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ASPECTS REGARDING THE IMPROVEMENT OF THE METHODOLOGICAL SYSTEM FOR TESTING ALPINE SKIERS

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Abstract. *The universality of sport, the altitude, the instability of performance and its ongoing progress towards biological and psychological limits still unknown to man compel reflection and analysis. Specialists are aware that performance does not spring from a cluster of facts and events, but is a product of the effects determined by the concentric action of some objective and subjective factors. In sports science, an important step forward was made by inventorying and measuring these indicators through various objectification procedures, followed by their interpretation. Researchers in the field aim to determine the maximum efficiency of these factors by establishing their value hierarchy, chronological order or the simultaneity of their useful intervention. Thus, the path towards organising the scientific management of sports training for performance achievement is open. Everything else is a matter of methodology and technology. The methods and strategies for training children and juniors are a very much discussed topic due to their different approaches within the most important ski schools worldwide. Children and juniors represent the next generations that will participate in major international alpine skiing competitions. Their technique is still developing and there are very few who master the adult technique. At this age, the main objective of training is the acquisition of a correct basic technique. If the basic technique is not properly acquired, future athletes will not be able to reach a high competitive level, in the sense that their sports results in major competitions will be negatively affected.*

Keywords: *alpine skiing, specific tests, methodological system.*

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Introduction

In Romania, alpine skiing is practised by many enthusiasts of this sport, whose number is constantly growing because this activity is primarily performed in the open air, and the effort provided leads to a better state of health compared to those who do not practise such a sports activity in an organised setting or independently. However, young people are less and less supported and guided towards competitive sports. The causes are multiple, but we will not go into details, although, in our opinion, the high expenses related to the practice of this sport are the main cause of this situation, starting with ski equipment and continuing with transport from home to the ski resort, accommodation, meal and ski pass (a paid ticket/card authorising the holder to use the ski lift). It is certain that "selecting the 'right' athletes to competitions and games is crucial in eventually deciding winners and champions" (Johansson & Fahlén, 2017).

We believe that the technique based on good physical fitness and applied in competition conditions is the key to performance in alpine skiing. "The philosophical-didactic-sporting collaboration created a major interdisciplinary approach to the artistic forms of *cutting* from simple executions and finalizing by generating elevated, perceptible but at the same time perfect reaching the ideal in performance and art." (Plăstoi et al., 2019) According to Pelin et al. (2020), "various researchers have investigated the characteristics of top athletes, wanting to highlight their personality traits, mental and physical states, feelings experienced in the moment of achieving tremendous performance." "The emotions that a person experiences when working best reflect the quality of their professional life." (Predoiu et al., 2021)

Thus, starting from the fact that Romanian alpine racers take a series of centralised tests (perhaps not the most suitable for this sport) aimed at checking their physical training levels, we wanted to identify the method of testing athletes from a technical point of view, too. It is known that good physical training does not necessarily lead an elite athlete to apply the learned techniques in competition conditions. "Youth and adolescent ski racers report lower injury rates compared to World Cup athletes. The knee was the most affected body part in relation to traumatic injuries." (Steidl-Müller et al., 2019)

The issue of current competition technique in alpine skiing is an extensively debated topic worldwide. There is much discussion about technical training within different ski schools that have produced highly valuable athletes of both genders, with outstanding performance in major international competitions. Thus, the results achieved at the World Championships, Olympic Games, etc. are shared between several powerful nations in this sports discipline.

Practice shows that alpine skiers use close or similar competition techniques, and the time differences between top-ranked competitors are often measured in hundredths of a second, even though they are from different ski schools. In other words, there is not only an 'Austrian technique' that should be duplicated and used by the rest of the world, but also an international modern technique. The best giant slalom and slalom racers have similar skiing trends. These general trends of modern technique go far beyond an alpine skier's body type and individual skiing style. They could be used uniformly by all competitors - from developing children to junior and senior national team members (Gurshman, 2016).

Turns on parallel skis are techniques used in both slalom and giant slalom. No convergence or divergence of the skis is noted at any stage of the turn throughout the run or during free skiing, and this is not easy to achieve on a consistent basis. When analysing the ski technique, it is important to separate the elements of individual style or some technical inefficiency from the trends of modern technique. Studying the ski technique of top racers leads to highly objective results because the fastest competitors exhibit the best technique, which is not affected by either their style or need to produce a certain impression (Saga & Saga, 2018).

At the age of participation in international FIS competitions (16-17 years), many junior racers experience obvious stagnation in their development and give up competitive skiing. Losing a great number of junior athletes is mainly caused by instilling unsound technical fundamentals between the ages of 10 and 13 years. If the technique of young racers has fundamental flaws at this age, then the skier-ski system simply does not work well at a higher level where the emphasis is on travel speed in competition conditions (Gurshman, 2016).

Pelin et al. (2018) add that “improving sport results in ski competitions is substantially dependent on the development level of strength in athletes”.

The central point of every training process and competition is the athlete, who strives to reach a certain value level, maintain it, improve it and achieve maximum efficiency in competition (Alexe et al., 2022; Šagát et al., 2021).

Performance capacity development involves stage-based strategies determined by the acquisition levels and compliance with bio-psycho-pedagogical rules (Ferrario-Chera et al., 2019; Dobrescu et al., 2014). In terms of sports training methodology, the development of performance capacity represents an objective with the highest degree of generality, which is then differentiated in steps depending on the aforementioned stages, ages and characteristics of particular sports branches.

Since the technical training of athletes is not given due attention, the preparation stages are completed much too quickly, and the period in which it is possible to ski in Romania is too short, the majority of coaches have to solve most problems of the competition season and year during the available time of the year when the slopes are covered with snow.

The *purpose* of this research is to highlight the impact of implementing a technical training programme for athletes aged 12-15 on the allocation of an increased time budget for the technical training of alpine skiers to increase their sports performance.

Hypothesis

The implementation of a technical training programme using the specific on-snow action systems proposed by us contributes to improving sports performance for the U14-U16 category.

Methodology

The research methods used in this study were intended to ensure rigor and optimal scientific conduct, being implemented throughout the development of this approach. Thus, the following research methods were used both independently and in the system: literature review method, observation method, psycho-pedagogical experiment method, graphical representation method and statistical mathematics method.

