EVALUATING THE EFFECTS OF INNOVATIVE TRAINING METHODS ON ALPINE SKI PROFICIENCY BASED ON PREVIOUS BALANCE STUDIES

UČINAK EKSPERIMENTALNOG TRENINGA TEMELJENOG NA PRETHODNIM STUDIJAMA RAVNOTEŽE NA IZVEDBU U ALPSKOM SKIJANJU

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SUMMARY

In the global context of skiing, discussions about ski training methods are the subject of ongoing academic and practical debate. Research efforts focus on achieving optimal outcomes in the learning process. The "Bulgarian Ski School" aims to improve the quality of training for beginners by transferring natural human coordination into alpine skills, considering the specifics of ski equipment. Our previous laboratory studies on stabilographs found that vertical movements ("up and down") result in considerable fluctuations in the projection of the center of gravity, contributing to "loss of balance" situations. Therefore, the aim of this study was to investigate the effectiveness of training in alpine skiing skills without the use of vertical movements.

The sample included 100 novice skiers aged 17-18, randomly divided into a control and an experimental group, each consisting of 50 subjects. They underwent a 10-day course on Vitosha Mountain, following two different pedagogical approaches: the standard Bulgarian ski school method and a method with minimal "vertical" movements, such as folding and unfolding, at the early stages of the course. Three experts evaluated their skills through 17 tasks, and the mean grade for each task was recorded. The evaluated tasks were then divided into four levels according to complexity.

The experimental group performed better in tasks such as basic turns without folding and unfolding, exhibited better posture and balance, improved direction changes, and demonstrated better control of skis during turns. It appears that this new training method, based on natural human coordination, made alpine skiing coordination,

SAŽETAK

U globalnom kontekstu skijanja, rasprave o metodama obuke skijanja predmet su kontinuirane akademske i praktične rasprave. Istraživački napori usmjereni su na postizanje optimalnih ishoda u procesu učenja. "Bugarska škola skijanja" nastoji poboljšati kvalitetu obuke za početnike prijenosom prirodne ljudske koordinacije na znanja alpskog skijanja, uzimajući u obzir specifičnosti skijaške opreme. Naša prijašnja istraživanja u laboratoriju uz upotrebu stabilografa su utvrdila da kretnje uzduž okomite osi rezultiraju značajnim fluktuacijama projekcije težišta, što doprinosi situacijama gubitka ravnoteže. Stoga je cilj ovog istraživanja bio istražiti učinkovitost obuke u alpskim skijaškim vještinama bez upotrebe naglašenih kretnji podizanja i spuštanj au ranoj fazi obuke.

Uzorak je uključivao 100 skijaša početnika u dobi od 17-18 godina, nasumično podijeljenih u kontrolnu i eksperimentalnu skupinu, svaku s 50 ispitanika. Prošli su 10-dnevni tečaj na planini Vitosha, prateći dva različita pedagoška pristupa: standardnu metodu bugarske škole skijanja i metodu s minimalno kretnji duž okomite osi u ranim fazama tečaja. Tri eksperta su ocjenjivala njihove izvedbe kroz 17 skijaških zadataka, a prosječna ocjena za svaki zadatak je zabilježena. Naknadno je tih 17 zadataka podijeljeno u 4 kategorije prema složenosti.

Eksperimentalna skupina je bolje izvodila zadatke poput osnovnih zavoja, pokazala je bolje pozicije na skijama i ravnotežu, bolje kontrole promjene smjera i bolju kontrolu skija tijekom zavoja. Ova nova metoda obuke, temeljena na prirodnoj ljudskoj koordinaciji je naizgled olakšala savladavanje koordinacije, ravnoteže i znanja u alpskom skijanju. Ovi rezultati bi se trebali primijeniti u praktičnim

balance, and skills easier to master. Experimental training significantly improved several critical aspects of acquiring alpine skiing skills.

