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EXPERT MODEL FOR THE EVALUATION OF POTENTIAL COMPETITION PERFORMANCE IN CROSS-COUNTRY SKIERS EXEMPLIFIED BY TWO EVALUATED ATHLETES

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Abstract. The objective of the present research was to obtain information on potential competition performance in cross-country skiers by the method of expert modelling. On the basis of expert knowledge, a model of potential performance (MFMPS) was constructed in the form of a decision tree, encompassing motor, functional, morphological, psychological, and sociological subspaces. For all base variables, normalisers were determined, and for all nodes in the MFMPS model, decision rules were determined according to the method applying dependent determination of weights. Potential competition performance of the sample of 14 subjects measured – cross-country skiers in the age of 17 and 18 years was assessed at all levels in the MFMPS model by means of the SMMS program. At the highest levels of the MFMPS model, the correlation between the scores of the variables and the criterion variable SLO_FIS was established by means of the Pearson correlation coefficient. The validity of the MFMPS model – by means of which 81% of the variance of the criterion variable was explained – was established. The model laid out in this way allows us to search for current weak and good points in the preparation status of an athlete, on which the direction and correction of the transformation process is based. In this way, objective longitudinal monitoring of the development of the athlete's potential is also ensured. ***(Biol.Sport 25:211-232, 2008)***

Key words: Cross-country skiing – Potential competition performance – Expert modelling

Introduction

The basic goal of top-level athletes is to be the most successful in a single competition or a series of competitions; and the achievements attained in the said competitions demonstrate their competition performance. Performance in a given competition depends in the first place on the then level of preparation of the psychosomatic status of an athlete. Psychosomatic status is a term which applies to the model of man and designates his state. The model is, of course, laid out on the strongly reduced man system [26]. Many researches in the field of anthropology have led to the knowledge of the existence of the various abilities, properties, and characteristics, representing the fundamental structure of the psychosomatic status of an athlete. By means of coarse taxonomy of the clusters of motor, morphological, functional, cognitive, connate and sociological abilities, characteristics and properties, the athlete can be defined as a biopsychosocial being, within whom there exist innumerable interactions between innumerable dimensions [15]. A hierarchical arrangement of the dimensions of the psychosomatic status of an athlete may enable a more transparent study of the said dimensions and also searching for their correlations with competition performance. All dimensions are mutually connected (correlated); yet, to what extent they are mutually connected depends on the individual athlete and the individual sport.

Based on the concept of the psychosomatic status, a general model of potential competition performance in Nordic skiing, to which cross-country skiing [12] also belongs, was constructed. The model allows us to predict, on the basis of carrying out suitable measurements on athletes, their current potential competition performance. In this way, the transformation process – which should lead the competitor to maximum competition performance during the competition period – can be successfully directed. To meet the requirements of the present research, a special model for cross-country skiing – covering essential subsystems and within them, those dimensions that are of primary importance for competition performance in this sport – was developed on the basis of a general model. The theory of multiparameter decision-making offers a formal basis for building the model, where the fundamental issue is the integration of scores obtained for individual parameters into an overall score [4].

Materials and Methods

The sample consisted of 14 active cross-country skiers (older juniors), who were 17 or 18 years old at the end of the competition season. All competitors participated in at least four competitions for the Slovenian Cup in the competition season.

In the potential model of competition performance (MFMPS: motorics, functional space, morphology, psychology, sociology), 70 independent variables are included. Here, only codes of the variables for individual subspaces – whose meaning can be seen in the description of the MFMPS model (Table 1,2,3,4, and 5) – are given.

Variables of the motor subspace: MMENSDM, MTRSK, MSRKF, MSRKS, MTAPRO, MSCT, MEMTEK, MMENS60, MPON, MKAOSP, MKVS, MSMIZT, MSDTSK, MSPSK, MSSNB, MTPK and MEMMED.

Variables of the functional subspace: VO_2max_LP, VO_2max_ANP (4 $mmol \cdot l^{-1}$), VO_2max_ABS, WATT_LP, WATT_ANP (4 $mmol \cdot l^{-1}$), WATT_ABS. VO_2max was expressed as $ml \cdot min^{-1} \cdot kg^{-1}$ of body weight. Relative loading WATT ($WATT \cdot kg^{-1}$ of body weight) was calculated according to the instructions [18]. A standardised test for cross-country skiers on a Woodway treadmill was carried out. The subjects measured walked on the treadmill with skiing poles at a speed of 7 $km \cdot h^{-1}$ in the first 9 min, and after the 9th min and till the end of the test, at a speed of 7.5 $km \cdot h^{-1}$. The inclination of the treadmill was increased every 3 min.

Variables of the morphological subspace: ATV, ATT, ADZGO, ADSPO, AON, AOPR, AOS, APKOM, ASR, ASM, APKOL and AKGT.

Variables of the psychological subspace: Special psychological abilities were measured with a 10-min series test (TN–10-A) – [20] and TKD test – test of concentration and achievement [3]: FLUIDINT, FUNVZPOD and FUNKONTR. Motivation or dynamic component of personality was measured by Costell's performance motivation questionnaire [5], Willis competitive motivation questionnaire [29], and by the self-motivation questionnaire [8]: USPEZDEL, USPNGDEL, MOC, POZITIVN, NEGATIVN and SAMOMOT. Personality traits were measured by the FDPI questionnaire – Freiburg personality questionnaire - 76 [2], by perseverance questionnaire [6], and by Spielberg's anxiety scale [25]: NEVROTIC, SPONTAGR, DEPRESIV, RAZDRAZL, DRUZABN, OBVLADAN, REAKTAGR, ZAVRTOST, ODKRITO, EKSTRAV, EMOCLAB, MASKULIN, VZTRAJNO, TEKMANKS and ANKOSLAS.