Research sample

a) Control group:

- 15 athletes, of which 5 girls and 10 boys;
- U14-U16 junior athletes aged between 12 and 15 years;
- All athletes are registered with the Carpați Sinaia Sports Club, coordinator: coach Andrei Burchiu, and participate in the domestic competitions scheduled by the Romanian Ski Biathlon Federation (FRSB).

b) Experimental group:

- 15 athletes, of which 5 girls and 10 boys;
- U14-U16 junior athletes aged between 12 and 15 years;

- All athletes are registered with the Petroșani School Sports Club, coordinator: teacher Toth Zoltan, PhD, and participate in the domestic competitions scheduled by the Romanian Ski Biathlon Federation (FRSB).

Both groups carried out their training, namely between 7 December 2020 and 6 March 2021, benefiting from similar conditions in terms of snow, slope preparation and weather. They performed a single workout per day, accumulating 24 hours per week and a total number of 264 hours throughout the 11 weeks of training (Table 1). Given that the research athletes also attended classes at their basic schools during the experiment, we chose to alternate their weekly schedule in the morning and afternoon.

Table 1. *Training period and schedule*

Microcycle (MCR)	Period	Schedule
MCR 1	7-12 December 2020	9:00 - 13:00
MCR 2	14-19 December 2020	12:00 - 16:00
MCR 3	4-9 January 2021	9:00 - 13:00
MCR 4	11-16 January 2021	12:00 - 16:00
MCR 5	18-23 January 2021	9:00 - 13:00
MCR 6	25-30 January 2021	12:00 - 16:00
MCR 7	1-6 February 2021	9:00 - 13:00
MCR 8	8-13 February 2021	12:00 - 16:00
MCR 9	15-20 February 2021	9:00 - 13:00
MCR 10	22-27 February 2021	12:00 - 16:00
MCR 11	1-6 March 2021	9:00 - 13:00

Anthropometric measurements

Athletes in both groups were investigated in anthropometric terms, and the measurements used were as follows:

1. Height – measured between the top of the head to the support surface with a stadiometer;
2. Body weight – measured with a digital scale;
3. Lower limb length – measured between the anterior superior iliac spine and the external malleolus.

Based on these data, we calculated the body mass index (BMI) and the proportionality ratio between the length of the lower limbs and height.

Table 2 shows the anthropometric measurements taken on 20.11.2020 in Sinaia and their processing for the control group.

Table 2. *Anthropometric values and their processing for the control group*

Item no.	Initials	Gender	Age	Height (cm)	Weight (kg)	BMI	Lower limb length (cm)	BMI/H %
1	CC	F	13	152	65	28.13	80	42.76
2	PM	F	15	165	70	25.71	82	42.42
3	CM	F	15	158	52	20.83	84	32.91
4	MA	F	12	167	48	17.21	87	28.74
5	ED	F	15	167	54	19.36	87	32.34
6	BA	M	12	136	32	17.3	70	23.53
7	VD	M	12	144	42	20.25	75	29.17
8	DȘ	M	13	141	40	20.12	71	28.37

9	TR	M	15	164	60	22.31	82	36.59
10	FC	M	15	171	68	23.53	88	40
11	NN	M	15	164	63	23.42	80	38.41
12	CD	M	13	154	53	22.35	75	34.42
13	BM	M	15	163	58	21.83	74	35.58
14	CM	M	15	189	84	23.52	93	44.44
15	FC	M	15	181	80	24.42	89	44.20

Table 3 shows the anthropometric measurements taken on 20.11.2020 in Petroşani (the Ski Hall of the Petroşani School Sports Club) and their processing for the experimental group.

Table 3. *Anthropometric values and their processing for the experimental group*

Item no.	**Initials**	**Gender**	**Age**	**Height (cm)**	**Weight (kg)**	**BMI**	**Lower limb length (cm)**	**BMI/H %**
1	AI	F	15	162	50	19.05	79	50
2	JC	F	13	163	54	20.32	72	48.91
3	SR	F	13	163	45	16.94	77	46.85
4	SD	F	15	157	56	22.72	58	52.07
5	PA	F	12	143	35	17.12	67	49.33
6	PD	M	14	166	58	21.05	87	44.17
7	TC	M	15	180	62	19.14	90	46.84
8	PS	M	15	169	56	19.61	88	51.76
9	FD	M	13	160	45	17.58	74	48
10	MA	M	15	158	47	18.83	74	52.41
11	GE	M	13	150	44	19.56	74	49.33
12	BE	M	13	150	59	26.22	72	48.00
13	PA	M	14	141	34	17.35	70	47.24
14	MM	M	13	137	36	19.18	67	46.25
15	PR	M	15	170	55	19.03	88	50

The comparative group analysis in terms of anthropometric data is shown in Figure 1.

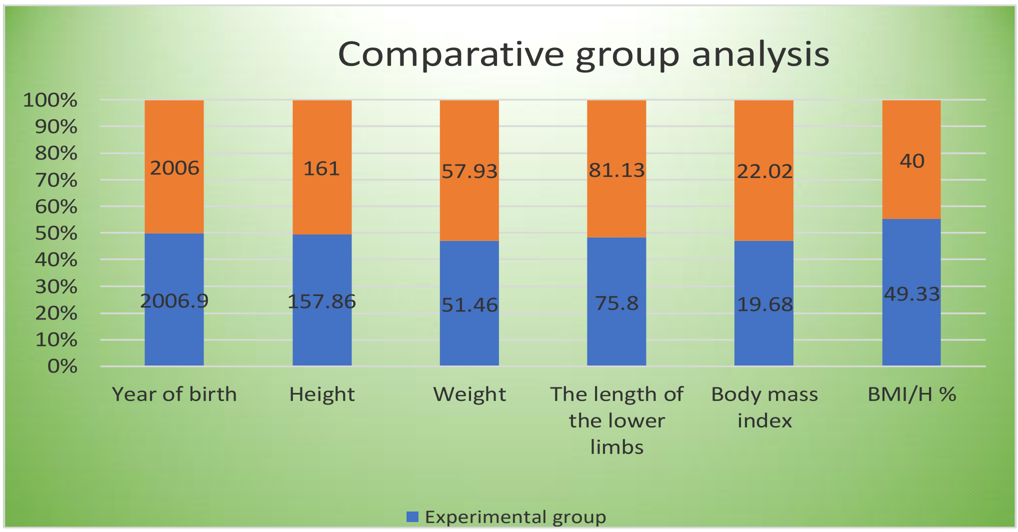


Figure 1. Anthropometric data

Interpretation of the results obtained through anthropometric measurements

In terms of height/weight ratio, a significant percentage of athletes in the experimental group, namely 93.5%, fall into the normal weight category (Neagu & Făgăraş, 2013). As regards the lower limb/height ratio, the length of the lower limbs is greater than half the height for 33.3% of them.

