Evaluation of the anaerobic ability of alpine skiing skiers through the slalom simulator

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Abstract

Purpose: The purpose of the research was the evaluation of efficiency of anaerobic ability (power), anaerobic endurance, anaerobic fatigue and the restitution of the pulse rate of alpine skiing students through the slalom simulator. In addition, the aim of the research was the correlation of the special tests of alpine skiing on dry ground (octagon test) and in snow (triangle test and slalom test) with the target of determining ability levels.

Material: The 20 people sample was composed by two teams of male and female who took the course for advanced (n = 7) aged 23±1.40 years and for beginners course (n = 13) aged 20±1.49 years. For the evaluation process two special tests were used, on the ground and in snow. The ground test was completed in the slalom simulator for 40 seconds. The second ground test was the octagon bouncing (40cm each side) x 3. The snow test was the Haczkiewicz test (triangle test) and the slalom (7 gates), where the time of a try was measured.

Results: The best efficiency in anaerobic power was made by the advanced males and females, while in the anaerobic endurance by the beginners males and females. The best performance in the dexterity tests in snow on the triangle and slalom test was made by the advanced males and beginners females respectively.

Conclusions: The significant correlation between the results of anaerobic performance in the slalom simulator and the triangle test in snow confirms the means of diagnosing skill and fitness on dry ground and snow respectively. There is a significant correlation between snow test results and there is no correlation with the octagon test. The aforementioned results can be used in the talent selection process of alpine skiing.

Keywords: slalom simulator, anaerobic power, special tests, alpine skiing, selection.

Introduction

Anaerobic power is an indicator of metabolic process, and represents the leg muscle ability to produce high mechanical power in a short amount of time, up to 5 seconds (maximum power). Anaerobic ability (power) is an indicator of metabolic process and represents the leg muscle ability to produce high mechanical power in a longer amount of time, up to 30 seconds (average power), where the full development of the galactic mechanism requires at least 60 seconds [5, 11, 13]. Anaerobic endurance is the human body's ability to resist fatigue in dynamic or static tries of small length. It is includes the speed endurance and the force endurance [12, 15, 29]. Anaerobic fatigue is the percentage decrease of power production during a trial and it represents the total ability of ATP production through median and short time energy systems [1, 27].

The following researchers have treated the subject of anaerobic ability of skiing athletes: [2, 7, 18], with its biomechanics of ski have treated the subject [4, 10, 22], while Giovanis et al. & Lazarenko [8, 16] have treated the subject of the simulation of winter and summer sports. The following researchers have treated the subject of anaerobic ability in physiology [19, 20, 21], and in training [3, 17, 26]. The following researchers have treated the subject of assessment of the physical condition and the restitution of the heart rate of the athletes: [6, 14, 30]. The following researchers have treated the subject of anaerobic ability with comparison Wingate test and Bosco test [24, 25, 28].

The purpose of the present research was the evaluation of the efficiency of anaerobic ability (power), anaerobic endurance, anaerobic fatigue and pulse ratio recovery of alpine skiing students through the slalom simulator. In addition, the aim of the research was the correlation of the special tests of alpine skiing on dry ground (octagon test) and in snow (triangle test and slalom test) with the target of determining ability levels.

Research questions and statistical hypotheses

The motives of initiating the present research were the following presented questions:

- Which alpine trial is the main talent selection in the alpine skiing?
- Which of the two teams composed (advanced skiers or beginners skiers) have the biggest anaerobic ability (power) and how is this calculated?
- Will the advanced skiers team overmatch the beginners team in the anaerobic tests, as they require experience and technique?

Statistical hypotheses: Zero hypotheses with the corresponding alternatives examined in this research are:

- Special tests can't evaluate the athlete's training level?
- Can special tests evaluate the athlete's training level?

Material and methods

Participants:

The 20 people sample was composed by two teams of male and female who took the skiing course for advanced (n = 7) aged 23±1.40 years and for beginners course (n = 13) aged 20±1.49 years. Age, gender and body features of the skier teams are shown in table 1.