These results should be translated into practical educational approaches for ski beginners, as they would improve their abilities and confidence on the slopes

Key words: *alpine skiing skills, vertical movements, balance, new ski teaching method*

pristupima za obuku početnika jer bi poboljšali njihove sposobnosti i samopouzdanje na stazi.

Ključne riječi: *alpsko skijanje, znanje skijanjan, vertikalni pokreti, ravnoteža, nova metoda podučavanja skijanja*

INTRODUCTION

Factors affecting the trends in ski training and methodic approaches (10, 11) are the development of the ski industry, the activity of the World Ski Association of Ski Teachers in snow sports "Interski," the ski style of the champions, and the appearance of new snow sports and disciplines.

Examining the curricula of elementary training in the alpine skiing technique of the different schools, we summarized similar methodical approaches in building essential skills (2,3,4,10). The authors (5) presented exercises for developing the skill of unloading by folding and unfolding. A review of Austrian (6) and German methodics (3) describe training exercises in straight descent and plough turns using vertical movements. The Swiss approach (2) presents folding and unfolding (loading and unloading) during straight descent and change of direction.

In description of skiing skills, the reliability is related to technical precision in performing exercises, while stability is determined by the ratio of successful to unsuccessful repetitions of the exercises (1). This interpretation of alpine skiing skills finds a place as "reliability" is expressed in the precise execution and coordination of basic alpine skills, and "stability" takes center stage when discussing ski balance. Another winter sport which shares the same problem (8) is figure skating, as the amplitude increases, the equilibrium fluctuations increase and establish a dependence between the equilibrium and the anthropometric indicators of the figure skaters.

On the other hand, arguments were presented showing the negative influence that vertical movements had on the initial stage of training. Our study of the balance stability of (9) found that in vertical movements (folding and unfolding), students who had never skied lagged and maintained unstable balance. Modern ski equipment, on the one hand, has provided excellent stability to all skiers, including beginners. However, on the other hand, it allows them to drive incorrectly and feel confident. The results of our previous studies showed the violation of equilibrium stability when using virtul reality glasses, which recreate a dynamic environment. This directly impacts the

projection of the centre of gravity, which is moved to the border of the longitudinal support area backward. This finding underscores the importance of ski balance and visual perception. In case of 6-7-year-old children of both sexes, insignificant fluctuations of the centre of gravity projection are observed when visual perception is affected by recreating virtual reality. This thesis is supported by other data, where the authors (4) found in a study of postural stability of healthy children that girls swayed less than boys during the age interval of 5-8 years. Adult-like use of vision for permanent balance is reached by the age of 10 years. Evidence that the reversal of the postural strategy points to the quiet position is at age eight years and more pronounced in girls.

Another key finding of our previous study is the restriction of movement in the ankle joint when using a ski boot, particularly when taking a 'half-squat' position (low skier's stance). This restriction is observed in beginners, who tend to lag behind in relation to the longitudinal support area. When unfolding, the projection of the centre of gravity varies on the sole of the stronger leg, which in ski training negatively affects the control of both skis. This finding highlights the practical implications of the ski boot's design on ski balance and control, and warrants further investigation for potential improvements in ski training.

The 'Bulgarian Ski School' actively participates in scientific and professional events, forging partnerships with scientific and research organizations. The idea of researching the effect of a new approach in skiing training is a practical project, based on a scientific initiative carried out by the 'Center for Scientific and Applied Activity' in Sports at the 'Vasil Levski' National Academy of Sciences Sofia. The topic of this project, 'The study of balance stability in alpine skiing', holds significant implications for the ski industry.

That is why the aim of the present study was to investigate the effectiveness of training in alpine skiing skills without the use of vertical movements, a potential game-changer in ski training methods as in vertical movements "bend to a semi-squat and hold for 10 seconds" and "stand up to a relaxed standing position" with ski boots, we found the

most considerable amplitude fluctuations of the projection of the centre of gravity to the "loss of balance" situation in previously mentioned studies.