In terms of height/weight ratio, 93.3% of athletes in the control group fall into the same normal weight category (Neagu & Făgăraş, 2013). As regards the lower limb/height ratio, the length of the lower limbs is greater than half the height for 60% of them.

We believe that the position of the centre of gravity is an important factor in alpine skiing performance. Its optimal position according to age and gender for a significant contribution to achieving maximum performance in alpine skiing is an issue to be clarified by further scientific research. The measurements recorded for both groups of athletes have close values, which allows us to state that the groups are similar from an anthropometric point of view.

Physical training assessment

Currently, the FRSB recommends applying the following tests to assess physical training:

1. 30 m Sprint
2. Endurance run - 300 m female and 400 m male
3. Standing long jump
4. Coxofemoral mobility in the anterior sagittal plane
5. Wall-bar hanging leg raises in the pike position at 90º
6. Standing lateral jumps over a 20 cm high bar within 30 seconds
7. 5 successive jumps from squat to squat (maximum distance travelled)

The results of physical training tests for the control group, which were performed on 23.11.2020 in Sinaia, are shown in Table 4.

Table 4. *Results of physical training tests for the control group*

Item no.	Initials	Gender	Year of birth	30 m (sec)	300/400 m (sec)	Standing long jump (cm)	Mobility	Wall-bar hanging leg raises	Lateral jumps	Successive jumps
1	CC	F	2007	4.97	80.73	205	8	16	26	7.4
2	PM	F	2005	4.80	78.46	215	18	30	36	9.8
3	CM	F	2005	5.25	79.61	185	4	30	38	8.9
4	MA	F	2008	5.05	86.46	228	14	28	38	9.3
5	ED	F	2005	5.60	88.73	178	0	22	28	7.6
6	BA	M	2008	4.87	65.45	214	15	20	34	10.5
7	VD	M	2008	5.48	70.87	178	1	10	28	7.6
8	DŞ	M	2007	4.85	88.37	235	12	26	34	9.0
9	TR	M	2005	5.08	60.67	220	10	18	36	9.1
10	FC	M	2005	5.29	62.64	182	4	16	40	8.4
11	NN	M	2006	5.23	84.58	196	12	15	39	8.8
12	CD	M	2007	5.36	85.51	190	8	24	40	8.5
13	BM	M	2006	4.75	83.52	185	6	18	30	8.2
14	CM	M	2005	4.78	84.63	180	6	18	28	8.4
15	FC	M	2005	5.45	68.43	168	5	18	36	7.4

The results of physical training tests for the experimental group, which were performed on 25.11.2020 in Petroșani, are shown in Table 5.

Table 5. *Results of physical training tests for the experimental group*

Item no.	Gender	Year of birth	30 m (sec)	300/400 m (sec)	Standing long jump (cm)	Mobility	Wall-bar hanging leg raises	Lateral jumps	Successive jumps
1	F	2005	4.75	83.55	225	5	8	48	11.4
2	M	2007	5.10	82.20	175	10	10	38	8.2
3	M	2007	5.53	70.82	16	16	17	44.5	8.5
4	M	2005	4.65	71.65	235	1	5	50	11.4
5	F	2008	5.05	86.55	225	10	17	42	7.4
6	M	2006	5.42	81.56	185	7	18	36	8.2
7	M	2005	4.90	80.20	195	7	10	40	10.4
8	M	2005	5.18	66.97	200	18	19	71	8.9
9	F	2008	5.55	89.55	205	8	15	44	8.4
10	M	2005	4.96	60.19	18	3	3	69	9.8
11	M	2008	4.48	76.12	235	5	14	47	8.2
12	M	2008	5.21	85.78	185	9	13	46	9.3
13	F	2006	4.95	88.55	215	5	6	40	10.4
14	M	2007	5.32	93.25	17	7	3	41	10.5
15	M	2005	5.18	66.90	210	18	19	71	8.9

The Romanian Ski Biathlon Federation (FRSB) has developed criteria for evaluating the results obtained in physical training tests by converting the scores achieved into FRSB points, which are customised according to gender and age characteristics. Regarding the category of athletes included in the experiment, the sum of FRSB points is recommended to be 300 for the U14 category (under 14 years old) and 350 for the U16 category (under 16 years old). Figure 2 highlights the comparative results of the experimental group and the control group in terms of the total score obtained.

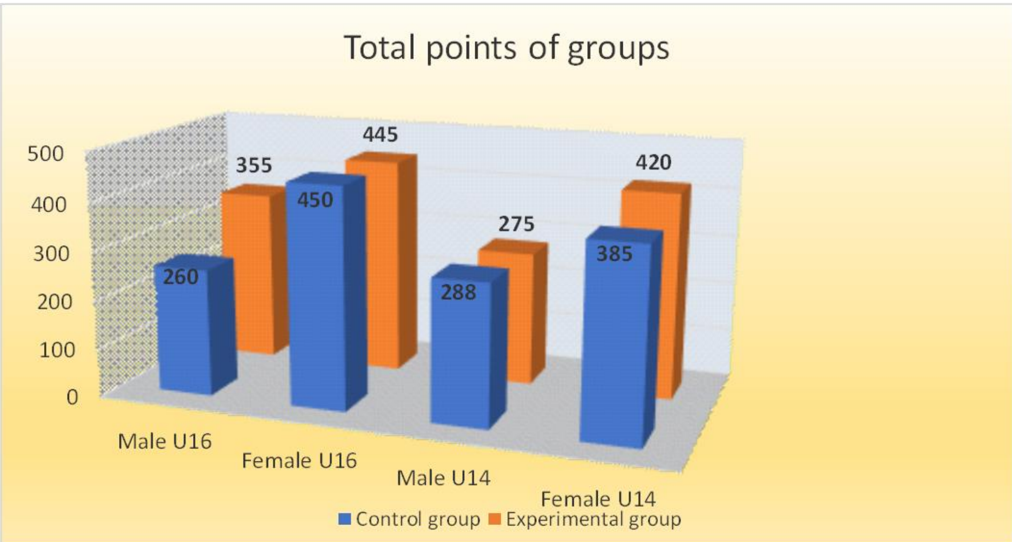


Figure 2. Comparative results of the experimental group and the control group in terms of the total score obtained

Interpretation of the results obtained in physical training tests

The scales (standards) set by the FRSB for these sports categories are exceeded by all female athletes in both the experimental and control groups. For male athletes, only the U16 category of the experimental group recorded values above the FRSB scale, while the other categories did not meet the scales established for the physical training tests. This is mainly due to their poor results in the 400 m run. We believe that one of the causes that have led to this situation was determined by the effects of the pandemic restrictions imposed starting from April 2020 in Romania.

