

CORRELATION BETWEEN BALANCE, SPECIFIC ALPINE SKIING KNOWLEDGE AND SITUATIONAL EFFICIENCY IN ALPINE SKIING

Vjekoslav Cigrovski, Ivica Franjko, Tomislav Rupčić,
Marijo Baković and Bojan Matković

University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia

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Abstract

A highly developed dynamic balance contributes to performance in competitive alpine skiing. This research was conducted to determine the correlation between balance and the acquired level of alpine skiing knowledge in recreational level skiers. In addition, another goal was to determine the correlation between the acquired level of alpine skiing knowledge and giant slalom results of recreational level skiers. 69 participants (23.3 ± 1.66 years old) who had never tried alpine skiing took part in this study. At the beginning of the research, all participants were tested on a balance evaluation test, after which they spent ten days learning alpine skiing. After finishing structured program of alpine ski school, all were evaluated on six elements of skiing technique and were timed in the giant slalom discipline. Regression analysis was used to establish a statistically significant correlation between the level of acquired alpine skiing knowledge and BAL40 test results, as well as the results in giant slalom discipline ($R=0,68$; $p<0,00$). Among the predictor variables, only the results achieved in the basic turn test ($Beta=-0,44$; $p=0,01$) and the short turn test ($Beta=-0,33$; $p=0,02$) independently contribute to participants' results in the giant slalom discipline. We have not established a separate contribution of the BAL40 test results to the results of the participants' situational efficiency in alpine skiing. The conclusion can be made that basic elements of alpine skiing should not be omitted during structured programme of alpine ski school while they are later incorporated in advanced and competitive elements of skiing technique.

Key words: alpine skiing school, alpine ski beginners, dynamic balance, giant slalom

Introduction

Alpine skiing is a specific and extremely widespread recreational level physical activity (Tate, 2007). The most efficient way to learn the basics of this popular snow sport is by finishing an alpine ski school programme. The common denominator of alpine ski schools is teaching as many participants alpine skiing in the shortest possible time period possible (Žvan et al., 2015). In order to succeed in doing so, ski instructors have been developing the most efficient programmes for learning alpine skiing, at the same time taking account all pedagogic rules and principles. Modern skiing equipment which is exceptionally well adapted to skiers' knowledge, morphological characteristics and abilities, facilitates the acquisition of alpine ski knowledge. On the other hand, participants of alpine ski schools are often beginners or skiers with a low level of skiing knowledge, so their drive for learning greatly determines progress and in fact efficiency of alpine ski schools. Besides mentioned, participants' level of physical fitness and preparedness also affects efficiency of alpine ski learning, and directly prevents injuries (Aerenhouts et al., 2015). Previous research showed how explosive strength, among the most important motor abilities for competitors in alpine skiing, is not however crucial in the process of learning the basics of this sport (Cigrovski et al., 2012; Huber et al., 2015). Meanwhile, balance is equally important both for skiing competitors and for recreational level skiers. Alpine ski beginners with balance developed at a higher level are much faster in acquiring skiing knowledge compared to those whose balance is on a lower level (Kostelić, 2005;

Ružić et al., 2008; Cigrovski et al., 2009). According to the research of Malliou and associates (2004), examinees that had additional 20-minute balance training on a balance platform in ski boots as a part of alpine ski school, were more successful in two agility tests in ski boots, as well as in slalom discipline and acquisition of snowplough technique. In addition, research also proved that process of learning basics of alpine skiing has a positive effect on development of dynamic balance (Wojtyczek et al., 2014). With respect to highlighted factors contributing efficiency of alpine ski learning process, this study aimed to determine correlation between dynamic balance and level of acquisition of motor knowledge in alpine skiing as well as the correlation between balance and situational efficiency in the giant slalom discipline of recreational level alpine skiers.

Methods

Participants

This study included 69 students (41 males and 28 females, average age of 23.3 ± 1.66) of the Faculty of Kinesiology University of Zagreb. Prior to taking part in this research, none of the participants had previous experience in alpine skiing.