SUBJECTS AND METHODS

The sample included 100 novice skiers aged 17-18, randomly divided into a control and an experimental group, each consisting of 50 subjects. They underwent a 10-day course on Vitosha Mountain, following two different pedagogical approaches. The experimental approach was developed based on previous laboratory studies of ski balance, which utilized a stabilograph with ski boots and virtual reality glasses to impact visual perception by recording skiing. These stabilographic studies confirmed the negative influence of vertical movements on training novice skiers in basic alpine skills.

For this reason, in the expert evaluation of alpine skiing skills, we used an advanced evaluation system based on additional criteria obtained from Zgurovski et al. (9,10). The control group followed the standard Bulgarian ski school methodology. Three experts evaluated their skills, and the mean grade for each task was recorded. Each element was evaluated according to a six-point system by three experts and recorded in a protocol, with the final result being an average. The statistical data processing included variational and comparative analysis of selected indicators.

The content of the training methodology in alpine skiing technique, as indicated in the curriculum of the Bulgarian Ski School, is analyzed and presented in Table 1 for the control group. Certain modifications were made

to the protocol of teaching in the experimental group, the main ones being:

- Vertical movements were removed (folding/unfolding; loading/unloading) to avoid problems related to frontal balance, such as backsliding and loss of ski control. Lightening and weighting are skills that are actively used in turns with parallel skis.
- New exercises were included based on natural human coordination, such as walking, to more easily master the transfer of weight and the handling of the pole.

RESULTS AND DISCUSSION

Table 2 presents the evaluation criteria according to which evaluations are given on a six-point evaluation scale, along with the averaged results of all examined individuals for individual alpine skiing skills and statistical indicators. For a more detailed analysis, we grouped the evaluation criteria according to the type of alpine skills. The data in the table indicate that the scores obtained by the experimental group were significantly higher than those obtained by the control group. The difference between the means ranges from a minimum of 0.22 to a maximum of 1.47, indicating that the difference in results between the two groups is considerable.

This substantial difference in results suggests a potentially important distinction between the two groups. The significant differences observed are likely because constructing the alpine stance using a half plough is more accessible than the formation and use of parallel skis.

Table 1.   Content of the exercises included in the training of the experimental and control groups.
Tablica 1. Metodički sadržaj vježbi uključenih u obuku eksperimentalne i kontrolne skupine.

Experimental group	Control group
- First steps (walking on level ground)	- First steps (walking on level ground)
- Types of climbing	- Types of climbing
- Types of reversal	- Types of reversal
- straight descent	- straight descent
- types of racks: with front, middle, and rear loading	- types of racks: with front, middle, and rear loading low, medium, high
- types of balance: lateral, frontal balance	- types of balance: lateral, frontal, and vertical balance
- straight descent->snow plough with front/middle strand	- straight descent->snow plough with unloading
- arch with a weight transfer plough with minor deviations close to the slope line	- bow with a plough with ease in targeting
- diagonal skiing in semi-plough	- diagonal descent with parallel skis
- basic turn rough shape without unloading	- basic turn rough shape with unloading
- basic turn fine form without unloading	- basic turn fine form with unloading
- a turn with parallel skis with walking guidance and driving the pole	- a turn with support on the top with high unloading, with a pole drive
- a turn with parallel skis with high unloading with a pole drive	- a turn with parallel skis with high unloading with a pole drive

Table 2. Evaluation criteria results of control and experimental group
Tablica 2. Rezultat kriterija ocjenjivanja kontrolne i eksperimentalne skupine