Variables of the sociological subspace: SIZOBR_M, SIZOBR_O, PDOBPOG, PDOBSTDE, PDOBORG, PSPAKT_M, PSPAKT_O, IKLFUN_M, IKLFUN_O, IDELMS_M and IDELMS_O.

Criterion variable: Slovenian FIS points (SLO_FIS) of competitors attained in the competition season 2001-02 were chosen as a criterion variable. In calculating the points for the entire season, the average of four most successful races of the individual competitor in the competition season was taken into account.

Motorics tests were carried out in the sports hall and on the athletic running track and the functional test protocol in the Laboratory for the Physiology of Sport, Faculty of Sport in Ljubljana in March 2002. The data were processed with the SPPS software package and SMMS program (Sport Measurement Management System), developed at the Faculty of Sport in Ljubljana. In agreement with the objectives and hypotheses, the research was conducted in the following phases:

A model of potential competition performance of cross-country skiers (MFMPS) in the form of a decision-tree was developed. The model covered motor, morphological, psychological, sociological, and functional subspaces of the psychosomatic status of competitors.

Normalisers for all elementary variables (tests) in the MFMPS model were set up. They represent the points that determine the utility function *v*, which for a given measured (raw) result *x* on the base criterion determines its value or utility [4]. The function is determined in such a way that in the variable for raw results, an arbitrary number of points is defined. The expert thus gives only the explicit, numerical and attribute values of the utility function for some points, while for other points, the values are determined by computing the straight line between two points by means of interpolation.

An example of normalisers for the MSPSK variable – jumps over Swedish gymnastic bench (Table 2: e.g. 31: 8 means that 31 repetitions in this test have received the numerical score 8: very good). Numerical and descriptive values of scores: 0-1.99 = unsatisfactory, 2-3.99 = satisfactory, 4-6.99 = good, 7-8.99 = very good, 8.99-10.00 = excellent.

Decision rules for all nodes in the MFMPS model were set up. This is the value of a hypothetical contribution (in %) of each individual variable to competition performance at the respective node of the MFMPS model. It was determined according to the method applying dependent determination of weights. According to this method, the total contribution of the weights of all variables of lower order that constitute a variable of higher order is, in relative terms, 100 at any individual node. In absolute terms, however, the sum of the weights of all variables of lower order (tests) in the MFMPS model yields the sum 100.

By the SMMS program, scores for all variables at all levels in the MFMPS model were calculated for each subject measured. First, for elementary variables (tests) and then gradually for all composite variables at higher nodes, up to the highest node, the so-called prognostic score of competition performance of the subject measured. The calculation was made according to the following formula:

$$Svr = (Snr_1 \times P) + (Snr_2 \times P) + \ldots + (Snr_n \times P)$$

Svr – normalised value of a higher-order variable
Snr – normalised value of a lower-order variable
P – weight of a lower-order variable (decision rule, weight).

At the highest levels of the MFMPS model, the correlation between the scores of the variables and the criterion variable were established by Pearson's coefficient of correlation. In this way, the validity of the whole MFMPS model was also established.

Results

Structure of the MFMPS model of potential competition performance: Tables 1,2,3,4, and 5 show the structure of the model of potential competition performance (MFMPS). Represented are the subspaces with variables, normalisers and decision rules (weights).

Table 1
Model of potential competition performance MFMPS at the highest levels

Test code	Name of test	Weights	Normalisers
OC_POTENC	Score of potential competition performance	100	
├─MOTOR	Motor abilities	30	
├─FUNKC	Functional abilities	30	
├─MORF	Morphology	12.5	
├─PSIH	Psychological abilities and properties	17.5	
└─SOCIO	Sociological characteristics	10	

OC_POTENC - score of potential competition performance; MOTOR - motor abilities;

Table 2
A segment of the MFMPS model of competition performance at the level of motor abilities

Test code	Weights	Normalisers
├MOTOR	30	
│ ├─ENKOGI	20.4	
│ │ ├─TRAEKS	12.8	
│ │ │ ├─VZD_MOC	5.6	
│ │ │ │ ├─REP_MOC	4.2	
│ │ │ │ │ ├─MSPSK	1.6	8:0, 24:2, 26:4, 27:5, 29:7, 31:8, 33:9, 42:10
│ │ │ │ │ ├─MSSNB	1.2	1:0, 10:2, 14:4, 16:5, 18:7, 20:8, 22:9, 25:10
│ │ │ │ │ └─MSDTSK	1.4	0:0, 12:2, 15:4, 17:7, 19:9, 21:10
│ │ │ │ └─ST_MOC	1.4	
│ │ │ │ └─MSMIZT	1.4	0:0, 56:2, 65:4, 85:7, 102:9, 120:10
│ │ │ └─TEK_VZD	7.2	

