ORIGINALNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

Hrvat. Športskomed. Vjesn. 2023; 38:54-59

DOBRO ODABRANA SKIJAŠKA OPREMA POVEZANA JE S RAZINOM USVOJENOG SKIJAŠKOG ZNANJA KOD SKIJAŠKIH POČETNIKA

WELL CHOSEN SKI EQUIPMENT CORRELATES WITH THE ACQUISITION OF SKI SKILLS IN ALPINE SKI BEGINNERS

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SUMMARY

Numerous factors influence efficacy of alpine ski learning, among which dominate weather conditions, motivation, and capabilities of ski beginners as well as motivation and knowledge of ski instructors and quality and suitability of ski equipment, which when suitable also prevents injuries. The aim of this research was to determine whether the length of skis and the length of ski boots affect learning of basic elements of alpine skiing technique. We included 178 ski beginners (132 males and 46 females). At the beginning of the research, the subjects' height and feet length were measured, and based on the measures, they were given adequate ski equipment. Afterwards participants were included in 10 days alpine skiing where they learned according to precisely defined program. Upon completion of the alpine ski program, participants demonstrated skiing skills (snowplough, basic turn, parallel turn, and short turn) in front of five independent judges. Small but statistically significant negative correlation was determined between ski length and average grade for element snowplough (r=-0,19). Statistically significant correlation was determined between feet length and average grade for parallel turn (r=-0,16) and length of ski boots and element parallel turn (r=-0,20). Our results suggest that ski equipment through ski length and ski boots can influence the speed and level of learning basics of alpine skiing.

Key words: alpine skiing, learning, ski equipment, evaluation

SAŽETAK

Više čimbenika utječe na učinkovitost procesa usvajanja osnova alpskoga skijanja. Između ostaloga uvjeti u kojima se uči, motiviranost i sposobnosti učenika, stručnost i motiviranost učitelja te prilagođenost skijaške opreme korisnicima, a dobro odabrana skijaška oprema je neophodan čimbenik i u prevenciji ozljeda. Cilj ovog istraživanja je bio utvrditi povezanost između duljine skija i duljine skijaških cipela s razinom usvojenog skijaškog znanja kod skijaških početnika. U istraživanje je bilo uključeno 178 skijaških početnika (132 muškog i 46 ženskog spola), kojima je na početku istraživanja izmjerena tjelesna visina te duljina stopala. Na temelju izmjerene tjelesne visine ispitanicima su iznajmljene adekvatne skije, a na temelju izmjerene duljine stopala skijaške cipele određene veličine. Nakon odabira skijaške opreme ispitanici su bili uključeni u desetodnevnu školu u kojoj su po točno definiranom programu usvajali skijaška znanja. Po završetku škole svi ispitanici su ispred pet nezavisnih ispitivača demonstrirali 4 elementa skijaške tehnike (plužni zavoj, osnovni zavoj, paralelni zavoj i vijuganje). Mala, ali statistički značajna negativna korelacija utvrđena je između duljine skija i prosječne ocjene skijaškog znanja na elementu plužni zavoj (r=-0,19). Između dužine stopala i prosječne ocjene skijaškog znanja na elementu paralelni zavoj utvrđena je mala, ali statistički značajna negativna korelacija (r=-0,16). Također mala ali statistički značajna negativna korelacija (r=-0,20) utvrđena je i između duljine skijaških cipela i ocjena na elementu paralelni zavoj. Ovo istraživanje potvrđuje kako skijaška oprema preko duljine skija i skijaških cipela može utjecati na brzinu i razinu stjecanja osnovnih skijaških znanja.

