional Romberg test.

1.2. Movement co-ordination test in connection with the voluntary displacement of centre of mass in biofeedback system.

2.1. Dispersion display of sampled data during the moving of body centre of mass projected on the covering plate of platform, completed with time displacement diagrams and Fourier spectra.

The battery of tests includes the following situations:

a.) standing on the platform, looking ahead with arms straight out from the body,

b.) as in "a" but with eyes closed,

c.) As described in 1.2 using a visual bio-feedback from the computer monitor. With a task of filling in a pre-determinated surface. The result will be automatically evaluated.

d.) standing in shooting position with biathlon rifle,

e.) as in "d" and shooting, following the rules of biathlon competition

The displaying of test results is based on the radius and centre co-ordinates of a characterising circle which contains 68.27 % of the sampled data of displacements, time functions of the displacements: x(t) and y(t) as well as on Fourier spectra.

R1: radius in the situation of open eyes

R2: with closed eyes

RESULTS

Table 1. Junior competitors, N=13

AGE YEARS	HEIGHT CM	MASS KG	R1	R2	R2/R1 %	COORD-PERF %	TIME %
14	168	52	3	4	133	66	97
15	167	60	3	4	133	59	97
15	165	54	4	4	100	52	98
14	154	44	4	4	100	73	89
18	172	68	4	4	100	65	95
10	145	37	4	5	125	63	82
15	161	48	4	6	150	55	89
15	165	60	4	7	175	62	99
12	157	45	5	7	140	60	92
10	135	38	5	9	180	50	95
16	173	66	5	9	180	52	96
14	162	52	6	7	117	58	96
8	120	30	6	10	167	54	86

Table 2. Evaluation of data, Program No. 1.Situations: a,b,c, N=13

Parameter	Mean values	St. deviation
AGE–YEARS	13.5385	2.7873
HEIGHT–CM	157.2308	15.4820
MASS–KG	50.3077	11.4774
R1 mm	4.3846	0.9608
R2 mm	6.1538	2.1926
R2/R1 %	138.4615	30.1043
COORD_PERF. %	59.1538	6.6313
TIME %	93.1538	5.1776

Table 3. Data and results. Program No. 1. (a., b., c.) N= 6

AGE YEARS	HEIGHTCM	MASS KG	R1	R2	R2/R1 %	COORD-PERF %	TIME %
20	182	72	4	5	125	58	87
25	183	74	4	8	200	55	98
22	170	62	5	5	100	60	98
21	176	65	5	6	120	54	98
24	173	70	3	10	333	48	98
17	165	52	6	8	133	48	97

Table 4. Evaluation of data of table 3. N=6

Parameter	Mean values	St. deviation
AGE_YEARS	21.5000	2.8810
HEIGHT_CM	174.8333	6.9690
MASS _KG	65.8333	8.1097
R1 mm	4.5000	1.0488
R2 mm	7.0000	2.0000
R2/R1 %	168.5000	87.4637
COORD_PERF. %	53.8333	4.9967
TIME %	96.0000	4.4272

Table 5. Measurement during shooting. N=4

Parameter	Mean values	St. deviation
SWAY_R68 mm	7.7500	1.7078
HIT PERFORM.	3.5000	1.2910
DOM_FR_X(Hz)	0.5750	0.3500
DOM_FR_Y(Hz)	0.1750	0.1500
AMPL._X (mm)	2.8750	0.9323
AMPL._Y (mm)	5.3000	2.1649

R68 : radius of the characterising circle of sway
DOM FR X : dominant frequency in Fourier spectrum. Direction: "x"
DOM FR Y : dominant frequency in Fourier spectrum. Direction: "y"
AMPL X and X: amplitudes of sway at the dominant frequencies.

DISCUSSION

The characteristics and performances of biathlon shooting can't be compared with other shooting sports without taking into consideration the loading of cross-country racing.

Significant correlation (r=-0.6265; n=13) has been found between the results of Romberg test with closed eyes and the co-ordination test containing tasks of moving the centre of mass of the body on a pre-determined path and surface reflected by a computer monitor. We assume that the former is mostly, the later is partially influenced by the proprioception system.

In our tests, the barrel was parallel to the X axis of the imaginary co-ordinate system in which the force platform is placed. The X components of the body sway (mediolateral direction) were significantly less during the period of shooting than the Y components (anteroposterior direction).

The dominant frequencies were generally higher to the mediolateral direction. The equilibrium factor of performance in this kind of sport can be investigated using the present methods, but further investigations are necessary to make the generalisation of results possible.

Stochastic moving of centre of mass of the body occur while shooting. On the displacement diagram the signal to noise ratio is determined by the level of signals correlating with the shot and the spontaneous body sway amplitudes as mentioned above

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