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Research article

CORRELATION BETWEEN EXPERT MODEL EVALUATION AND COMPETITIVE SUCCESS OF YOUNG CATEGORIES IN ALPINE SKIING

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Abstract. *Expert modelling has been represented as an important part of planning and conducting training and analysing the effects of training of different categories of competitors in Alpine skiing in Slovenia. On the basis of a heuristic approach, a model of success was formed. In the category of older boys (U16), the model consists of 17 dimensions of a motor subsystem and of 8 dimensions of a morphological subsystem; on the other hand, competitive success (the criterion variable) was assessed based on the calculation of points won in the Rauch Cup competitions in the 2015/16 season. Motor and morphological dimensions were measured on a sample of 31 active competitors in the category of older boys (U16). With the help of the SMMS program package, marks were calculated at all the levels of a potential model of success. Marks calculated for an individual competitor as well as for the whole group are used by coaches as a useful orientation when planning and conducting the training process. In the second part of the survey, we intended to establish a connection between the marks calculated by means of the expert system method (heuristic approach) and the criterion variable. The calculated Pearson's correlation coefficient confirmed the statistically significant connection between the calculated marks (expert system method) and the actual success (points won in the Rauch Cup competitions). The result obtained (r=0.47) is a relevant indicator of the validity and appropriate configuration of a reduced model of potential success.*

Key words: *alpine skiing, expert modelling, assessment of success, young competitors*

INTRODUCTION

In Slovenia, expert modelling represents an important part in planning and conducting training as well as in analysing the effects of training in different categories of competitors in

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Alpine skiing. This is based on a holistic handling of problems and on a regular adaptation of the contents of the exercises to the developmental trends in the technique and tactics of movement in competitions (Jošt, Pustovrh, & Ulaga, 1998). The methods of determining the state of sportsmen should also be adapted to the requirements of the modern competitive skiing technique and system of competitions (Lešnik & Žvan, 1998). For many decades we were therefore oriented primarily towards the determination of those sets of factors that were – according to the results of scientific studies – the best indicators of a psychomotor state of a particular category of competitors in Alpine skiing (Savić, Stojanović, Stojiljković, & Jorgić, 2013; Bandalo & Lešnik, 2011; Lešnik, 1996; Žvan & Lešnik, 2000). In determining the success of sportsmen, we could come quite close to objective reality only if in the process of observation we were able to take into account and measure all the dimensions which may in some way or another influence the achievement of an individual's end result (Leskošek, Bohanec, & Rajković, 2002). Since we know that this is not possible, we are working on the development of the model of success. This is divided into the model of potential success and the model of competitive success. ***The model of potential success*** consists of hierarchically arranged potential dimensions such as motor abilities, morphological characteristics, psychological characteristics, etc. ***The model of competitive success*** comprises hierarchically arranged sets of competitions of a higher or lower rank (international, national, regional and lower competitions). The mutual connection between the results of the potential and competitive models of success is an indicator of the suitability and quality of both models that have been developed (Lešnik, 1996). The success of a sportsman is determined on the basis of the results achieved in competitions. In Alpine skiing as well as in other sports, results achieved in competitions are the best criterion of the quality of the training process in the transition, preparatory and competitive periods (Maffiuleti, Jordan, Spring, Impellizzeri, & Bizzini, 2007). This means that the developed model of success will only be reliable if it consists of suitably weighted potential dimensions of the success of a particular sample of participants; on the other hand, competitive success will be assessed on the basis of the most important competitions, in which the same sample of participants took part (Bandalo, 2016).

Taking the basic aim of our study into consideration, we intended to check the validity of the set model of success. For this reason, we first had to determine the criterion which is represented by the actual success of the participants in the high level national U16 competition Rauch Cup (SAS, 2016). Then two methods were used: the first one is the method of expert modelling with the help of which the marks at all levels of the tree of success were calculated, the second method (the calculation of Pearson's correlation coefficient) was used to determine the connection between the marks obtained at the highest level of the tree of success and the points scored in the Rauch Cup competitions (SAS, 2016).