Test code	Weights	Normalisers
│ │ │ └─MSCT	7.2	480:10, 492:9, 504:8, 515:7, 530:5, 537:4, 554:2, 820:0
│ │ └─INTEKS	7.6	
│ │ ├─HIT_MOC	4.4	
│ │ │ ├─MMENSDM	2.2	150:0, 225:2, 233:4, 237:5, 243:7, 250:8, 257:9, 270:10
│ │ │ └─MEMMED	2.2	300:0, 695:2, 719:4, 781:7, 861:9, 910:10
│ │ ├─EKS_MOC	1.2	
│ │ │ └─MEMTEK	1.2	2,9:10, 3,2:9, 3,27:7, 3,43:4, 3,53:2, 5,1:0
│ │ └─EL_MOC	2	
│ │ └─MTRSK	2	450:0, 700:2, 725:4, 762:7, 799:9, 810:10
│ └─INKOGI	9.6	
│ ├─REGSIN	4.2	
│ │ ├─RAVNOT	0.9	
│ │ │ ├─MSRKS	0.3	0:0, 1,7:2, 3,3:4, 5,6:7, 7,5:9, 30:10
│ │ │ └─MSRKF	0.6	0:0, 1,6:2, 2,5:4, 4,1:7, 5,1:9, 30:10
│ │ ├─HITR	2.8	
│ │ │ ├─MTAPRO	0.4	0:0, 34:2, 37:4, 40:7, 43:9, 50:10
│ │ │ └─MMENS60	2.4	7,7:10, 8:9, 8,1:8, 8,2:7, 8,5:5, 8,6:4, 9,1:2, 13:0
│ │ └─GIBLJIV	0.5	
│ │ └─MTPK	0.5	0:0, 44:2, 49:4, 54:7, 59:9, 65:10
│ └─KOORD	5.4	
│ ├─MKVS	1.3	7,9:10, 8,2:9, 8,8:7, 9,3:4, 10:2, 18,5:0
│ ├─MKAOSP	1.8	15,1:10, 16:9, 16,2:8, 16,5:7, 17,1:5, 17,4:4, 18,2:2, 25,1:0
│ └─MPON	2.3	6,1:10, 7,2:9, 7,5:8, 7,8:7, 8,2:5, 8,6:4, 9,4:2, 18,1:0

MOTOR - motor abilities; ENKOGI - energy component of movement; TRAEKS - excitation duration; VZD_MOC - endurance power; REP_MOC - repetitive power; MSPSK - jumps over Swedish gymnastic bench; MSSNB - bent hangs on parallel bars; MSDTSK - trunk lifting on Swedish gymnastic bench; ST_MOC - static power; MSMIZT - hang with elbows bent; TEK_VZD - running endurance; MSCT - Cooper's test (2400 m); INTEKS - excitation intensity; HIT_MOC - fast power; MMENSDM - long jump from standing; MEMMED - heavy ball throw; EKS_MOC - explosive power; MEMTEK - 20-m sprint (high start); EL_MOC - elastic power; MTRSK - triple jump from standing; INKOGI - information component of movement; REGSIN - regulation of synergists; RAVNOT – balance; MSRKS - balance sagitally; MSRKF - balance frontally; HITR – speed; MTAPRO - tapping with hand; MMENS60 - 60-m run; GIBLJIV - flexibility; MTPK - bending forward on bench; KOORD – coordination; MKVS - side steps; MKAOSP - eight with bending; MPON - polygon backwards.

The tree structure of the elementary and aggregated variables of motorics was built on the basis of a hypothetical general hierarchic arrangement of the motor space [16]. Normalisers and decision rules are founded on the scientific outcomes of the previous researches in the field of cross-country skiing [11,22] and take into account the demands of modern competitive cross-country skiing in the motor space.

Table 3
A segment of the MFMPS model of potential competition performance at the level of functional abilities and morphological characteristics

Test code	Weights	Normalisers
├FUNKC	30	
│├─VO_2max	17	
││ ├─VO_2max_LP	4.8	20,5:0, 37,5:2, 41,8:4, 46,1:7, 49,5:9, 52,5:10
││ ├─VO_2max_ANP	5.8	35:0, 53,5:2, 56,8:4, 59,6:7, 62,25:9, 68:10
││ └─VO_2max_ABS	6.4	45,5:0, 62,4:2, 65:4, 68,5:7, 72,3:9, 75,2:10
│└─WATT	13	
│ ├─WATT_LP	3.7	0,5:0, 1,31:2, 1,4:4, 1,59:7, 1,73:9, 2,15:10
│ ├─WATT_ANP	4.3	1:0, 2,29:2, 2,49:4, 2,69:7, 2,99:9, 3,3:10
│ └─WATT_ABS	5	1,5:0, 3,14:2, 3,26:4, 3,5:7, 3,75:9, 4,1:10
├MORF	12.5	
│├─MEROKOS	5	
││├─DOLOKOS	1.8	
│││ ├─ATV	0.9	120:0, 157,9:2, 163,3:4, 171,7:7, 177,3:9, 181,5:10, 185,4:9, 189:7, 194,4:4, 198:2, 205:0
│││ ├─ADZGO	0.4	45,3:0, 76:2, 77,7:4, 79,6:7, 80,3:9, 85:10
│││ └─ADSPO	0.5	40,5:0, 99,9:2, 101,3:4, 103,1:7, 105,1:9, 109:10
││└─SIROKOS	3.2	
││ ├─APKOM	0.8	3,1:0, 6,5:2, 6,9:4, 7,1:7, 7,3:9, 8:10
││ ├─APKOL	1	5,3:0, 8,9:2, 9,3:4, 9,6:7, 9,9:9, 11:10
││ ├─ASR	1.2	15,7:0, 38:2, 38,7:4, 39,4:7, 40,9:9, 43:10
││ └─ASM	0.2	10,5:0, 26,3:2, 27:4, 28,5:7, 29,4:9, 30:10
│└─MERVOLUM	7.5	
│ ├─OBSEGI	4.5	
│ │ ├─AON	1.4	8,3:0, 27,5:2, 28,3:4, 28,9:7, 29,5:9, 31:10
│ │ ├─AOS	1.3	25,6:0, 53,5:2, 54,9:4, 56:7, 57,5:9, 63:10
│ │ └─AOPR	1.8	40,5:0, 89:2, 91:4, 92,9:7, 94,5:9, 100:10
│ └─MASE	3	
│ ├─ATT	2.4	15,5:0, 53,9:2, 57,5:4, 62,9:7, 66,5:9, 70,5:10, 73,6:9, 77,2:7, 82,6:4, 87,3:2, 101,7:0