Tasks at each skiing skill level	Evaluation criteria	Experimental group results	Control group results	Absolute difference d	Percentage difference d[%]
1	Ski control/downhill	5.41	4.31	1.10	20.33
	Weight distribution/straight descent	5.60	4.39	1.21	21.61
	Posture/Straight Down	5.44	4.51	0.93	17.1
	Ski and speed/snow plough control	5.48	4.38	1.10	20.07
	Weight Distribution/Snow Plough	5.76	4.29	1.47	25.52
	Posture/Snow Plough	5.35	4.42	0.93	17.38
2	Ski control when turning with a snow plough	5.44	4.51	0.93	17.1
	Weight transfer when turning with a snow plough	5.47	5.25	0.22	4.02
	Posture/bow with plough	5.38	4.33	1.05	19.52
3	Ski control/Diagonal descent	5.35	4.02	1.33	20.35
	Weight distribution/Diagonal descent.	5.26	4.03	1.23	19.46
	Alpine stance/side bending	5.34	4.12	1.22	21.07
4	Main turn/diagonal transitions and plough turn/orientation to LN	5.42	4.05	1.37	25.28
	Basic turn rough shape without unloading	5.35	4.17	1.18	22.06
	Basic turn fine form without unloading/ connection between plough and parallel skis in turn control	5.25	4.2	1.05	20
	1. Parallel ski turn with walking guidance and pole driving/pole coordination, parallel ski cantering and weight transfer 2. A turn with support on the top with high unloading, with a pole drive	5.28	4.32	0.96	18.18
	High Unloading Parallel Ski Turn with Pole Loading/Unloading, Pole Coordination, Parallel Ski Canter and Weight Transfer	5.12	4.22	0.90	17.58

Table 3 presents the statistical values characterizing the variable values of the individual evaluation criteria. The difference in the average arithmetic value (estimate achieved by the subjects) between the two groups is 1.07.

The lowest mean score (min) for alpine skill in the experimental group was obtained for the criterion "High unloading parallel ski turn with pole driving/unloading, coordination of pole use, cantering with parallel skis and weight transfer " - 5.12. In the control group, the lowest mean score was for the "Ski control/Diagonal descent" criterion.

The maximum average value (max) for the experimental group was on the test criterion "Weight distribution/snow plough" - 5.76, and for the control group - "Bow weight transfer with low" - 5.25. These criteria fall into the same group of "support turns."

The low values of the R- range indicate that the data is highly consistent, which is also evident in the table. The sample is homogeneous because the coefficient of variation V% for the scores of the experimental and control groups is less than 10%. The sign's dispersion is small, as shown by the standard deviations (standard deviation), which ranges from 0.14 to 0.28.

Table 3.   Mean values and dispersion indices of the studied tasks
Tablica 3.   Srednje vrijednosti i indeksi disperzije proučavanih zadataka

	Experimental group	Control group
average	5.39	4.32*
STDV	0.14	0.28
min	5.12	4.02
max	5.76	5.25
R	0.64	1.23
V	3%	7%

*asterix represents significant difference at level p<0.05

In alpine ski training, folding and unfolding are not just mechanical actions. They are much more than that - they are a precise process that requires exceptional fine motor skills, good coordination, a harmonious relationship between the body and the equipment, and the control of muscle groups. In our opinion, flexion aids in controlling roll (horizontal movement) and is a type of muscular effort through which pressure is controlled. Unfolding, on the other hand, reduces pressure and makes the skier more unstable. Fine motor skills also include integrating body and mind, and the skier must be able to adapt his movements to the changing terrain conditions.

This requires not only physical coordination but also mental concentration and awareness. After all, the folding and unfolding movements in alpine skiing are not simply mechanical actions but communication between the skier and the equipment. They require careful interaction and feeling of the reactions of ski boots and skis to achieve optimal control. Therefore, it is too early in initial training to form such a unique interaction between skiers and equipment; rather than the results obtained, it negatively affects the learning process.

In the next step we systematized the results of the evaluated tasks into four groups (table 4) in order to see if at all skill levels the experimental groups performed better. The tasks were described in Table 1.