METHODS

The measurements of morphological and motor dimensions of younger categories of competitors in Alpine skiing have been carried out at the Faculty of Sport. The research included 31 competitors in the U16 category of older boys (born in 1999 and 2000) who took part in the Rauch Cup competitions in the 2015/16 season (SAS, 2016). The battery of tests for the younger categories of competitors consisted of 17 motor and 8 morphological tests (Fig. 1), and according to the results of previous studies (Lešnik, 1996; Lešnik & Žvan, 1998; Žvan & Lešnik, 2000; Reid, Johnson, Kipp, Albert, & White, 1996; Rosenhagen, Thiel, Vogt, & Banzer, 2009), they can be good predictors of success in Alpine skiing.

Code	**Names of nodes and variables***
Ocena	final mark
├─MORFO	MORPHOLOGY
│ ├─MASA	internal geometric dimensions
│ │ └─**AT**	**Variable: body weight**
│ ├─EKSEGOR	external geometric dimensions
│ │ ├─DOLRAZ	longitudinal body dimensions
│ │ │ ├─**AV**	**Variable: body height**
│ │ │ └─**AND**	**Variable: length of leg**
│ │ ├─PRAZSO	transverse body dimensions
│ │ │ ├─**APKOLL**	**Variable: diameter of the left knee**
│ │ │ └─**APSSL**	**Variable: diameter of the left ankle joint**
│ │ └─VOLSO	circumference of the legs
│ │ └─**AOSL**	**Variable: circumference of the left thigh**
│ └─INTEGOR	internal geometric dimensions
│ ├─**AKGT**	**Variable: stomach skin fold**
│ └─**AKGSL**	**Variable: skin fold of the left thigh**
└─MOTOR	MOTOR SKILLS
├─OSMOT	basic motor skills
│ ├─ENKOGI	energy component of movement
│ │ ├─MOČ	basic power
│ │ │	
├─ODRMOČEN	takeoff power – single leg
│ │ │	
└─**MMEN3SM**	**Variable: standing triple jump**
│ │	
├─ODRMOČSO	takeoff power – double leg
│ │ │	
├─**MMENSDM**	**Variable: standing long jump**
│ │ │	
└─**MSKOK10**	**Variable: ten consecutive double leg jumps**
│ │	
└─REPMOČROK	repetitive power
│ │ └─**MZGIBE**	**Variable: bent arm hangs with an undergrip**
│ └─HITROST	Speed
│	speed of the maximum muscle
├─HITRMAKEKS	excitation
│ │	
└─**MMENS20**	**Variable: 20-metre sprint – crouch start**
│	
├─HITRMAKS	maximum speed
│ │	
└─**MHGNS20L**	**Variable: 20-m sprint – running already before the start**
│ └─HITRVZDR	speed endurance
│ └─**MT300**	**Variable: 300-metre run**
└─INKOGI	Information component of movement

Code	Names of nodes and variables*
Ocena	final mark
├─MORFO	MORPHOLOGY
│ ├─MASA	internal geometric dimensions
│ │ └─**AT**	**Variable: body weight**
│ ├─EKSEGOR	external geometric dimensions
│ │ ├─DOLRAZ	longitudinal body dimensions
│ │ │ ├─**AV**	**Variable: body height**
│ │ │ └─**AND**	**Variable: length of leg**
│ └─REGSINANT	regulation of synergists and antagonists
│	
├─RAVNOTEŽJE	Balance
│ │	
├─**MRSOSPT**	**Variable: balance transversely on a T-bench**
│ │	
└─**MRSOSVT**	**Variable: balance longitudinally on a T-bench**
│	
└─GIBLJIVOST	Flexibility
│ └─**MGATPK**	**Variable: forward bend on the bench**
└─SPMOT	special motor skills
├─ENKOGI	energy component of movement
│ ├─MOČ	special power
│	
├─ODRMOČEL	elastic power
│ │ │	
└─**MMRNPK**	**Variable: jumps over the bench for 30 seconds**
│ │ └─STATMOČ	static power
│ │ └─**SMPRE**	**Variable: Egg (downhill) position**
│ └─HITROST	Speed
│ └─MHALTN	speed of performing alternating movements with legs
│ ├─**MHFNTD**	**Variable: right leg tapping**
│ └─**MHFNTL**	**Variable: left leg tapping**
└─INKOGI	Information component of movement
└─KOORDIN	special coordination
├─MHK	speed of performing complex motor tasks
│ └─**MKHRVIS**	**Variable: ascending and descending**
├─MAG	Agility
│ └─**SKI9**	**Variable: figures 8 around 9 clubs**
└─MRE	ability of reorganization of motor stereotypes
└─**MMENSDN**	**Variable: standing long jump backwards**