Test code	Weights	Normalisers
└─AKGT	0.6	1,2:0, 4,4:2, 4,8:4, 6,4:7, 7,2:9, 8,5:10, 9,8:9, 10,6:7, 11,8:4, 12,3:2, 25:0

FUNKC - functional abilities; VO_2max - relative oxygen consumption; VO_2max_LP - oxygen consumption at lactate threshold; VO_2max_ANP - oxygen consumption at anaerobic threshold; VO_2max_ABS - maximal oxygen consumption; WATT - loadings at thresholds; WATT_LP - load at lactate threshold; WATT_ANP - load at anaerobic threshold; WATT_ABS - maximal load; MORF - morphological characteristics; MEROKOS - skeletal dimensions; DOLOKOS - length of skeleton; ATV - body height; ADZGO - length of upper limbs; ADSPO - length of lower limbs; SIROKOS - width of skeleton; APKOM - elbow diameter; APKOL - knee diameter; ASR - shoulder width; ASM - pelvis width; MERVOLUM - voluminosity dimensions; OBSEGI - circumferences of body segments; AON - circumference of relaxed upper arm; AOS - thigh circumference; AOPR - chest circumference; MASE - body masses; ATT - body weight; AKGT - abdominal skinfold.

The concept of the human organism comprises the system of structures and their functions [17]. Relative oxygen consumption (VO_2max) and the ability to overcome the largest possible load (WATT) were included into our model. The both dimensions are evaluated by individual variables measuring the power of energy processes of the organism and thereby also the manifestation of the said power at the respective levels (thresholds) of the intensity of man's biodynamic effort [1,9].

Morphological space was, consistent with theoretical points of departure and researches in this branch of sport [11,22], divided at the highest level into skeletal dimensions (MEROKOS) and voluminosity dimensions (MERVOLUM). The latter are assigned a larger weight. Skeletal dimensions are hierarchically divided into skeletal dimensions of length and width.

Table 4
A segment of the MFMPS model of competition performance at the level of psychological abilities and properties

Test code	Weights	Normalisers
├PSIH	17.5	
│├SPECPSSP	1.5	
││├─INTELIG	0.4	
│││└─FLUIDINT	0.4	0:0, 14:2, 18,25:4, 21,25:7, 23,75:9, 27:10
││└─KONCENTR	1.1	
││ ├─FUNVZPOD	0.7	0:0, 61:2, 81:4, 111:7, 145:9, 244:10
││ └─FUNKONTR	0.4	0,48:10, 5,75:9, 6,45:7, 7,8:4, 8,47:2, 15:0
│├MOTIVAC	7	
││├─SPLSTMOT	1.7	
│││├─USPEZDEL	1.2	0:0, 1:1, 2:2, 4:4, 6:7, 8:9, 9:10
│││└─USPNGDEL	0.5	0:0, 1:2, 2:4, 3:7, 4:9, 5:10, 6:9, 7:7, 9:4, 10:2, 13:0
││├─TEKMOT	3.6	
│││├─POZITIV	2	10:0, 50:2, 56:4, 65:7, 72:9, 80:10
│││├─NEGATIV	1	10:0, 20:2, 28:4, 32:7, 36:9, 38:10, 41:9, 44:7, 49:4, 60:2, 72:0
│││└─MOC	0.6	0:0, 33:2, 35:4, 39:7, 45:9, 68:10
││└─SAMOM	1.7	
││ └─SAMOMOT	1.7	40:0, 116:2, 125:4, 142:7, 156:9, 173:10
│└OSEBLAST	9	
│ ├─SPSTRLAS	3.7	
│ │├─MASKULIN	1.2	0:1, 2:2, 3:4, 4:7, 5:9, 7:10
│ │├─DEPRESIV	0.7	0:10, 2:9, 3:7, 5:4, 6:2, 7:1
│ │├─ODKRITO	0.3	0:1, 2:2, 3:4, 5:7, 6:9, 7:10
│ │├─SPONTAGR	0.8	0:10, 2:9, 3:7, 5:4, 6:2, 7:1
│ │└─RAZDRAZL	0.7	0:10, 1:9, 2:7, 5:4, 6:2, 7:1
│ ├─SOCPSLAS	1.5	
│ │├─ZAVRTOST	0.2	0:10, 2:9, 3:7, 5:4, 6:2, 7:1
│ │├─DRUZABN	0.4	0:1, 1:2, 3:4, 5:7, 6:9, 7:10
│ │├─REAKTAGR	0.4	0:10, 1:9, 2:7, 4:4, 6:2, 7:1
│ │└─EKSTRAV	0.5	0:1, 2:2, 3:4, 5:7, 6:9, 7:10
│ └─TEKMLAST	3.8	
│ ├─VZTRAJN	1.4	
│ │└─VZTRAJNO	1.4	0:0, 11:2, 13:4, 15:7, 18:9, 20:10
│ ├─ANKSIOZ	0.5	
│ │├─ANKOSLAS	0.2	20:10, 30:9, 38:7, 45:4, 51:2, 80:0
│ │└─TEKMANKS	0.3	25:10, 29:9, 38:7, 47:4, 54:2, 90:0
│ └─OBVLSTR	1.9	