Ključne riječi: alpsko skijanje, učenje, skijaška oprema, procjena

INTRODUCTION

Alpine skiing is one of the widest spread winter sports, practiced in over 2000 ski resorts worldwide (2). It is difficult to assume the exact number of recreational level skiers, but according to Horterer (11) the number exceeded 82 million in 2005, and since then there was a raising trend and potentially 400 million people in over 68 countries are engaged in this popular winter sport activity (24). Alpine skiing has a positive influence on health (2, 20) but some prerequisites need to be done before recreational skiers are introduced to skiing in order to prevent potential injuries. One of the best ways is to include ski beginners and recreational skiers with basic ski knowledge to alpine ski programs which are regularly offered in all ski centres (4). Due to the raising trend of alpine skiers, current ski resorts are continuously modernized and new are built and connected to already existing. In this way current centres can serve the higher number of visitors and also cut down the number of skiers per ski slope by enlarging the ski terrains, which helps in injury prevention. Moreover, the attention is also focused on maintenance of ski terrains, primarily on the amount of snow and signalling of potentially difficult and dangerous parts of terrains as well as protective fences on the edges. Despite all the efforts made by organizers of ski resorts, accidents on the ski terrains are still happening (17, 8). Accidents are more often during weekends and holidays when the number of visitors is at its peak. The reasons for accidents are numerous and related to skiers' preparedness, inadequate terrain selection, poor weather conditions, alcohol consumption and inappropriately chosen ski equipment (18). According to the literature, the latter is one of the most prominent reasons for injuries of recreational skiers (9) and led to the efforts of ski industry to design and manufacture equipment which is adapted to the level of ski knowledge, terrains, and skiers' capabilities. Mentioned equipment is mostly rented, and in more than a few cases skiers renting the equipment for the first time make the mistakes in choosing the proper one. As a result, skiers are either inefficient in learning skiing skills or in some cases even injured because of it.

To be successful in acquisition of alpine skiing skills it is necessary that each ski program follows the general principles of learning certain motor knowledge. Since alpine skiing consists of uncommon movements to human body, gradual learning is crucial. Also, in order to be successful in mastering each ski element the skier has to choose optimal equipment individually (14).

This can be best explained on the example of ski boots. In case of too small ski boots blisters can form which disable the skier from further skiing. On the other hand, if the ski boots are too large, they will prevent the skier to make the proper ski turns. Namely, skiing is a product of different movements in leg ankles which are transferred to the snow surface through ski boots and skies. So, if the skier has inadequate ski boots, he will have more difficulties to learn specific ski movements and the risk of injury will rise (4).

Also, choosing the optimal skies for beginners is one of the factors that directly influence learning process and injury prevention. For example, if the skis are too long, it is very hard to execute even the simplest ski elements. At the beginning of the learning process ski novices are struggling to get used to feeling of steering the skies which is especially emphasized when having inadequate (too long) skis (1).

The aim of this research was to determine the correlation between the ski beginners' optimal equipment fitting like length of skis and size of ski boots with the level of acquired ski knowledge.

PARTICIPANTS AND METHODS

Participants: This research included 178 participants (132 males and 46 females) average age 23.6±1.73 years, who were ski beginners. Prior to research start they rented the ski equipment (skies, ski boots and ski poles) in a specialized ski rental service with the help of a professional.

Variables: We measured three morphological characteristics according to the International Biological Program-body height (in centimetres), body weight (in kilos) needed for proper adjustment of ski bindings, and the length of feet (in centimetres). Investigated equipment included skies and ski boots, whose lengths were taken from the manufacturer (in centimetres). We used four elements of alpine ski to assess the ski knowledge of each participant; i.e. snowplough turn, basic turn, parallel turn and short turn.

Research Protocol: Participants learned the basics of alpine skiing during the 10-day alpine ski program. After getting familiar with the equipment, participants were randomized to groups of 10, regardless of gender. Each group started with the learning at 9:00 AM and finished at 1:00 PM. Every participant had a possibility/opportunity to train the learned skills during the 2 hours in the afternoons. Ski instructors engaged in this research had years long experience in teaching alpine skiing and were in detail informed about the program. Methods used to learn skiing skills were unified and used by all ski instructors in the same way and order and therefore all participants were provided the same conditions to learn alpine skiing. At the end of the learning, participants demonstrated the knowledge of alpine skiing in the alphabetical order and were rated on the scale one to five by five independent judges. Grade 1 was consistent with the worse and 5 with the best performance. The study was conducted over a period of 80 days.

Statistical methods: Pearsons' coefficients of correlation (r) were calculated between the obtained grades for the demonstration of ski knowledge and lengths of skis and ski boots. Metric characteristics of judges were defined according to the same procedure used in previous investigation and determined that judges estimated the same object (5). In addition, calculated were correlation

coefficients (r) between the grades given by each judge for participants' performance of ski skills. Results were considered statistically significant when $p \leq 0.05$.

RESULTS

Participants' characteristics and grades obtained for tested alpine ski skills are presented in Table 1.