The measuring instruments and methods:

1) a timer with an accuracy of 0.01sec,

2) a slalom simulator of Spanish design BH SLALOM, MOD. G92,

3) a special rubber tape and the simulator platform,

4) two sticks (poles) of ski,

5) a UWE-type dynamometer, to determination the elongation force (resistance) of the simulator's rubber tape (Table 2).

6) a digital camera (50hz) placed in 3,5m distance from the simulator. With the assistance of the video analysis

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Table 1. The body features of the athletes taking part in the research

TEAMES	PARTICIPANTS	AGE (years)		HEIGHT (m)		WEIGHT (kg)		BMI (kg/ m²)	
	n	M	SD	M	SD	M	SD	M	SD
ADVANCED SKIERS	7	23	1,40	1,73	0,05	68	8,50	22,81	2,08
M	5	23	1,41	1,75	0,05	72	5,31	23,67	1,21
F	2	22	0,71	1,69	0,01	59	8,49	20,63	2,63
BEGINNERS SKIERS	13	20	1,49	1,70	0,09	65	15,92	22,29	3,88
M	4	21	2,52	1,81	0,05	83	18,51	25,42	5,66
F	9	19	0,71	1,65	0,04	57	3,70	20,90	1,85
SUM	20	20,7	2	1,71	0,08	66,1	13,64	22,47	3,30

Table 2. Determination of the simulator's rubber tape elongation force (every 10cm)

Number of part (range of part)	1 (0-1)	2 (0-2)	3 (0-3)	4 (0-4)	5 (0-5)	6 (0-6)
Length of part (cm)	10cm	20cm	30cm	40cm	50cm	60cm
Elongation force of rubber tape (kg)	20kg	34kg	44kg	53kg	65kg	80kg

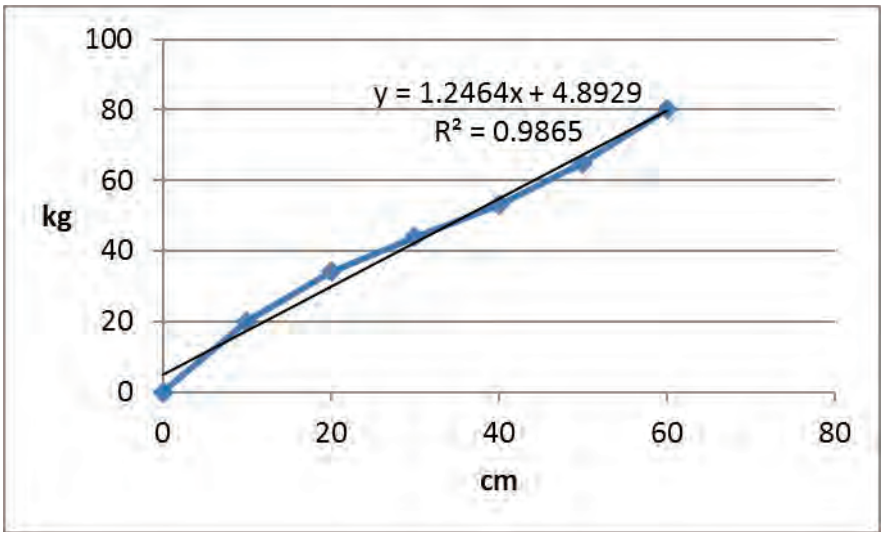

Figure 1. Regression between the force of elongation and the length of the parts

in the "Kinovea 32" 3D application has determined the maximum deviation of the platform left and right.

7) two simple gates (red and blue) placed in spot "3" in the middle of each arm respectively, as a reference point of the platform's deviation range.

8) The following equations of anaerobic ability (power), anaerobic endurance were used based on the definition of the equation in correlation with the athlete's mass. The anaerobic fatigue in correlation with the length and the time exercise, and of the pulse restitution ratio [9, 14, 27]:

Anaerobic power (M) = m x s / t [N]

where:
m – body mass (kg)
s - distance (m)
t - time (40 sec)

Max anaerobic endurance (Pmax) = v x m x g [W]

where:
v - speed (m/s)
m – body mass (kg)
g - gravitation acceleration (m/s²)

Anaerobic fatigue (FI) = t x 100 / THR x 2

where:
FI – Fitness Index
t - time of try (40 sec)
THR - total heart pulse (after the 1min and 3min)

8) The heart pulse restitution ratio Index (WR), has been used after the end of try, of 1 min and 3 min: WR = HRmax – HRmin

9) Octagon test (with a 40cm side length) on dry ground, with the goal of timing bounces of 3 rounds in an effort,

10) Triangle test Haczkiewicz [23] in snow (10mx10mx10m),

11) Slalom test (7 gates).