Fig. 1 Hierarchically arranged expert model of morphological and motor variables for U16 category of competitors in alpine skiing (Lešnik, 1996)

The data were processed by means of the SMMS (Sport Measurement Management System) program (Rajković, Bohanec, Leskošek, & Šturm, 1997; Leskošek et al., 2002). The criterion variable is represented by a sum of points scored in competitions within the Rauch Cup in the 2015/16 season (SAS, 2016). When seeking answers to the research questions, two methods were used. The first one is the method of expert modelling which belongs to the methods of artificial intelligence. The expert model is composed of hierarchically arranged dimensions of the specification equation which have the characters of multi-dimensionality. This means that at individual levels, and in the end also at the highest level, the characteristics of all the other (hierarchically lower) variables as well as the lowest possible share of mistake are encompassed. Individual variables were joined in a hierarchical tree form, where the potential success of an individual within the group of test participants was calculated on the basis of a criterion function (normalizers) and weights (Jošt et al., 1998). The second part of the research dealt with the calculation of the basic statistical parameters and the calculation of Pearson's correlation coefficient between the calculated marks (obtained by means of the expert model method) and competitive success (results obtained by the final calculation of all the Rauch Cup competitions). By calculating the correlation, we tried to answer the dilemma whether those competitors who had better motor abilities or who were morphologically more suitable achieved better or worse results in the Rauch Cup in the 2015/16 season.

RESULTS

The values of final marks based on the expert system method are in accordance with the quality of the selected sample. This sample consists of competitors who differ to a great extent in marks at the highest level, as well as in marks at hierarchically lower levels. This was also proved by the range of the calculated marks from the lowest 1.64 (satisfactory) to the highest 4.15 (excellent). The normal distribution of the results obtained is confirmed by the calculated value of the coefficient of the normality of distribution according to the K–S test (r=0.884).

The presented final order of the potential success of the sample of test participants (Table 1) shows that the competitors with the mark 'good' are most numerous (14 test participants). At the highest level of the tree of success, the 'very good' mark was achieved by 9 test participants, 4 test participants were marked 'suitable', 2 competitors obtained the 'excellent' mark and the 2 'satisfactory' mark. On the basis of the calculation of Pearson's correlation coefficient between the marks obtained by the expert system method and the actual success (points scored in the Rauch Cup competitions), we established a statistically significant level of connection. The calculation of the level of connection between the assumed assessment of the competitive success (expert system) and the actual success (points) is a relevant indicator of the validity and quality of the reduced model of potential success.

The value of Pearson's correlation coefficient of the connections between the assumed assessments of success based on the expert model method and competitive success of older boys in Alpine skiing is statistically significant and amounts to 0.47. The value of the obtained coefficient is statistically significant at the level of 1 %, which proves not only the quality of the chosen sample of variables of morphology and motor skills but also

the suitability of the configuration of the developed potential model of success for the treated sample of test participants. The calculation of the marks at the highest level according to the expert system method, the final Rauch Cup classification with achieved points and calculation of Pearson's correlation coefficient between the calculated marks and competitive successfulness are shown in Table 1.

Table 1 The calculation of the marks at the highest level according to the expert system method, final Rauch Cup classification with achieved points and calculation of Pearson's correlation coefficient (r) between the calculated marks and competitive success

Expert system rank	Competitor	Expert system mark	Descriptive mark	Final Rauch Cup rank (2015/16)	Achieved points	Correlation (r)
1.	C	4.15	Excellent	2.	645	
2.	F	4.02	Excellent	9.	315	
3.	AC	3.88	very good	15.	206	
4.	E	3.84	very good	1.	750	
5.	L	3.8	very good	12.	231	
6.	G	3.78	very good	27.	73	
7.	AD	3.77	very good	3.	533	
8.	N	3.76	very good	10.	286	
9.	D	3.7	very good	17.	193	
10.	AE	3.65	very good	21.	150	
11.	Z	3.54	very good	8.	327	
12.	A	3.47	good	24.	120	
13.	J	3.46	good	19.	174	
14.	M	3.45	good	12.	231	
15.	V	3.43	good	6.	374	
16.	AF	3.41	good	25.	112	**r=0.47****
17.	S	3.35	good	7.	341	
18.	AH	3.35	good	23.	143	
19.	AA	3.33	good	4.	435	
20.	T	3.26	good	31.	57	
21.	H	3.23	good	20.	153	
22.	K	3.23	good	16.	203	
23.	I	3.22	good	14.	230	
24.	O	3.15	good	5.	412	
25.	R	3.09	good	26.	198	
26.	B	2.93	suitable	18.	182	
27.	AI	2.8	suitable	29.	69	
28.	AG	2.62	suitable	22.	148	
29.	AB	2.61	suitable	11.	283	
30.	P	2.34	satisfactory	28.	72	
31.	U	1.64	satisfactory	30.	64	