The correlation between body height and ski length was high and statistically significant (r=0,92, Table 2). In addition, there was a significant correlation between feet length and ski boot length (r=0,97, Table 2).

Namely, ski boots depending on the manufacturer and model, are designed, and produced varying one to three numbers of the inner boot in the same plastic cast. This was the reason why some participants had deviations ranging from 0.5 to 2 cm. However, given the analysed correlations, it is unlikely that the identified deviations would influence the process of acquiring ski skills. On the contrary, it suggests that participants had well-chosen equipment which is the starting point for effective learning of alpine skiing.

Moreover, there was a small but statistically significant negative correlation between the ski length and average grade of element snowplough turn (r=-0.19), explainable by the fact that ski beginners and recreational skiers with poor ski knowledge learn ski basics more easily on skies of shorter length.

In addition, when analysing correlations between feet length and average grade for element parallel turn a small but statistically significant negative correlation was also noticed (r=-0,16). It is to be assumed that beginner skiers with shorter feet and ski boots will find it easier to perform parallel turns compared to participants whose ski boots are longer in length.

Table 1 Basic descriptive parameters of participants' characteristics and grades participants earned for their ski skills.
Tablica 1. Osnovni deskriptivni pokazatelji karakteristika ispitanika i ocjena dodijeljenih za njihove skijaške vještine.

VARIABLE	N	MEAN	Min	Max	SD
Body height (cm)	178,00	178,35	155,00	200,00	9,48
Body weight (kg)	178,00	77,03	49,60	110,00	11,86
Foot length (cm)	178,00	26,59	22,50	30,00	1,69
Ski length (cm)	178,00	164,40	140,00	180,00	9,84
Ski boot length	178,00	27,65	23,50	31,50	1,78
Snowplough turn	178,00	3,69	2,00	5,00	0,74
Basic turn	178,00	3,34	2,00	5,00	0,83
Parallel turn	178,00	3,29	2,00	5,00	0,76
Short turn	178,00	2,98	2,00	5,00	0,68

Table 2 Corelations between chosen anthropometric characteristics and grades obtained for demonstration of ski skills.
Tablica 2. Korelacije između odabranih antropometrijskih karakteristika i ocjena dobivenih na temelju demonstracije skijaških vještina.

VARIABLE	Body height	Body weight	Foot length	Ski length	Ski boot length	Snow plough turn	Basic turn	Parallel turn	Short turn
Body height	1,00	0,77*	0,85*	**0,92***	0,85*	-0,15*	-0,01	-0,17*	-0,14
Body weight		1,00	0,75*	0,78*	0,76*	-0,14	0,05	-0,11	-0,08
Foot length			1,00	0,82*	**0,97***	-0,13	-0,03	**-0,16***	-0,13
Ski length				1,00	0,82*	**-0,19***	0,01	-0,16	-0,12
Ski boot length					1,00	-0,12	-0,02	**-0,20***	-0,13
Snowplough turn						1,00	0,30*	0,42*	0,35*
Basic turn							1,00	0,60*	0,51*
Parallel turn								1,00	0,66*
Short turn									1,00

* $p<0.05$

Mentioned is also confirmed in the result of correlation between length of ski boot and grades on element parallel turn, where the correlation was also small, but statistically significant (r=-0,20). This result once again points that recreational skiers perform parallel turns more easily if their ski boots are of smaller length.

Judges' objectivity in grading elements of alpine ski technique is presented in Table 3.

Table 3 Correlation coefficients between the grades given by five judges for each element of alpine skiing.
Tablica 3. Koeficijenti korelacije između ocjena dodijeljenih od strane 5 ocjenjivača za svaki pojedini element alpskog skijanja.

	Snowplough turn	**Basic turn**	**Parallel turn**	**Short turn**
judge 1 & 2	0.80**	0.83**	0.75**	0.81**
judge 1 & 3	0.80**	0.77**	0.80**	0.80**
judge 1 & 4	0.80**	0.81**	0.77**	0.81**
judge 1 & 5	0.81**	0.78**	0.72**	0.83**
judge 2 & 3	0.80**	0.86**	0.79**	0.83**
judge 2 & 4	0.83**	0.91**	0.79**	0.84**
judge 2 & 5	0.86**	0.87**	0.88**	0.85**
judge 3 & 4	0.86**	0.87**	0.82**	0.83**
judge 3 & 5	0.84**	0.86**	0.82**	0.84**
judge 4 & 5	0.84**	0.83**	0.78**	0.83**

** $p<0.05$

High levels of correlation suggest satisfactory objectivity of all five judges. Based on the presented results, it is evident that the obtained grades reflect the demonstrated knowledge by participants and are not influenced by judges.