Table 4.   Average scores of different levels of alpine skiing skills for experimental and control groups
Tablica 4.   Prosječna ocjena više razina ocjenjivanih zadataka alpskog skijanja za eksperimentalnu i kontrolnu grupu

Alpine ski skill levels	Experimental group	Control group
Tasks level 1	5.51	4.38*
Tasks level 2	5.43	4.70*
Tasks level 3	5.32	4.06*
Tasks level 4	5.28	4.19*

*asterix represents significant difference at level p<0.05

As the experimental group performed better at all four levels we tried to analyse the components to understand a little better the possible underlying mechanisms:

At Tasks Level 1: The higher scores achieved by the experimental group can be explained by several factors influencing the skiers' technique and performance. First, the improved results may be due to the reduced use of vertical movements in their technique. Vertical movements can result in improper body posture or uneven weight distribution during descent. By avoiding these movements, skiers can maintain better control of their skis and more easily maintain stability while skiing. When folding or unfolding, one ski often bears more stress due to the dominant leg. Proper weight distribution is essential for maintaining stability during descent.

At Tasks Level 2: In the experimental group, a simplified steering technique was used in the turns, involving only the transfer of weight from one ski to the other, with both skis already angled for the turns from the plough position. This simplified approach contributed to greater efficiency and better control over the skiers' movements. Additionally, students in this group performed minor deviations in a "plough turn" close to the slope line. In contrast, the control group used the standard approach of high lightening and weight transfer during cornering, which led to issues such as upright posture, lagging behind, and impaired balance. This approach can cause additional movements or compensations, making it difficult to control the skis during turns.

At Tasks Level 3: The development of the alpine stance in skiing begins with the first steps of learning to ski, when skiers engage in step climbing. Knowing the correct alpine stance and adapting to the slope is essential. One of the most challenging exercises is the diagonal descent, as students often struggle to form the correct alpine stance. In the experimental group, the alpine stance was learned with skis placed in the "semi-parallel" position instead of parallel. Half-plough skis provide more support and stability, which likely contributes to the easier formation of the correct alpine posture. This more stable base probably helps students feel more secure and confident, leading to higher grades compared to those learning with parallel skis. Diagonal descent emphasizes further development of alpine skiing technique and side bending as an alpine stance, transferring them to the fourth group of criteria of alpine skiing skills—the turns with facilitated guidance and the turns with parallel skis.

At Tasks Level 4: The experimental group adopted a simplistic approach to targeting, not fully addressing the "facilitation" concept in the second group of criteria. Instead of the support turn, a "walking lead" turn was performed. This approach is seen as a close coordination task for students who demonstrate good coordination when using the pole and transferring weight. Introducing this simplified technique to the experimental group probably contributed to the higher ratings they received.

CONCLUSION

The experimental program significantly improved several critical aspects of alpine skiing skill acquisition. These positive results represent a substantial advance in developing practical educational approaches for beginners, enhancing their ability and confidence on the piste. The higher success achieved by the experimental group is likely due to a combination of factors, including the minimization of vertical movements, which leads to better control of the skis and improved weight distribution. This, in turn, results in overall better mobility in the ski position. The simplified cornering technique applied in the experimental group likely contributes to these better results by avoiding the high unloading and additional movements characteristic of the control group. This approach allows for more efficient and smooth execution of the technique, leading to the higher ratings observed for the experimental group.

The experimental group's use of skis in the "semi-relaxed" position may provide advantages in learning the alpine stance, such as additional stability, increased heaviness of the lower ski, lateral bending, and the typical asymmetry of skis oriented to the traverse. Diagonal descent and side bending are essential elements of the alpine skiing learning process. They help develop skiers' technique and skills, providing them with the necessary abilities to handle different gradients on the piste, particularly in cornering with ease and turning with parallel skis. The walking steer turn is an excellent example of transferring natural to alpine coordination by building three complex skills: pole handling, canting, and weight transfer. We believe that these factors are the primary reasons for the better results recorded among students in the experimental group.

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