Taking the entire group into consideration, the obtained results show the average level of the morphological and motor dimensions of the sample of young competitors in Alpine

skiing. The marks obtained show that there are quite a few differences among them and that those competitors, in particular, who obtained worse marks could make progress in future if their training process was planned and suitably led. If a coach wants to plan the training process well, he must know the better and worse developed dimensions of each individual and on the basis of this, the training process should be adapted in terms of quantity and contents. A suitable analysis of an individual's state and well-planned and organized training can have a positive effect on the achievement of better placings in competitions in the season to come.

DISCUSSION

In Alpine skiing, the quality of this ability is useful in the testing and selection of the skis for the competitive skiing season, as well as adapting topical knowledge and techniques to new trends which are the key to achieving better or even the best results in competitions (Bandalo, 2016).

On the basis of information obtained by the coach about each individual competitor in the training process, the coach can numerically and descriptively assess the competitor's state of motor abilities and morphological characteristics with the help of expert modelling. The data processing with the SMMS program also makes various presentations of results (profiles, graphs, histograms, etc.) possible; these presentations enable the coach to quickly understand the state of each individual (Leskošek, Bohanec, Kapus, & Rajković, 1997). Taking the individual's advantages and disadvantages into account, the coach can make more detailed plans concerning the quantity as well as the contents of training in future (Lešnik, 1996; Dolenec, 1996).

The results obtained are a relevant indicator of the quality of the formed model, but despite this we have to be aware that the extension of the model of success can help us to come even closer to the actual state of an individual competitor as well as the whole group (LeMaster, 2007). In the past, expert modelling was used to establish not only the motor and morphological but also the psychological status of young competitors. In younger categories of competitors, the psychological model did not show a statistically significant influence on competitive success (Lešnik, 1996; Dolenec, 1996). The reasons for that can be due to the fact that the 15 and 16-year old children are immature personalities, therefore they are unable to appropriately answer the questionnaires concerning personality characteristics and motivation (Cobb, 2007; Davis & Mogk, 1994). Besides psychological and other aspects of treating young competitors (social, medical status, etc.), the quality and quantity of work on snow is another important factor in the training process itself. In this respect and in case of a suitable distribution of cycles and determination of the number of days with snow, it is important to emphasize the exercise of technical and tactical elements in different course settings and exercise conditions (SAS, 2015).

Expert modelling represents a method of holistic study and establishment of the dimensions of the psychomotor status of competitors in a certain period of training, and these dimensions are important for success (Auersperger, Ulaga, & Škof, 2009). Due to a high number of factors and influences which accompany competitors on their way to success (Gorski, Rosser, & Hoppeler, 2014), it is difficult to know all of them, but we do strive to reduce the unresearched and unknown to a minimum. The starting point for the development

of the model of potential success is, therefore, the objective reality which is, however, too wide to be encompassed in its entirety. This is why we limited ourselves to certain aspects of treatment only (Fig. 1) which provide a profound insight into the psychosomatic status of an individual competitor on the one hand, and open up new possibilities of research and closeness to the objective reality on the other. The training process that is focussed on an individual must aim at developing positive young personalities who develop in accordance with the rules of biopsychosocial development (LeMaster, 2007). The consequences of unharmonized growth of the musculoskeletal system are primarily reflected in a reduced ability for the regulation of movement (information component), and the dimensions of basic motor skills play an important role in this process (Malina, Bouchad, & Bar-Or, 2004). Especially in this age category, these motor skills represent the widest necessary part of motor abilities which are a basis for the development into a top competitor (Lešnik, Šimunič, Žvan, & Pišot, 2012).