For male athletes in both the experimental and control groups, there are considerable possibilities to increase the value of the obtained results and indirectly of physical training by improving their performance in lateral jumps over a 20 cm high bar within 30 seconds, because this test involves essential anatomical elements for elite alpine skiing.

Results of the technical training levels for the control and experimental groups

After testing all athletes in the control and experimental groups for the standardised slalom route, we summarised the total times of the best 3 runs from the initial and final tests. Table 6 shows the data for the control group.

Table 6. *Summary table for the control group*

		CONTROL GROUP		
Item no.	**First and last name initials**	**Total time - Initial test**	**Total time - Final test**	**Progress**
1	CC	46.09	45.84	-0.25
2	PM	52.12	51.78	-0.34
3	CM	49.99	50.95	0.96
4	MA	52.85	54.23	1.38
5	ED	49.55	50.58	1.03
6	BA	52.90	56.07	3.17
7	VD	52.79	51.99	-0.8
8	DȘ	52.75	47.17	-5.58
9	TR	53.00	56.54	3.54
10	FC	52.53	50.76	-1.77
11	NN	52.09	53.53	1.44
12	CD	51.41	50.41	-1
13	BM	50.36	46.69	-3.67
14	CM	49.26	46.32	-2.94
15	FC	47.80	52.75	4.95

The data collected from the initial and final testing of the experimental group are shown in Table 7.

Table 7. *Summary table for the experimental group*

Item no.	First and last name initials	EXPERIMENTAL GROUP Total time - Initial test	Total time - Final test	Progress
1	AI	49.26	48.30	-0.96
2	JC	49.62	47.18	-2.44
3	SR	51.10	47.80	-3.3
4	SD	48.65	43.73	-4.92
5	PA	49.03	50.11	1.08
6	PD	49.82	43.19	-6.63
7	TC	51.19	52.29	1.1
8	PS	51.84	49.14	-2.7
9	FD	50.30	49.90	-0.4
10	MA	52.13	50.00	-2.13
11	GE	52.84	46.28	-6.56
12	BE	50.21	46.90	-3.31
13	PA	51.81	53.03	1.22
14	MM	62.22	52.24	-9.98
15	PR	49.87	48.82	-1.05

Table 8 shows the descriptive statistics of both tests for the experimental group.

Table 8. *Descriptive statistics for the experimental group*

	Initial testing (IT)	Final testing (FT)
Mean	51.33	48.59
Mean difference (FT-IT)	-2.74	
Median	50	49
Standard deviation	3.3	2.9
Minimum	49	43
Maximum	62	53
Range	14	10
Coefficient of variation	6.3%	5.9%

For the experimental group, the mean total time corresponding to the best 3 runs of the standardised slalom route decreased by 2.74 sec, from 51.33 sec in the initial test to 48.59 sec in the final test. The mean difference falls within the 95% confidence interval (-4.51; -0.95), and the dispersion of times is homogeneous for the experimental group athletes in both testing phases.

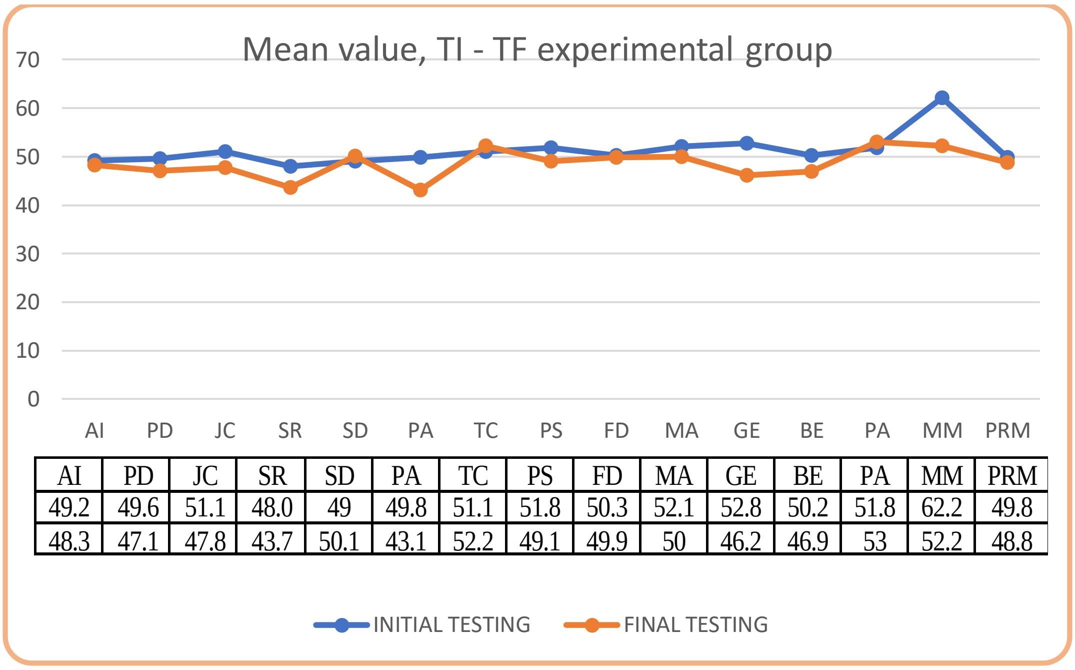
Table 9 shows the inferential statistics for the experimental group.

Table 9. *Two-sided dependent t-test for the experimental group*

STATISTICAL INDICATORS differences between results (TF-TI)					Two-sided dependent t-test		
Mean	Standard deviation	Standard error	95% Confidence interval	Effect size	t	df	p
-2.74	3.21	0.83	(-4.51; -0.95)	0.850	3.29	14	0.0053

In terms of inferential statistics, the mean difference reached the statistical significance threshold, $p = 0.0053 < 0.05$ for $t = 3.29$ and $df = 14$, according to the dependent t-test for paired samples. The effect size (0.85) indicates that the mean difference is large to very large, which rejects the null hypothesis. The decrease in mean total time for the best 3 runs (out of the 5) is statistically significant.