Test code	Weights	Normalisers
│ ├─EMOCLAB	0.6	0:10, 1:9, 3:7, 5:4, 6:2, 7:1
│ ├─NEVROTIC	0.5	0:10, 1:9, 2:7, 3:4, 5:2, 7:1
│ └─OBVLADAN	0.8	0:1, 2:2, 3:4, 5:7, 6:9, 7:10

PSIH - psychological abilities and properties; SPECPSSP - special psychological abilities; INTELIG – intelligence; FLUIDINT - fluid intelligence; KONCENTR - concentration and achievement; FUNVZPOD - function of encouragement; FUNKONTR - function of control; MOTIVAC – motivation; SPLSTMOT - general performance motivation; USPEZDEL - performance (success) based on work; USPNGDEL - performance (success) irrespective of work; TEKMOT - competition motivation; POZITIV - positive competition motivation; NEGATIV - negative competition motivation; MOC - motive of power; SAMOM - self-motivation; OSEBLAST - personality traits; SPSTRLAS - special structural traits; MASKULIN – masculinity; DEPRESIV – depressiveness; ODKRITO – sincerity; SPONTAGR - spontaneous aggressiveness; RAZDRAZL - irritability; SOCPSLAS - sociopsychological properties; ZAVRTOST – inhibition; DRUZABN – sociability; REAKTAGR - reactive aggressiveness; EKSTRAV – extroversion; TEKMLAST - competition properties; VZTRAJN – endurance; VZTRAJNO – endurance; ANKSIOZ – anxiety; ANKOSLAS - anxiety as personality trait; TEKMANKS - competition anxiety; OBVLSTR - ability to cope with stress; EMOCLAB - emotional lability; NEVROTIC – neuroticism; OBVLADAN – self control.

The framework of referenceability of the knowledge base in the psychological subspace of athletes was taken according to the psychological model prepared for ski jumpers [28]. It was adjusted to the expert knowledge in the field of psychological behaviour and motivational dynamics of cross-country skiers and to the characteristics of their sport.

Table 5

A segment of the MFMPS model of competition performance at the level of sociological characteristics

Test code	Name of test	Weights	Normalisers
└SOCIO	Sociological characteristics	10	
├SOC_PODSIS	Socialisation subsystem	2	
│└─IZOBRAZBA	Education	2	
│ ├─SIZOBR_M	*Education of mother*	1	1:3, 2:5, 3:7, 4:10, 5:7, 6:5, 7:3

Test code	Name of test	Weights	Normalisers
│ └─SIZOBR_O	*Education of father*	1	1:3, 2:5, 3:7, 4:10, 5:7, 6:5, 7:3
├POSL_PODSIS	Consequential subsystem	5	
│ ├─KLUB_DELO	Work in club	2.4	
│ │ ├─PDOBPOG	*Conditions for training*	0.8	1:2, 2:4, 3:7, 4:9, 5:10
│ │ ├─PDOBSTDE	*Good expert work*	0.8	1:2, 2:4, 3:7, 4:9, 5:10
│ │ └─PDOBORG	*Good organisation of club*	0.8	1:2, 2:4, 3:7, 4:9, 5:10
│ └─SPORT_AKT	Involvement of parents in sport	2.6	
│ ├─PSPAKT_M	*Involvement of mother in sport*	1.3	1:7, 2:10, 3:7, 4:3, 5:3
│ └─PSPAKT_O	*Involvement of father in sport*	1.3	1:7, 2:10, 3:7, 4:3, 5:3
└INST_PODSIS	Institutional subsystem	3	
├─KLFUNST	Functions of parents in club	1.5	
│ ├─IKLFUN_M	*Function of mother in club*	0.7	1:5, 3:7, 4:9, 5:10
│ └─IKLFUN_O	*Function of father in club*	0.8	1:5, 3:7, 4:9, 5:10
└─DELMST	Occupation of parents	1.5	
├─IDELMS_M	*Position of mother at work*	0.7	2:10, 3:8, 4:5, 5:3
└─IDELMS_O	*Position of father at work*	0.8	2:10, 3:8, 4:5, 5:3

SOCIO - sociological characteristics; SOC_PODSIS - socialisation subsystem;…

The phenomenon model of social stratification [24] represents the fundamental theoretical point of departure for the construction of a sociological subsystem. As a knowledge base, information from the researches establishing social and demographic characteristics of cross-country skiing competitors [21] were also used.

Validity of the MFMPS model of potential performance:

Table 6
Validity of the MFMPS model and correlations between individual subspaces and the criterion of competition performance (SLO_FIS)

Relationship between variables	Correlation	Explained variance (%)
OC_POTENC : SLO_FIS	-0.90**	81 %
├─OC_MOTOR : SLO_FIS	-0.80**	64 %
├─OC_FUNKC : SLO_FIS	-0.75**	56 %
├─OC_MORF : SLO_FIS	-0.36	13 %
├─OC_PSIH : SLO_FIS	-0.55*	30 %
└─OC_SOCIO : SLO_FIS	-0.25	6 %

SLO_FIS - criterion variable; OC_POTENC - score of general potential competition performance; OC_MOTOR - score of potential competition performance in motor abilities; OC_FUNKC - score of potential competition performance in functional abilities; OC_MORF - score of potential competition performance in morphological characteristics; OC_PSIH - score of potential competition performance in psychological abilities and properties; OC_SOCIO - score of potential competition performance in sociological characteristics; $*p_{(0.05)}=0.53$; $**p_{(0.01)}=0.66$;

Results of the evaluation of potential competition performance for two subjects:

Tables 7,8,9,10, and 11 show the results of the evaluation of potential competition performance at all levels of the MFMPS model for two subjects.