The results of the present study are important from the point of view of theory and practice, since they confirm the validity of the set model and the suitability of the selection of the encompassed dimensions which should represent a basis for the monitoring of the development of the psychosomatic status of competitors in future. The set model is intended primarily for work with young categories of competitors; with certain modifications it is also intended for work with older categories of competitors in Alpine skiing (SAS, 2015). The established values play an important role in the direction of the training process of young categories of Alpine skiers. On the basis of the results obtained in this study, it is possible to regulate the process of transformation with the aim of influencing the development of those abilities which are most important for achieving top sports results. Here, we should not forget the importance of a further development of the model as well as the continuous monitoring of the development (possibly not only the phychomotor development) of young Alpine skiers. This is only possible with a regular and systematic performance of measurements and the establishment and control of the initial and final state of the participans in particular periods of the training process (Lešnik, 1996).

CONCLUSION

In Slovenia, there is an increasing number of coaches who make use of the SMMS program in planning and conducting training. On the basis of the results of studies that have been obtained over a period of more than twenty years (Bandalo, 2016; Lešnik, 1996), the coach can (with greater certainty) include those contents in the training process with the help of which an individual will make progress in worse assessed dimensions and will consequently have a greater chance to achieve better results in competitions. The regular checking of the dimensions of the psychosomatic status of competitors with the help of expert modelling is useful in planning and directing the training process of younger categories of Alpine skiers (Žvan & Lešnik, 2000).

With the help of expert modelling we have confirmed that the coaches' work concerning the motor preparation of competitors is well planned. The calculation of the correlation between potential and competitive success has confirmed the quality of the choice of predictors which form the current model of potential success. Despite that the obtained curve of the connection between the calculated marks of the expert model and

criterion variable leads to the conclusion that besides the morphological and motor status, competitors possess quite a few potentials that are not exploited sufficiently (psychology, technique, tactics, etc.). In future, it will be necessary to find ways and methods that can be used to measure and evaluate those factors of success in younger categories of competitors that will enable an even better insight into the work with younger competitors. Good work carried out by the coaches can be observed in the results achieved by the Slovene competitors in international competitions. These results are also the best proof of the quality-oriented selection process and this process is important for younger as well as for older categories of competitors. The results achieved in the most important international competitions for children (Trofeo Topolino, Loka Cup, etc.) already confirm the correct orientation of the coaches' work. We will try to make use of this in the future. Our task is to help the greatest possible number of young potentials in order to direct them to become champions in senior competitions.

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KORELACIJA IZMEĐU PROCENE EKSPERTSKOG MODELA I TAKMIČARSKE USPEŠNOSTI MLAĐIH KATEGORIJA ALPSKIH SKIJAŠA

Ekspertsko modeliranje predstavljeno je kao važan deo planiranja i sprovođenja obuke i analize efekata obuke različitih kategorija takmičara u alpskom skijanju u Sloveniji. Na osnovu heurističkog pristupa, formiran je model uspeha. U kategoriji starijih dečaka (U16) model se sastoji od 17 dimenzija motoričkih podsitema i 8 dimenzija morfološkog podsistema; s druge strane, uspeh u konkurenciji (kriterijumska varijabla) je procenjen na osnovu obračuna bodova osvojenih na takmičenjima Rauch Cupa u sezoni 2015/16. Motoričke i morfološke dimenzije su merene na uzorku od 31 aktivnih takmičara u kategoriji starijih dečaka (U16). Uz pomoć SMMS programskog paketa, ocene su izračunate na svim nivoima potencijalnog modela uspeha. Markeri izračunati za pojedinačne takmičare kao i za celu grupu koristili su treneri kao korisna orijentacija prilikom planiranja i sprovođenja procesa obuke. U drugom delu ankete nameravali smo uspostaviti vezu između oznaka izračunatih metodom ekspertskog sistema (heuristički pristup) i kriterijumske varijable. Izračunati koeficijent korelacije Pearson-a potvrdio je statistički značajnu vezu između izračunatih maraka (metod stručnog sistema) i stvarnog uspeha (bodovi osvojeni na takmičenjima Rauch Cup-a). Dobijeni rezultat (r = 0,47) je relevantan indikator validnosti i odgovarajuće konfiguracije smanjenog modela potencijalnog uspeha.

Ključne reči: *alpsko skijanje, ekspertsko modeliranje, procena uspeha, mladi takmičari*