Variables

The set of predictor variables in this research was composed of participants' results in the BAL40 balance evaluation test, as well as their knowledge of six elements of ski technique. Participants' level of acquired alpine ski knowledge was determined

by assessing the traversing, uphill turn, snowplough turn, basic turn, parallel turn and short turn. Participants demonstrated the mentioned skiing technique elements in front of independent judges, and based on their demonstrations they were evaluated using grades between one and five. The BAL40 balance evaluation test was performed on a measuring instrument with dimensions 170.00 cm X 22.00 cm. The height of the basic edge was 2.5 cm, whereas the height and the width of the elevations was 4 cm (Image 1).

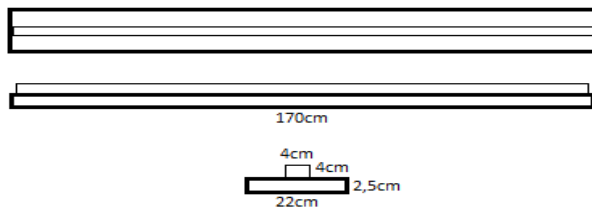


Image 1. Construction characteristics of the balance evaluation instrument

The upper elevation was marked with a line which was divided into two equal parts. Participants had to place both feet on the elevation on one side of the line. After taking a starting position, they arbitrarily performed two foot jumps while skipping over the marked line that divided the elevation into two symmetrical parts (Image 2). The participant's task was to attempt at performing as many correct two feet jumps as possible. The total number of performed two feet jumps was recorded and the task was repeated three times. The final result in this test was the best achieved result. An attempt was considered as invalid if participant touched the lower surface of the measuring instrument or the line in the middle of the measuring instrument with any part of foot during the performance of the two feet jumps.



Image 2. Presentation of the BAL40 test

The criterion variable in this research was participant's result in the giant slalom discipline. The ski course on which the participants were timed was identical for all with regard to slope of the ski terrain, the number of gates, the distance between the gates as well as their mutual distance.

The course had a total of 15 gates. The distance between the starting line and the first gate was 10 meters, while the distance between all the remaining gates was 20 meters. The final distance between the last gate and the finish line was once again 10 meters. The distance between the middle of the slope line and the first marking (beginning of the gate) on each side and in all gates was 3 meters, which ultimately formed a 6-meter corridor. The time was measured by Brower® Timing System (1/100 sec).

Research protocol

The first test that participants had to perform was the balance test. Afterwards participants were taught alpine skiing during 10-days structured programme of alpine ski school. All participants had identical conditions during learning process of alpine ski basics. Identical ski courses at the same ski centre were used, ski equipment was of identical quality, and they all learned alpine skiing according to the same programme, including hours of practice.

In order to ensure the quality of learning, participants were divided into smaller groups, more precisely, into six groups of ten participants and one group of nine participants. After completing the alpine ski school, participants took part in assessment of the acquired ski knowledge. Three independent judges carried out the evaluation of six elements of skiing technique. The grade range was between one and five; one representing the lowest level, whereas five represented the highest level of skiing knowledge. The judges who took part in this study possessed the necessary knowledge and long-time experience in assessing ski knowledge. Each grade assigned to a participant for a demonstration of a ski technique element had to meet precisely determined criteria which enabled the judges to focus on the identical parts of each element in the grading process.

The objectivity and homogeneity of the judges who participated in this study was confirmed in previous research, which allowed their involvement for the purpose of assessing the acquired alpine ski knowledge in this research (Cigrovski et al., 2008). The final test in this research was the electronic timing of the giant slalom discipline.

Statistical methods

The obtained data was processed by statistical programme Statistica ver.12. Basic descriptive parameters were calculated for BAL40 test assessing participants' balance, for participants' situational efficacy test-giant slalom and average grades obtained for six elements of alpine ski technique. In addition, regression analysis was used to determine the correlation between the participants' results on the balance evaluation test (BAL40) and the assigned grades for the six elements of skiing technique as well as between participants' situational efficiency in alpine skiing. The acquired results were considered statistically significant at $p < 0.05$.