DISCUSSION AND CONCLUSION

High correlation between participants' height and length of chosen skis (r=0,92) as well as between feet length and size of chosen ski boots (r=0,97) confirms that the equipment used in this research was optimal. There are many prerequisites for efficient ski learning, and among them adequate and well-chosen equipment is one of the most important. When analysing length of skies in correlation to skiers' height and size of ski boots in correlation to length of skiers' feet one cannot exactly conclude to which extent it will influence the learning process of basic alpine ski program. On the other hand, skiing injuries resulting from inadequately chosen ski equipment are well documented (10). Moreover, there is an ample of literature about injuries in ski competitors resulting from musculoskeletal strain due to construction characteristics of modern skies (13, 23). Therefore, in order for a ski equipment not to cause injuries or directly (negatively) affect the process of acquiring ski knowledge, it is necessary to be informed by an expert while in the process of choosing. Ski boots are the most personal and most important part of ski equipment, and due to their specific structure made of hard plastic, it is difficult to move within them and skier's foot must get used to them (6). Out of ignorance, ski beginners tend to choose larger ski boots believing that they will be more comfortable or warmer and therefore prevent injuries such as skier's toe. But what beginners do not know is the fact that in ski boots there must be no free space between the feet and the inner part of the shoe, because otherwise all movements made by a skier in the feet and lower legs will not be focused on turn management, but will rather end in ski boots, and moreover, also lead to injuries (25). Ski boots directly influence joint mobility and postural control. Namely, they are constructed to protect from feet and lower leg injuries but at the same time due to rigidity reduce the ankle movements (16). On the other hand, postural control is among the most important skills protecting from injury and ensuring mobility (2). Various studies investigated the impact of ski equipment and sex-specific risk of injury and suggested a link between a greater ski length and a higher risk for sustaining a knee injury (19). Moreover, a link between female recreational carving skiers not using newly adjusted ski bindings and a higher risk of knee injuries was also detected compared to that of newly adjusted bindings (3). Adequate skies, chosen according to skiers' height, capabilities and ski knowledge of recreational skiers are another important part of ski equipment. Skies are adapted in shape and dimensions as well as built to the skiers' knowledge and purpose where they will be used. It can be assumed that ski beginners with inadequately chosen ski boots and skies learn alpine skiing more slowly and with more difficulties compared to ski beginners with well-chosen equipment (21). Our results lead to the conclusion how ski beginners and recreational skiers with lower ski level learn alpine skiing more easily

on shorter skies, while there was a positive correlation between acquired ski knowledge and element snow plough when using skies of shorter length. In addition, ski length to height ratio is also an independent risk factor related to ski injuries (22). One of the programs for learning alpine skiing is to alternate skis of different lengths, starting from shorter and then progressing to longer ones. It is precisely this approach to learning the basics that was applied back in 1959 by the American teacher Cliff Taylor. He first taught ski beginners on skis only 50 cm long, then on skis 160 cm long, and finally on skis of standard length at the time. The method of learning alpine skiing by gradually changing the length of the skis is called GLM (Graduated Length Method) and it was later taken on by Slovenian ski instructor Sandi Murovec and adapted to modern skies. His method, like the GLM method uses skis of different lengths; during the first days of training, skis 90 cm long, then followed by skies of 125 cm, and finally, depending on the morphological characteristics of a skier, skis between 150 and 175 cm long (15). In our research we focused on the influence of quality of ski equipment on the speed of learning process in alpine ski beginners unlike other studies which correlated the quality of equipment to risk of injuries (12, 7). As a main limitation of our study, we see the investigation of just one small segment of what possibly influences the speed of learning of alpine skiing. This research points to the fact that ski instructors must tend to the proper ski equipment of their pupils. Moreover, results support the need that recreational level skiers must be informed and advised on the ski equipment before starting alpine ski learning in order to speed up the learning process and its safety.

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