The mean values obtained by the experimental group athletes in the two standardised tests as well as their differences are shown in Figure 3 and Figure 4.



AI	PD	JC	SR	SD	PA	TC	PS	FD	MA	GE	BE	PA	MM	PRM
49.2	49.6	51.1	48.0	49	49.8	51.1	51.8	50.3	52.1	52.8	50.2	51.8	62.2	49.8
48.3	47.1	47.8	43.7	50.1	43.1	52.2	49.1	49.9	50	46.2	46.9	53	52.2	48.8

Figure 3. Initial and final measurements for the experimental group

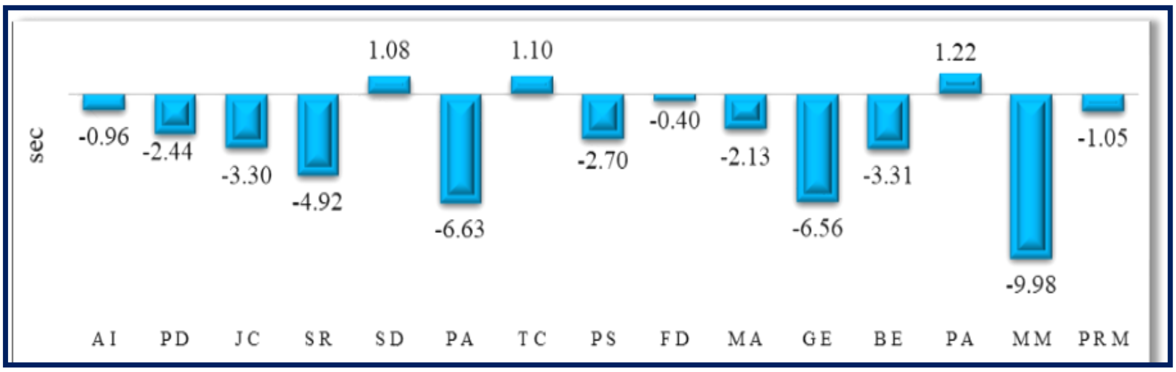


Figure 4. Angle difference for the experimental group

The dynamics and interpretation of the results obtained by the control group are highlighted in Table 10.

Table 10. *Descriptive statistics for the control group*

	Initial testing (IT)	**Final testing (FT)**
Mean	51.03	51.04
Mean difference (FT-IT)	0.01	
Median	52	51
Standard deviation	2.1	3.4
Minimum	46	46
Maximum	53	57
Range	7	11
Coefficient of variation	4.2%	6.6%

For the control group, the mean total time corresponding to the best 3 runs of the standardised slalom route increased by 0.01 sec, from 51.03 sec in the initial test to 51.04 sec in the final test. The confidence interval is between -1.72 and 1.74, and the dispersion of times is homogeneous for the control group athletes in both testing phases. (Figure 5)

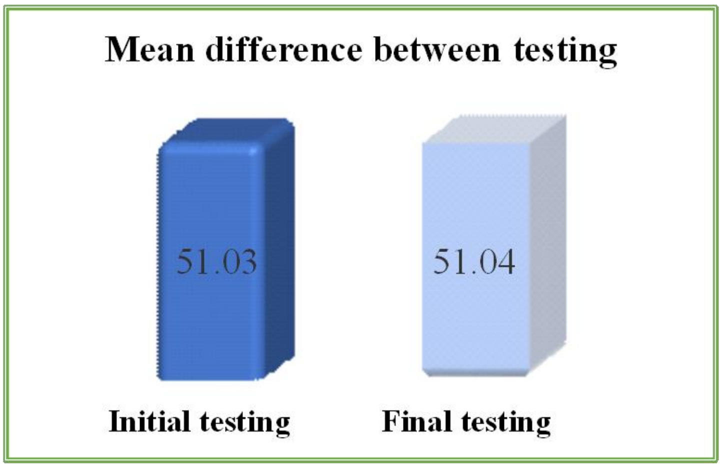


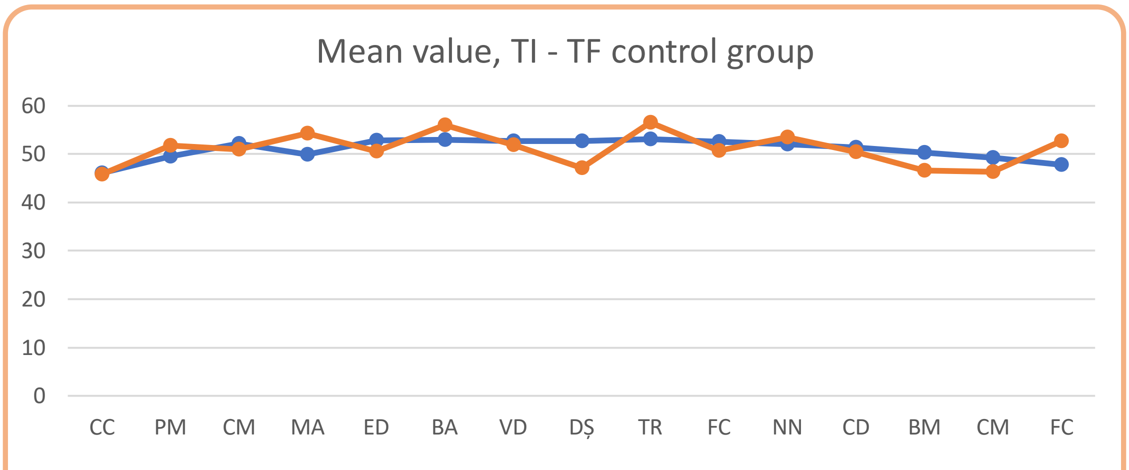
Figure 5. Mean difference between tests for the control group

In Table 11, the dependent t-test for the control group and the resulting differences between the initial and final testing are calculated.