Results

Table 1. Descriptive statistic parameters for the set of predictor variables and the criterion variable

Variable	Descriptive Statistics				
	Valid N	Mean	Minimum	Maximum	Std. Dev.
traversing	69	3,68	2,00	5,00	0,81
uphill turn	69	3,66	2,00	5,00	0,68
snowplough turn	69	3,56	2,00	5,00	0,95
basic turn	69	3,14	2,00	5,00	0,91
parallel turn	69	3,61	2,00	5,00	0,97
short turn	69	3,19	2,00	5,00	0,94
BAL40	69	4,99	2,00	8,00	1,39
giant slalom	69	49,03	33,38	85,40	11,17

Legend: BAL40 balance evaluation test

Table 1 shows basic descriptive statistic parameters for skiing technique elements demonstrated upon completion of alpine ski school programme. Likewise, Table 1 gives participants' basic descriptive statistic parameters in the balance evaluation test (BAL40) and the giant slalom discipline. Results of regression analysis between predictor variables (results on balance test and grades obtained for six elements of alpine ski technique) and criterion variable-time in giant

slalom are given in Table 2. Table 2 demonstrates the impact of six evaluation tests for alpine skiing knowledge and one balance evaluation test on the score in giant slalom. In Table 2, statistically significant results can be identified between the set of predictor variables (grades assigned to participants for six elements of alpine ski technique and the results on the balance evaluation test) and the criterion variable (results of participants in the giant slalom discipline).

Table 2. Regression analysis results

N=69	R= ,68609913 R2= ,47073202 Adjusted R2= ,40999635 F(7,61)=7,7505 p<0,00					
	b*	Std. Err. of b*	b	Std. Err. of b	t (61)	p-value
Intercept			78,80	7,18	10,98	0,00
traversing	0,22	0,12	3,06	1,66	1,84	0,07
uphill turn	-0,29	0,16	-4,76	2,63	-1,81	0,08
snowplough turn	0,10	0,14	1,15	1,61	0,71	0,48
basic turn	-0,44	0,15	-5,39	1,89	-2,85	0,01
parallel turn	0,06	0,17	0,65	1,94	0,34	0,74
short turn	-0,33	0,14	-3,90	1,61	-2,43	0,02
BAL40	-0,02	0,10	-0,13	0,77	-0,17	0,86

Legend: BAL40 balance evaluation test

It can be noticed that there is a considerable effect of predictor variables on the participants' results in situational efficiency ($R=0.68$; $p<0.00$), which reaffirms the result of the relevance coefficient ($R^2=0.47$). Upon individual analysis of results for each predictor variable (grades assigned to participants for six elements of alpine ski technique and the results on the balance evaluation test), the conclusion can be made that a statistically significant effect on situational efficiency of skiers is present in the results obtained for basic turn test ($Beta=-0.44$; $p=0.01$) and short turn test ($Beta=-0.33$; $p=0.02$). With regard to the negatively scaled variable, one can conclude that a higher level of acquired alpine ski knowledge in elements of skiing technique of the basic turn and the traversing also enable a higher level of situational efficiency in the giant slalom.

Discussion and conclusion

The goal of the alpine ski school programme is to enable ski beginners to independently master ski courses and terrains, at the same time controlling their speed on the skies (Matković et al., 2004). During the basic ski school programme, beginners first master the basic turns, in the course of which they also learn to perform ski movements, which are then in specific proportions applied in more advanced and competitive types of turns (Cigrovski & Matković, 2015). From the perspective of participants who attend the ski school, goal is to acquire ski knowledge in the shortest possible time period, which can then lead to skipping certain parts of the ski school programme. That kind of approach does not result in complete acquisition of ski movements that are applied in all types of turns, regardless of type of ski school programme -

elementary, advanced or competitive school programme (Cigrovski et al., 2014). It is important to master the elements of basics ski school while they later enable learning of more advanced and proficient elements of ski technique. Our research demonstrated that knowledge of elements from the elementary (basic turn) and advanced programmes (short turn) have a statistically significant effect on the results of the giant slalom discipline. Likewise, the results obtained in this research showed that all six assessed elements of alpine ski technique, as well as the results of the BAL40 test commonly have a significant impact on the results in the competitive skiing technique of giant slalom.