Test procedure

For the evaluation two special tests were used on dry ground and two in snow. On dry ground one test was used on a slalom simulator, where the subject, after warming up begins a try. From the initial position on the simulator platform, the goal of the subject is to apply pressure, for example on his right foot and subsequently to move the platform on the simulator's rails, where the course's difficulty marks are spotted, alternately left and right for 40 seconds (this corresponds to 40 turns or 20 cycles), counting the repetings number in one try, which corresponds with the anaerobic ability (power – P). The second special test on dry ground was the octagon bouncing (40cm each side) x 3, counting the time on three consequent rounds of one try by choosing right or left (space and time sense test). In the snow, the first test was the Haczkiewicz test (triangle dexterity) and the second the slalom (7 gates), measuring the time of a try.

Statistical analysis

The research plan consisted of 4 research groups. For all the attributes of the subjects the average value (M) and the standard deviation (SD) were calculated. The statistical analysis was made with the statistic program Excel 2007. In order to evaluate the selected special tests on dry ground as feasible, they have been correlated with the two special tests in snow.

Results

Evaluation of the efficiency of the anaerobic ability using the slalom simulator

The table 3, present the differences between the advanced (males- females) and beginners (males- females) teams, that participated on the test of anaerobic power, anaerobic endurance, anaerobic fatigue as well as the measurements in the difference of maximum to minimum heart rate after the try. The second dry ground test was the octagon test, assessing the time performance. The results of the anaerobic power showed that the advanced team had better efficiency than the beginners team with 65,2±6,92 about males and 35,4±4,58 about females. The results of the anaerobic endurance showed that the beginners team had better efficiency than the advanced team with 663±101,77 about males και 599±68,02 about females.

The results of the anaerobic fatigue showed that advanced females had better efficiency than beginners females with 8,9±0,84, on the other hand beginners males had better efficiency than advanced males with 10,3±1,81 (Table 3).

The measurements of the max heart rate's difference provided almost the same results for the advanced and the beginners team (table 3). The advanced team had a slightly larger heart rate difference than the beginners team with 48±12 versus 47±23,39.

Assessment of the performance of the skiers in the octagon test:

The results of the octagon test measurements showed that the beginners team had better records than the advanced team with 19,80±3,17 versus 20,71±1,52 (table

Table 3. The efficiency of anaerobic ability (power) of the advanced and beginners teams that participated in the slalom simulator test and the octagon bouncing off on dry ground

TEAMS	Anaerobic power (M)		Anaerobic endurance (Pmax)		Anaerobic fatigue (FI)		Recovery factor H.R. (WR=max-min)		Time of octagon (sec)	
	M	SD	M	SD	M	SD	M	SD	M	SD
ADVANCED SKIERS	56,7	15,72	555,9	154,01	8,5	0,53	48	12	20,71	1,52
M	**65,2**	6,92	639,4	67,84	8,3	0,33	**49**	14,32	21,05	1,19
W	**35,4**	4,58	347,3	44,89	**8,9**	0,84	45	4,24	**19,87**	2,50
BEGINNERS SKIERS	39	13,73	619	81,31	8,9	1,56	47	23,39	19,80	3,17
M	55	8,65	**663**	101,77	**10,3**	1,81	41	36,46	**18,96**	0,61
W	32	7,98	**599**	68,02	8,3	1,03	**49**	17,18	20,17	3,79

3). Notably the best performances were (from best to worse): beginners males (18,96±0,61), advanced females (19,87±2,50), beginners females (20,17±3,79) and advanced males (21,05±1,19).

Assessment of the performance of the skiers on the dexterity tests in snow:

a) triangle test performance evaluation,

b) slalom test performance evaluation.