Table 11. *Two-sided dependent t-test for the control group*

STATISTICAL INDICATORS differences between results (TF-TI)				**Two-sided dependent t-test**			
Mean	Standard deviation	Standard error	95% Confidence interval	Effect size	t	df	p
0.01	3.12	0.81	(-1.72; 1.74)	0.003	0.01	14	0.992

In terms of inferential statistics, the dependent t-test for paired samples reveals a statistically insignificant mean difference, $p = 0.992 > 0.05$ for $t = 0.01$ and $df = 14$. No significant increase in mean total time for the best 3 runs (out of the 5) is recorded by the control group. The graphical representation of the mean scores obtained by each athlete in the initial and final testing of the standardised slalom event and their differences are shown in Figure 6 and Figure 7.



CC	PM	CM	MA	ED	BA	VD	DȘ	TR	FC	NN	CD	BM	CM	FC
46	49.5	52.1	49.9	52.8	52.9	52.7	52.7	53	52.5	52	51.4	50.3	49.2	47.8
45.8	51.7	50.9	54.2	50.5	56	51.9	47.1	56.5	50.7	53.5	50.4	46.6	46.3	52.7

Figure 6. Initial and final measurements for the control group

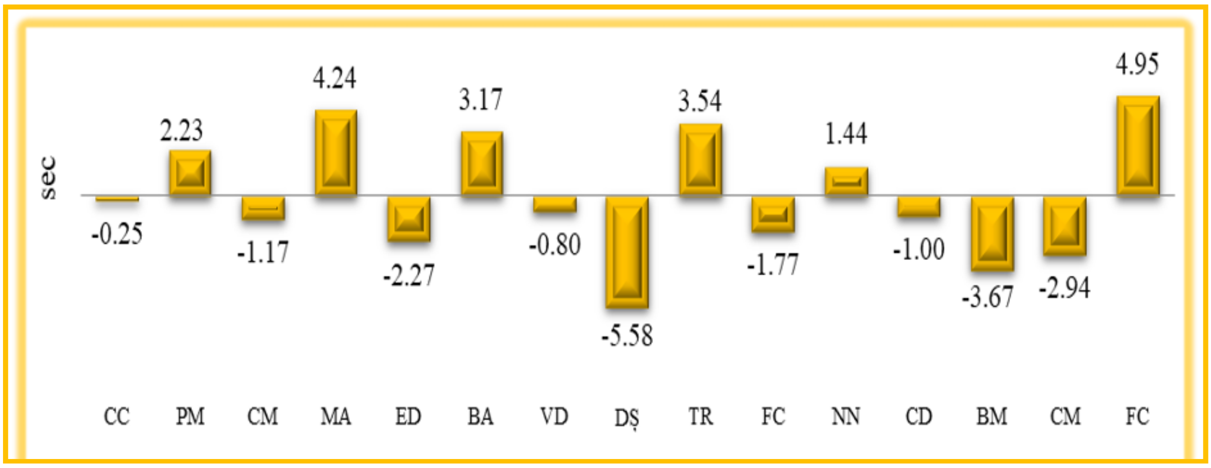


Figure 7. Angle difference for the control group

Regarding the interpretation of the results obtained in the initial testing by the control group and the experimental group, Table 12 highlights the related descriptive statistics.

Table 12. *Descriptive statistics for the initial testing – A comparison between the two groups*

	Experimental group (EG)	Control group (CG)
Mean	51.33	51.03
Mean difference (EG-CG)	0.30	
Median	50.30	52.09
Standard deviation	2.09	2.12
Minimum	48.65	46.09
Maximum	62.22	53.00
Range	13.57	6.91
Coefficient of variation	6.3%	4.2%

In the initial test, the mean total time corresponding to the best 3 runs of the standardised slalom route is 51.33 sec for the experimental group and 51.03 sec for the control group. The dispersion of times is homogeneous for both groups of athletes, and the mean difference between the experimental group and the control group is 0.30 sec (0.6%).

Table 13. *Inferential statistics for the initial testing*

Levene's test for equality of variances		Equal variances	Independent t-test for equality of means					
			Mean difference	Effect size	t	t Critical	df	p
F	Sig.							
0.038	0.847	YES	0.30	0.11	0.292	2.048	28	0.772

According to Levene's test from Table 13, the two groups have equal variances, Sig. = 0.847 > 0.05. The independent t-test for equal variances indicates a significance threshold of p = 0.772 > 0.05 for t = 0.292 and df = 28. The t-test values reveal a statistically insignificant difference between the mean scores of the two groups.

Regarding the interpretation of the results obtained in the final testing by the control group and the experimental group, Table 14 highlights the related descriptive statistics.

Table 14. *Descriptive statistics for the final testing – A comparison between the two groups*

	Experimental group (EG)	Control group (CG)
Mean	48.59	51.04
Mean difference (EG-CG)	-2.45	
Median	48.82	50.95
Standard deviation	2.89	3.38
Minimum	43.19	45.84
Maximum	53.03	56.54
Range	9.84	10.70
Coefficient of variation	5.9%	6.6%

In the final test, the mean total time corresponding to the best 3 runs of the standardised slalom route is 48.59 sec for the experimental group and 51.04 sec for the control group. The dispersion of times is homogeneous for both groups of athletes, and the mean difference between the experimental group and the control group is -2.45 sec (4.8%).

Table 15. *Inferential statistics for the final testing*

Levene's test for equality of variances		Equal variances	**Independent t-test for equality of means**					
F	Sig.		Mean difference	Effect size	t	t Critical	df	p
0.300	0.588	YES	-2.45	0.78	2.130	2.048	28	0.042

According to Levene's test, the two groups have equal variances, Sig. = 0.588 > 0.05. The independent t-test for equal variances indicates a significance threshold of p = 0.042 < 0.05 for t = 2.130 and df = 28. The effect size (0.78) shows that the mean difference between the two groups is large. (Table 15) These results highlight a statistically significant difference between the mean scores of the two groups.

The mean values obtained by the two groups and the times achieved by each individual athlete in the final test are shown in Table 16.

Table 16. *Times achieved by each individual athlete in the final test*

CONTROL GROUP			**EXPERIMENTAL GROUP**		
Item no.	**First and last name initials**	**Total time - Final test**	**Item no.**	**First and last name initials**	**Total time - Final test**
1	CC	45.84	1	AI	48.30
2	PM	51.78	2	JC	47.18
3	CM	50.95	3	SR	47.80
4	MA	54.23	4	SD	43.73
5	ED	50.58	5	PA	50.11
6	BA	56.07	6	PD	43.19
7	VD	51.99	7	TC	52.29
8	DȘ	47.17	8	PS	49.14
9	TR	56.54	9	FD	49.90
10	FC	50.76	10	MA	50.00
11	NN	53.53	11	GE	46.28
12	CD	50.41	12	BE	46.90
13	BM	46.69	13	PA	53.03
14	CM	46.32	14	MM	52.24
15	FC	52.75	15	PR	48.82

In order to have a tool for assessing the technique of alpine skiers, we have developed an evaluation system that can be used in specific conditions (on snow) to test their ability to transfer the skills acquired during the training stages to their actions when passing through gates and gate systems.