Table 7

Scores for subjects A and B at the highest levels of the MFMPS model of potential competition performance

Test code	MFMPS model					
	Competitor "A" (SLO_FIS=165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS=99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
OC_POTENC		6.83	good		7.55	very good
├─OC_MOTOR		6.41	good		6.70	good
├─OC_FUNKC		5.68	good		8.70	very good
├─OC_MORF		7.86	very good		6.34	good
├─OC_PSIH		7.90	very good		7.80	very good
└─OC_SOCIO		8.36	very good		7.67	very good

OC_POTENC - score of general potential competition performance; OC_MOTOR - score of potential competition performance in motor abilities; OC_FUNKC - score of potential competition performance in functional abilities; OC_MORF - score of potential competition performance in morphological characteristics; OC_PSIH - score of potential competition performance in psychological abilities and properties; OC_SOCIO - score of potential competition performance in sociological characteristics; Res - raw test results; F (x) - numerical score; Score - attribute score;

Numerical and descriptive values of scores: 0-1.99=unsatisfactory, 2-3.99=satisfactory, 4-6.99=good, 7-8.99=very good, 8.99-10.00=excellent.

Table 8
Scores for subjects A and B in the MFMPS model of potential competition performance at the level of motor abilities

Test code	MFMPS model					
	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
OC_POTENC		6.83	good		7.55	very good
├OC_MOTOR		6.41	good		6.70	good
├ENKOGI		6.34	good		6.99	good
├TRAEKS		6.05	good		8.38	very good
├VZD_MOC		7.06	very good		7.48	very good
├REP_MOC		7.00	very good		6.95	good
├─MSPSK	28	6.00	good	33	9.00	excellent
├─MSSNB	17	6.00	good	12	3.00	satisfactory
└─MSDTSK	19	9.00	excellent	18	8.00	very good
└ST_MOC		7.24	very good		9.06	excellent
└─MSMIZT	87	7.24	very good	103	9.06	excellent
└TEK_VZD		5.27	good		9.08	excellent
└─MSCT	528	5.27	good	491	9.08	excellent
└INTEKS		6.84	good		4.64	good
├HIT_MOC		6.49	good		3.81	satisfactory
├─MMENSDM	235	4.50	good	239	5.67	good
└─MEMMED	840	8.48	very good	685	1.95	unsatisfactory
├EKS_MOC		9.07	excellent		4.56	good
└─MEMTEK	3.18	9.07	excellent	3.4	4.56	good
└EL_MOC		6.27	good		6.51	good
└─MTRSK	753	6.27	good	756	6.51	good
└INKOGI		6.54	good		6.10	good
├REGSIN		7.74	very good		6.08	good
├RAVNOT		7.05	very good		7.83	very good
├─MSRKS	2.3	2.75	satisfactory	4.2	5.17	good
└─MSRKF	9.9	9.19	excellent	9.1	9.16	satisfactory
├HITR		9.00	very good		5.29	good
├─MTAPRO	40	7.00	very good	40	7.00	very good
└─MMENS60	7.9	9.33	excellent	8.5	5.00	good
└GIBLJIV		1.95	unsatisfactory		7.40	very good
└─MTPK	43	1.95	unsatisfactory	55	7.40	very good

Test code	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years) Res	F(x)	Score	Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years) Res	F(x)	Score
└KOORD		5.60	good		6.12	good
├─MKVS	9.1	5.20	good	9.8	2.57	satisfactory
├─MKAOSP	17.7	3.25	satisfactory	17.1	5.00	good
└─MPON	7.6	7.67	very good	7.2	9.00	excellent

MFMPS model

Res - raw test results; F (x) - numerical score; Score - attribute score;
Numerical and descriptive values of scores: 0-1.99=unsatisfactory, 2-3.99=satisfactory, 4-6.99=good, 7-8.99=very good, 8.99-10.00=excellent;

Table 9
Scores for subjects A and B in the MFMPS model of potential competition performance at the level of functional abilities and morphological characteristics

MFMPS model

Test code	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years) Res	F(x)	Score	Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years) Res	F(x)	Score
├OC_FUNKC		5.68	good		8.70	very good
├─VO2max		6.56	good		7.96	very good
├─VO2_LP	49.8	9.10	excellent	49.39	8.94	very good
├─VO2_ANP	58.97	6.32	good	61.72	8.60	very good
└─VO2_ABS	66	4.86	good	68.1	6.66	good
└─WATT		4.54	good		9.66	excellent
├─WATT_LP	1.58	6.84	good	2.06	9.79	excellent
├─WATT_ANP	2.5	4.15	good	3.18	9.61	excellent
└─WATT_ABS	3.21	3.17	satisfactory	3.96	9.60	excellent
├OC_MORF		7.86	very good		6.34	good
├─MEROKOS		8.83	very good		6.66	good
├─DOLOKOS		9.38	excellent		7.50	very good
├─ATV	183	9.62	excellent	173.5	7.64	very good
├─ADZGO	81.3	9.21	excellent	80.5	9.04	excellent
└─ADSPO	105.4	9.08	excellent	102.5	6.00	good
└─SIROKOS		8.53	very good		6.19	good
├─APKOM	7.6	9.43	excellent	7.1	7.00	very good