For this reason, neither part of the alpine skiing school programme should be omitted during the acquisition of ski knowledge. It would therefore be best if ski beginners made the necessary preparation before inclusion in alpine ski school rather than skip particular parts of basic alpine ski programme. For this reason ski beginner could use inline skating, as mentioned is activity with similar elements to alpine skiing (Roman et al., 2007). Research results of Takahashi and Yoneyama (2001) confirmed better learning of alpine skiing in participants previously practising recreational inline skating. So it is possible to accelerate the learning process of alpine skiing by completing physical conditioning and motor preparations prior to leaving for the ski terrains. The mentioned preparations imply using training in order to impact the development of motor abilities, especially those that are extremely important for recreational level skiers. As all the previously mentioned research established that balance, in particular its dynamic

form, contributes to an efficient learning of alpine skiing, this research also included a balance evaluation test. Namely, a highly developed level of balance enables a skier to take and maintain a stable position on the skies, as well as to regain stable position after it has been disturbed. However, our results suggest that applied balance evaluation test did not have an independent effect on the alpine ski situational efficiency. In terms of the limitations of this study, the selected balance evaluation test should certainly be mentioned. The scale of results in the BAL40 test was rather small and it included between two and eight repetitions. It is possible that the absence of a separate contribution of the results in the BAL40 test on the success in the giant slalom discipline is related to the selection of an extremely demanding test for the participants who are ski beginners. The BAL40 test was adopted from the research by Franjko "Analysis of extrinsic feedback of motor learning in alpine skiing" (2012), during which an almost identical test was applied to competitive level skiers. Perhaps with ski beginners/recreational level skiers, it would be better to use an adapted version of the BAL40 test, which would primarily imply using a larger support surface than 4 cm. Despite the results of previous research that determined important role of balance in learning alpine skiing, the BAL40 test used in our research has not proved to be a good predictor for situational efficiency. However, elements of technique both in elementary and advanced alpine ski school programmes are statistically significantly correlated with the success in situational efficiency, i.e. in the giant slalom discipline.

References

- Aerenhouts, D., De Raedemaeker, L., Clarys, P., & Zinzen, E. (2015). Energy expenditure in novice skiers and snowboarders. In: E. Muller, J. Kroll, S. Lindinger, J. Pfusterschmied, T. Stoggl (Ed.), *Science and skiing*, (pp. 89-94). Oxford: Meyer and Meyer Sport.
- Cigrovski, V., Božić, I., & Prlenda, N. (2012). The influence of motor abilities on learning of alpine ski technique. *SportLogia*, 8(2), 188-201.
- Cigrovski, V., & Matković, B. (2015). Skijaška tehnika-carving. [Skiing technique - carving. In Croatian.]. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
- Cigrovski, V., Matković, B., & Prlenda, N. (2009). Povezanost ravnoteže s procesom usvajanja skijaških znanja. [Linkage of balance with the process of adoption of ski knowledge. In Croatian.]. *Hrvatski sportsko medicinski vjesnik*, 24(1), 25-29.
- Cigrovski, V., Radman, I., Matković, B., Gurmmet, S., & Podnar, H. (2014). Effects of alpine ski course program on attitudes towards alpine skiing. *Kinesiology*, 46(S1), 46-51.
- Franjko, I. (2012). Analiza ekstrinzičnih povratnih informacija motoričkog učenja u alpskom skijanju. [Analysis of extrinsic feedback motor learning in alpine skiing. In Croatian.]. /PhD thesis/ Faculty of Kinesiology, University of Split.
- Huber, A., Goll, M., Stocker, F., Spitzenpfell, P., & Waibel, K. (2015). Evaluation of the 75-second strength endurance test by comparing metabolic and biomechanical values in lab and field. In: E. Muller, J. Kroll, S. Lindinger, J. Pfusterschmied, T. Stoggl (Ed.), *Science and skiing*, (pp. 177-186). Oxford: Meyer and Meyer Sport.
- Kostelić A. (2005). Prikaz i analiza kondicijske pripreme Ivica i Janice Kostelić tijekom sportske karijere (razvoj i rezultati). (Neobjavljeni diplomski rad). [Review and analysis of training of Ivica and Janica Kostelić during the sports career (development and results). (Unpublished thesis). In Croatian.]. Zagreb: Faculty of Kinesiology, University of Zagreb.
- Malliou, P., Amoutzas, K., Theodosiou, A., Gioftsidou, A., Mantis, K., Pylianidis, T., & Kioumourtzoglou, E. (2004). Proprioceptive training for learning downhill skiing. *Percept Mot Skills*, 99(1), 149-154.
- Matković, B., Ferenčak, S., Žvan, M. (2004). *Skijajmo zajedno*. [Let's ski together. In Croatian.]. Zagreb: Europapress holding i FERBOS inženjering.