The exercises in Table 17 are included in the training system used for the experimental group throughout the 11 weeks of the programme and have been shown to be effective in increasing sports performance. They are organised by age group, with one for each skiing-specific objective (pressure, edging, pivoting, balance), as part of evaluating each particular phase. The grading criteria are revealed in Table 18.

Evaluation (scoring) system

Each exercise is provided with a specific scoring (grading) set that identifies important performance-related aspects of the exercise and relative deductions for any mistakes. The evaluator should focus on execution to observe whether the racer accomplishes the task at a high level in relation to their stage of development, but also to identify any execution errors.

The tests are designed so as to allow the most skilled skiers to get a 10. The scoring system contains information about the grades, execution, and the task to complete in order to be awarded the appropriate grade.

The development of technical knowledge occurs in stages that are related to the individual's rate of growth and physical, psychological, social and emotional maturation. This is a natural, systematic and predictable process. The repeated inclusion of technical exercises in athletic training is necessary for the acquisition of new skills and performance improvement. For this purpose, the following aspects should be taken into account:

- selecting a terrain that meets the requirements;
- providing exercises that correspond to the athlete's age and level of motor skills;
- allowing enough time for the skier to adapt to the requirements of the task received;
- ensuring the success of attempts;
- changing the suitable variables to produce further adaptation;
- being patient with the skiers' progress;
- creativity and inventiveness.

For an accurate and objective analysis, we recommend that the evaluation committee should be made up of at least 4-5 teachers or coaches who will decide later, after watching and analysing the videos taken during the testing sessions. A clear and precise view is obtained with a camera providing a front view of the athlete, and a second one can be obtained from the above using a drone. The analysis and discussions should take place, if possible, immediately after the athletes have completed the test batteries so that the information is fresh in the evaluators' minds.

Table 17. *Exercises for the evaluation of technical skills*

Objectives Age:	**1. 12-13 years (U14)**	**2. 14-15 years (U16)**
a. PRESSURE	1.a. Jumping over cones	2.a. Jumping over cones in the downhill position
b. EDGING	1.b. Turning on the outside ski	2.b. Turning on one ski
c. PIVOTING	1.c. Controlled skid with stop on edge	2.c. Direct descent with successive left-right skids
d. BALANCE	1.d. Giant slalom turns with pole plant	2.d. Giant slalom turns with ski lane change

1.a. Jumping over cones

Description: Eight cones are placed on the ground 8 meters away from each other and at a 90-degree angle to the slope line, with the start positioned 12 meters above the first cone and the finish 12 meters after the last cone. The cones are recommended to be fixed in the snow.

The athlete moves in a straight line from start to finish, jumping over the cones placed on the ground with both skis at a time.

Requirements for the athlete:

- to maintain the straight line,
- not to touch the cones placed on the ground,
- not to lose balance,
- to push both skis off the ground simultaneously,
- to maintain an equal distance between the skis and between the knees,
- to land as smoothly as possible (for shock absorption).

Evaluation: Starting from grade 10, deductions are applied as follows:

- 2 points for deviation from the straight line (from start to finish);
- 1 point each time the skis touch a cone;
- 1 point for each jump or landing that is not performed on both feet simultaneously;
- 1 point for spreading the legs or bringing them together;
- 1 point for each loss of balance on landing.

1.b. Turning on the outside ski

Description: Free skiing, giant slalom turns by lifting the uphill ski and crossing its tip over the downhill ski (support ski).

Requirements:

- the trunk position must permanently remain downhill-oriented,
- the fists must face forward,
- the support ski must be on the edge,
- the tip of the downhill ski must be X-shaped over the support ski.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 1 point for each contact of the inner ski with the snow;
- 1 point for each pole contact for balance;
- 1 point for each turn that is not performed with the outside ski on edge;
- 1 point for each turn where the trunk position is not downhill-oriented;
- 1 point for each form of incomplete turn.

1.c. Controlled skid with stop on edge

Description: From the basic position, a 15-meter direct descent followed by controlled skid with a 90-degree pivot turn on both skis so as to completely stop on edge after 6 metres, marking the stop by pole planting and holding in the snow for 2-3 seconds. One downhill run is performed on each side (left and right).

Requirements:

- the trunk position must permanently remain downhill-oriented,
- the descent must be parallel to the slope line,
- the pivot turn of the skis must be at 90 degrees,
- the stop must be marked by pole planting and holding in the snow for 2-3 seconds.

Evaluation: The total score is the average of the grades obtained for the left and right sides. Starting from grade 10, deductions are applied as follows:

- 5 points for lifting the ski to perform the pivot turn;

- 1 point for every 2-meter deviation from the slope line (to the left or right side);
- 1 point for trunk rotation simultaneously with pivoting;
- 1 point for failure to keep the edge and finish position fixed for 2-3 seconds at the end.

1.d. Giant slalom turns with pole plant

Description: The athlete performs 6-8 giant slalom turns with pole plant to initiate the turn phase.

Requirements:

- the balance must be maintained throughout the exercise,
- the turns must be round and connected to keep the speed constant during the exercise,
- the trace left by the skis must be skid-free.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 2 points for each imbalance;
- 1 point for each turn that is not round and complete;
- 1 point for each turn where the speed is not maintained;
- 1 point for each skidded turn;
- 1 point for each turn where the pole plant is not performed.

2.a. Jumping over cones in the downhill position

Description: Eight cones are placed on the ground 8 meters away from each other and at a 90-degree angle to the slope line, with the start positioned 12 meters above the first cone and the finish 12 meters after the last cone. The cones are recommended to be fixed in the snow. The athlete moves in a straight line from start to finish in the downhill position ("egg" or "half-egg" position) jumping over the cones placed on the ground with both skis at a time.