Test code	MFMPS model					
	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
│ │ ├─APKOL	9.8	8.33	very good	9.5	6.00	good
│ │ ├─ASR	40.1	7.93	very good	39.2	6.14	good
│ │ └─ASM	29.7	9.50	excellent	27.1	4.20	good
│ └─MERVOLUM		7.21	very good		6.13	good
│ ├─OBSEGI		9.52	excellent		4.24	good
│ │ ├─AON	30.3	9.53	excellent	27.3	1.98	unsatisfactory
│ │ ├─AOS	62.3	9.87	excellent	53.5	2.00	satisfactory
│ │ └─AOPR	95.9	9.25	excellent	93.4	7.63	very good
│ └─MASE		3.74	satisfactory		8.96	very good
│ ├─ATT	82.9	3.87	satisfactory	66	8.72	very good
│ └─AKGT	12	3.20	satisfactory	8.4	9.92	excellent

Res - raw test results; F(x) - numerical score; Score - attribute score;
Numerical and descriptive values of scores: 0-1.99=unsatisfactory, 2-3.99=satisfactory, 4-6.99=good, 7-8.99=very good, 8.99-10.00=excellent;

Table 10
Scores for subjects A and B in the MFMPS model of potential competition performance at the level of psychological abilities and properties

Test code	MFMPS model					
	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
├OC_PSIH		7.90	very good		7.80	very good
│├SPECPSSP		5.71	good		3.54	satisfactory
││├INTELIG		5.75	good		8.00	very good
│││└─FLUIDINT	20	5.75	good	22.5	8.00	very good
││└KONCENTR		5.70	good		1.92	unsatisfactory
││ ├─FUNVZPOD	96	5.50	good	60	1.97	unsatisfactory
││ └─FUNKONTR	6.88	6.04	good	9	1.84	unsatisfactory
│├MOTIVAC		7.24	very good		8.75	very good
││├─SPLSTMOT		6.53	good		9.12	excellent

Test code	MFMPS model					
	Competitor "A" (SLO_FIS = 165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS = 99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
│ │ │ ├─USPEZDEL	5	5.50	good	9	10.00	excellent
│ │ │ └─USPNGDEL	4	9.00	excellent	7	7.00	very good
│ │ ├─TEKMOT		6.55	good		8.24	very good
│ │ │ ├─POZITIV	66	7.29	very good	75	9.38	excellent
│ │ │ ├─NEGATIV	26	3.50	satisfactory	30	5.50	excellent
│ │ │ └─MOC	49	9.17	excellent	45	9.00	excellent
│ │ └─SAMOM		9.41	excellent		9.47	excellent
│ │ └─SAMOMOT	163	9.41	excellent	164	9.47	excellent
│ └OSEBLAST		8.78	very good		7.78	very good
│ ├─SPSTRLAS		8.73	very good		8.34	very good
│ │ ├─MASKULIN	5	9.00	excellent	5	9.00	excellent
│ │ ├─DEPRESIV	0	10.00	excellent	3	7.00	very good
│ │ ├─ODKRITO	2	2.00	satisfactory	4	5.50	good
│ │ ├─SPONTAGR	1	9.50	excellent	2	9.00	excellent
│ │ └─RAZDRAZL	1	9.00	excellent	1	9.00	excellent
│ ├─SOCPSLAS		8.80	very good		6.80	good
│ │ ├─ZAVRTOST	1	9.50	excellent	4	5.50	good
│ │ ├─DRUZABN	7	10.00	excellent	7	10.00	excellent
│ │ ├─REAKTAGR	2	7.00	very good	4	4.00	good
│ │ └─EKSTRAV	6	9.00	excellent	5	7.00	very good
│ └─TEKMLAST		8.82	very good		7.62	very good
│ ├─VZTRAJN		9.00	excellent		9.00	excellent
│ │ └─VZTRAJNO	18	9.00	excellent	18	9.00	excellent
│ ├─ANKSIOZ		9.65	excellent		7.90	very good
│ │ ├─ANKOSLAS	25	9.50	excellent	33	8.25	very good
│ │ └─TEKMANKS	26	9.75	excellent	35	7.67	very good
│ └─OBVLSTR		8.47	very good		6.53	good
│ ├─EMOCLAB	0	10.00	excellent	4	5.50	good
│ ├─NEVROTIC	1	9.00	excellent	2	7.00	very good
│ └─OBVLADAN	5	7.00	very good	5	7.00	very good

Res - raw test results; F (x) - numerical score; Score - attribute score;
Numerical and descriptive values of scores: 0-1.99=unsatisfactory, 2-3.99=satisfactory, 4-6.99=good, 7-8.99=very good, 8.99-10.00=excellent;

Table 11
Scores for subjects A and B in the MFMPS model of potential competition performance at the level of sociological characteristics