The table 4 presents the differences between the advanced team (males - females) and the beginners team (males - females), that participated on the triangle and the slalom test. The results of the triangle test measurements showed that the advanced team had better results than the beginners team with 27,92±4,58 versus 32,93±5,32 (table 4). Notably the best performances were (from best to worse): Advanced males (25,9±3,67), beginners females (32,29±5,2), advanced females (32,99±0,57) and beginners males (34,36±6,10). The results of the slalom test showed that the advanced team had better records than the beginners team with 12,66±1,4 versus 12,99±1,84 (table 4). Specifically the performances were noted (from best to worse): Advanced males (12,26±1,33), beginners females (12,52±1,5), advanced females (13,65±1,39) and beginners males (13,79±2,45).

The important correlation between the anaerobic ability results of the slalom simulator and the triangle test in the snow confirms the evaluation techniques of the dexterity and physical state on dry ground and in snow respectively. There is also an important correlation between the results of the snow tests, while there is no correlation with the octagon test (table 5).

Discussion

In the procedure through simulator of slalom according to the results, in the anaerobic power's efficiency it is observed that the advanced males and

Table 4. The efficiency (time) of the triangle test and the slalom test in snow

TEAMS	TRIANGLE TEST (sec)		SLALOM TEST (sec)	
	M	**SD**	**M**	**SD**
ANDVANCED SKIERS	27,92	4,58	12,66	1,4
M	**25,9**	3,67	**12,26**	1,33
F	32,99	0,57	13,65	1,39
BEGINNERS SKIERS	32,93	5,32	12,91	1,84
M	34,36	6,10	13,79	2,45
F	**32,29**	5,2	**12,52**	1,5
SUM	31,18	5,53	12,82	1,66

Table 5. The aggregated correlation results between the dry and snow performance of advanced skiers and beginners skiers respectively ($p \leq 0,05$ n = 20)

Variables	Anaerobic power (M)	Anaerobic endurance (Pmax)	Anaerobic fatigue (FI)	Time of octagon	Triangle test	Slalom test
Anaerobic power (M)	X	**0,46**	0,27	-0,07	**-0,48**	-0,05
Anaerobic endurance (Pmax)		X	0,39	-0,06	**-0,42**	-0,29
Anaerobic fatigue (FI)			X	-0,21	-0,19	0,01
Time of octagon				X	0,17	0,26
Triangle test					X	**0,71**
Slalom test						X

females had better performance in comparison with the beginners. In the anaerobic endurance', it is observed that the beginners males and females had a better performance in comparison with the advanced teams. At last, in the anaerobic fatigue it is observed that the beginners males had better efficiency than the advanced males, although on the other hand the advanced females had better efficiency than the beginners females, but as a sum the beginners team appears to have better results than the advanced team. It should be pointed out that in relation to the heart rate after the procedure, the results of the male advanced team and the female beginners team were better than the male beginners and female advanced teams respectively. In the octagon test it is observed that male beginners had better results than advanced male and advanced females than beginners females. In the triangle and the slalom tests in snow it is observed that on both tests the best performances were held by the advanced male team and the beginners females team. This study is approached by the following studies: [6, 8, 9].

Conclusions

Based on the results of the present research we can conclude to the following: The anaerobic power's efficiency evaluation of alpine skiing students is possible via the slalom simulator ("slalom ergo meter"). The best efficiency in anaerobic power was made by the advanced males and females, while in the anaerobic endurance by the beginners males and females. At last the best efficiency in anaerobic fatigue and the best performance on the octagon test on dry ground was made by the beginners team. The best performance in the dexterity tests in snow on the triangle and slalom test was made by the advanced males and beginners females respectively. For the talent selection on Alpine skiing, the evaluation tests of anaerobic power efficiency on the slalom simulator outmatches the octagon test. The team of advanced skier students did not outmatch the beginners team. The application of the tests could be the evaluation criteria of the physical state and the technique of the athletes. The important correlation between the anaerobic ability results of the slalom simulator and the triangle test in the snow confirms the evaluation techniques of the dexterity and physical state on dry ground and in snow respectively. At last, there is also an important correlation between the results of the snow tests, while there is no correlation with the octagon test.

Conflict of interests

The authors declare that there is no conflict of interests.

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