Requirements for the athlete:

- to maintain the straight line,
- not to touch the cones placed on the ground,
- not to lose balance,
- to push both skis off the ground simultaneously,
- to maintain an equal distance between the skis and between the knees,
- to land as smoothly as possible (for shock absorption),
- to maintain the downhill position throughout the exercise.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 2 points for deviation from the straight line (from start to finish);
- 1 point each time the skis touch a cone;
- 1 point for each jump or landing that is not performed on both feet simultaneously;
- 1 point for spreading the legs or bringing them together;
- 1 point for each loss of balance on landing.

2.b. Turning on one ski

Description: Six giant turns with an average radius of 15-30 metres are performed on a single ski. The athlete wears only one ski (the other being left at the start) and demonstrates their skills with the left leg and then the right leg.

Requirements:

- the ski-free foot must not touch the snow throughout the exercise,
- the poles can be planted but cannot be used as permanent support on snow for balance.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 1 point for each pole contact for balance;
- 1 point each time the ski-free foot touches the snow;
- 1 point for each turn that is not performed with the outside ski on edge;
- 1 point for each turn where the trunk position is not downhill-oriented;
- 1 point for each form of incomplete turn.

2.c. Direct descent with successive left-right skids

Description: From the basic position, a 15-meter direct descent followed by the simultaneous ski pivoting to the left and then to the right, maintaining the skid over a distance of 5-6 meters on each side. Four consecutive skids are performed on each side.

Requirements:

- the trunk position must permanently remain downhill-oriented,
- the skis must reach a position perpendicular to the slope line,
- the skier must remain in the same direction, without deviations from the slope line,
- the skis must pivot simultaneously,
- the skier must maintain the travel speed during the exercise.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 5 points for lifting the ski to perform the pivot turn;
- 1 point for every 2-meter deviation from the slope line (to the left or right side);
- 1 point for trunk rotation simultaneously with pivoting;
- 1 point for failure to keep the edge and finish position fixed for 2-3 seconds at the end.

2.d. Giant slalom turns with ski lane change

Description: The slope is imaginarily divided into three lanes of 5 metres wide each. Athletes first perform 3 turns in the first lane, then cross the middle lane and perform 3 turns in the opposite extreme lane; they cross the middle lane again and perform 3 turns in the first lane. Finally, they perform 6-9 crossings and a maximum of 10 sets of turns per exercise.

Requirements:

- the balance must be maintained throughout the exercise,
- the turns must be round and well defined,
- the speed must be kept constant during the exercise,
- the pole plant must be used to mark the initiation of the turn phase.

Evaluation: Starting from grade 10, deductions are applied as follows:

- 2 points for each imbalance.
- 1 point for each turn that is not round and complete.
- 1 point for each turn where the speed is not maintained.
- 1 point for each skidded turn.
- 1 point for each turn where the pole plant is not performed.
- 1 point for deviation from the lane boundaries.

Table 18. *Grading criteria*

Grade	Description	Execution	Task
10	Perfect	Flawless execution	Nothing to change
9	Remarkable	A small change is needed	A minor change
8	Excellent	A few small changes are needed	A turn or a small mistake that can be easily corrected
7	Very good	The skills are refined	A few mistakes that need a slight adjustment
6	Good	The skill level is above average	Task performance is above average
5	Average	The skill level is average	Task performance is average
4	Fair	Appropriate skills	No problem with task performance, although some adjustment is needed
3	Mediocre	Substandard skills	Slight problems with task performance, so some improvements are needed
2	Poor	Vague demonstration of skills	Task performance is vague
1	Very poor	Extremely poor skills	Task performance is hard to distinguish
0	Unable	Nothing resembles the requirements	The task is unrecognisable

Discussion and Conclusion

The results obtained from our research highlight the following aspects:

The element of originality in this paper is the development of a methodological system aimed at evaluating the on-snow technique of alpine skiers, which complements the already existing general and specific motor skill tests performed on dry land.

The selected tests provide teachers and coaches with new opportunities for diversifying training sessions and thus make them much more attractive for athletes. We are confident that this is only a start in developing the imagination of specialists in the field, who can carry on this research by refining the standards.

The proposed tests have improved the athletes' technique and their motor skills. "Identifying the optimal approach and time to concurrently develop these systems is a challenge for sport scientists. Further research is required using modern portable investigative tools for determining aerobic and anaerobic demands and abilities, especially in the areas of muscle function and relative energy system contribution during both single and multiple runs on varying terrains." (Turnbull et al., 2009)

The discussions with fellow coaches across the country (who are active in alpine skiing) have revealed positive but also negative aspects regarding the technical testing of athletes aged 12-15 years. Romanian specialists have unanimously agreed that on-snow testing is needed for our skiers, but not all of them have agreed with the proposed exercises. From these discussions, we will present below only a few fragments:

The idea of implementing an action focused on the technical aspect is very good, given that alpine skiing is a predominantly technical sports discipline. I am a supporter of school skiing and believe that elite and top-elite alpine skiing cannot exist without a sound technical foundation. I think that, in the initial form of the proposed material, there are too few exercises to make a complete evaluation; at the same time, some exercises or benchmarks chosen to be followed do not seem relevant for current alpine skiing.

Coach,
Andrei Szilagyi

Evaluating an athlete's technique is certainly a challenge for the team of technicians involved. The complexity of the turn in alpine skiing also entails some difficulty in evaluating the technical execution. Identification of the simplest and most accessible means to perform technical evaluation falls within the competence of technicians with experience in the field of alpine skiing. Thus, breaking down the turn into phases can help the teacher-coach to evaluate, from a technical point of view, the turn in alpine skiing.

I believe that this ***methodological system for testing the technique of alpine skiers*** *is appropriate for the specified age categories and is also a good evaluation tool.*

Teacher-coach
Viorel Sebastian Selejan, CSS Baia Sprie

Interesting exercises, I agree with them and they will certainly help us and the athletes!!!

Coach
Andrei Burchiu

Alpine skiing competitions involve the complex integration of many different physiological systems, none of which can be more important than the other for overall performance. While technical ability appears to be the major performance-influencing factor, "the ability to continually exhibit technical competence through a long competitive season requires high capabilities with all physiological systems" (Turnbull et al., 2009).

We hope that our study will be accepted by the Alpine Skiing Technical Committee and adopted by the Steering Committee of the Romanian Ski Biathlon Federation in order to be implemented as mandatory technical on-snow testing, at least for the national team members in the U14 and U16 categories.

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