- Roman, B., Miranda, M.T., Martinez, M., & Jesus, V. (2007), Transfer from In-line skating to alpine skiing instruction in physical education. In: Muller, E., Lindinger, S. and Stoggl, T. (Ed.), *Skiing and Science* (pp. 430–439). Oxford, UK: Mayer & Mayer Sport.
- Ružić, L., Rađenović, O., & Tudor, A. (2008). The predictive power of balance board: tests for «on-the-skis» balance performance. In: Milanović D, Prot F (Ed), Proceeding book "5th International Scientific conference on Kinesiology". (pp.196-200). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
- Takahashi, M., & Yoneyama, T. (2001). Basic ski theory and acceleration during ski turn. In: E. Müller, H. Schwameder, C. Raschner, S. Lindinger, E. Kornexl (Ed.), *Science and skiing*, (pp. 307-321). Hamburg: Verlag Dr. Kovač.
- Tate, D. (2007). *Parallel dreams alpine skiing: Taking your skiing performance to new levels*. UK: Parallel dreams publishing.
- Wojtyczek, B., Paśławska, M., & Raschner, C. (2014). Changes in the balance performance of polish recreational skiers after seven days of alpine skiing. *J Hum Kinet.*, 30, 44: 29-40.
- Žvan, M., Lešnik, B., & Supej M. (2015). Progressive increase in velocity, ground reaction forces and energy dissipation in alpine ski school elements. In: E. Muller, J. Kroll, S. Lindinger, J. Pfusterschmied, T. Stoggl (Ed.), *Science and skiing*, (pp. 354-358). Oxford: Meyer and Meyer Sport.

POVEZANOST RAVNOTEŽE I SPECIFIČNIH SKIJAŠKIH ZNANJA SA SITUACIJSKOM EFIKASNOŠĆU U ALPSKOME SKIJANJU

Sažetak

Visokorazvijena dinamička ravnoteža doprinosi boljem rezultatu natjecatelja u alpskome skijanju. S obzirom na dokazanu povezanost između razine razvijenosti ravnoteže kod alpskih skijaša te uspjeha tijekom natjecanja, ovim istraživanjem pokušalo se utvrditi povezanost između ravnoteže te usvojenog skijaškog znanja kod skijaša rekreacijske razine. Isto tako cilj ovog istraživanja bio je utvrditi povezanost između usvojenog skijaškog znanja i rezultata u veleslalomu kod skijaša rekreacijske razine. U istraživanju je sudjelovalo 69 ispitanika (23.3±1.66 godina), koji se nikada nisu bavili alpskim skijanjem. Na početku istraživanja svi ispitanici testirani su testom za procjenu ravnoteže, a potom su deset dana usvajali alpsko skijanje. Po završetku usvajanja skijaških znanja svi ispitanici su ocijenjeni na šest elemenata skijaške tehnike te im je izmjereno vrijeme u disciplini veleslalom. Regresijskom analizom utvrđeno je kako postoji statistički značajna povezanost između razine usvojenog skijaškog znanja i rezultata u testu BAL40 te rezultata u disciplini veleslalom ($R=0,68$; $p<0,00$). Od prediktorskih varijabli jedino rezultati u testovima osnovni zavoj ($Beta=-0,44$; $p=0,01$) i vijuganje ($Beta=-0,33$; $p=0,02$) samostalno doprinose u objašnjenju povezanosti s rezultatom ispitanika u disciplini veleslalom. Nije utvrđen zasebni doprinos rezultata u testu BAL40 s rezultatom ispitanika u situacijskoj efikasnosti u alpskome skijanju. Moguće je zaključiti kako se niti jedan dio programa škole alpskoga skijanja ne bi trebao izostaviti tijekom usvajanja skijaških znanja, jer su u napredne i natjecateljske elemente tehnike ugrađena i specifična skijaška gibanja iz osnovnog programa.

Ključne riječi: škola alpskoga skijanja, skijaški početnici, dinamička ravnoteža, veleslalom

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Correspondence to:

Assist. Prof. Vjekoslav Cigrovski, PhD.

University of Zagreb

Faculty of Kinesiology

Horvaćanski zavoj 15, 10 000 Zagreb

Phone: +385 1 3658 702

E-mail: vjekoslav.cigrovski@kif.hr