Test code	MFMPS model					
	Competitor "A" (SLO_FIS=165.40, rank=2, age=17.5 years)			Competitor "B" (SLO_FIS=99.50, rank=1, age=18 years)		
	Res	F(x)	Score	Res	F(x)	Score
└OC_SOCIO		8.36	very good		7.67	very good
├SOC_PODSIS		10.00	excellent		6.00	good
│ └─IZOBRAZBA		10.00	excellent		6.00	good
│ ├─SIZOBR_M	4	10.00	excellent	6	5.00	good
│ └─SIZOBR_O	4	10.00	excellent	3	7.00	very good
├POSL_PODSIS		8.12	very good		8.74	very good
│ ├─KLUB_DELO		9.33	excellent		9.00	excellent
│ │ ├─PDOBPOG	5	10.00	excellent	5	10.00	excellent
│ │ ├─PDOBSTDE	4	9.00	excellent	5	10.00	excellent
│ │ └─PDOBORG	4	9.00	excellent	3	7.00	very good
│ └─SPORT_AKT		7.00	good		8.50	very good
│ ├─PSPAKT_M	1	7.00	very good	2	10.00	excellent
│ └─PSPAKT_O	1	7.00	very good	3	7.00	very good
└INST_PODSIS		7.67	very good		7.00	very good
├─KLFUNST		7.33	very good		6.00	good
│ ├─IKLFUN_M	5	10.00	excellent	2	6.00	good
│ └─IKLFUN_O	1	5.00	good	2	6.00	good
└─DELMST		8.00	very good		8.00	very good
├─IDELMS_M	3	8.00	very good	3	8.00	very good
└─IDELMS_O	3	8.00	very good	3	8.00	very good

Res - raw test results; F(x) - numerical score; Score - attribute score;
Numerical and descriptive values of scores: 0-1.99=unsatisfactory, 2-3.99=satisfactory, 4-6.99=good, 7-8.99=very good, 8.99-10.00=excellent.

Discussion

In building the model, the largest contribution to competition performance was hypothetically ascribed to the motor and functional subspaces (both have a weight of 30) followed by the psychological, morphological, and sociological subspaces. Within the motor subspace, larger weight was assigned to the energy component of movement than to the information one (relative weights in a relationship 20.4:9.6). From Tables 1- 5 one can see how the weights were determined also at all the remaining nodes of the MFMPS model. In the said tables, normalisers were also set up for all variables (tests) of lower order.

When establishing the validity of the model, we were interested in to what extent the criterion variable of competition performance SLO_FIS can be explained on the basis of the thus set up model (selection of variables, tree structure of the variables, decision rules and normalisers). Table 6 shows the correlations between final scores (OC_POTENC) and scores for individual subspaces in the MFMPS model and the criterion variable SLO_FIS. The final score in the MFMPS model (OC_POTENC) represents a kind of suprasummative, synergic consequence of the scores for individual studied subspaces of the psychosomatic status. This score correlates statistically significantly with the SLO_FIS criterion at the error level of 1 % (-0.90). This correlation tells us that at the highest level of the thus structured model, it is possible to explain even 81% of the criterion variance for our sample of subjects. From Table 6, the explanatory degree of the criterion on the basis of individual subspaces of the MFMPS model can also be seen.

The objective of expert modelling [14] and construction of the MFMPS model is to obtain quality information on the status of the subjects measured, on the basis of which their actual competition performance can be predicted with great probability. Tables 7-11 give the scores for two subjects at all nodes of the MFMPS model. The raw results of individual tests (RES), numerical score (f(x)) and attribute score (SCORE) are shown. On the scale of the selected criterion SLO_FIS, the two evaluated competitors followed immediately each other (1st and 2nd place). Their age difference was half a year. Although the difference between the final numerical scores (OC_POTENC) is relatively large, the both subjects attain the same attribute (descriptive) score (good).

In the final score of motorics (OC_MOTOR) there is no large quantitative difference between the two competitors. The competitor B is more efficient in terms of energy (ENKOGI); however, the competitor A is slightly more proficient in terms of information (INKOGI). The competitor B has, in comparison with the competitor A, substantially better scores in the dimension of excitation duration (TRAEKS) of the neuromuscular system, which is a much more important factor of performance in cross-country skiing than the dimension of excitation intensity (INTEKS), where the competitor A demonstrates greater abilities. The score of running endurance (MSCT) - for which we say that it represents a simple, fast and rather reliable score (evaluation) of the preparation status of a competitor - is also substantially better in the competitor B (a difference of 37 s). However, in the latter competitor, poorer potentials in the power of the upper body (MSSNB, MSDTSK) and arms (MEMMED) were seen. This is not good from the aspect of efficiency demands in cross-country skiing [10]. As already mentioned, the competitor A was better equipped as regards information, yet this is only apparent. The competitor B attained also here better results in the dimension of coordination (KOORD), which was in cross-country skiing more important than the dimension of regulation of synergists (REGSIN).

In the subspace of functional abilities (OC_FUNK), the competitor B was much more efficient (Table 9). In the dimension of oxygen consumption (VO_2max), the two competitors were equal only at the lactate threshold, while at the anaerobic threshold − where a significant part of the race takes place − and later at the maximal oxygen consumption, the difference between them is large. The larger the anaerobic demands, the greater is the difference between the two competitors. This somehow coincides with running endurance [27]. In the competitor B, similar tendency can also be observed in the variable of the ability of overcoming loads (WATT). In him, this ability is constantly good all the time, while in the competitor A, this ability decreases rapidly.

Morphologically – if we can at all talk about this suitability of competitors [19] – the competitor A better met the demands of this sport. The fact is that the competitor A, with some length and width dimensions of the skeleton (ADZGO, ADSPO), only partially compensated the deficit in the motor and in functional subspaces. However, this morphological difference between the competitors A and B did not change the fact that the competitor B had the advantage, because he had a better relationship between body height (ATV) and weight (ATT) and a much better score in the segment of body masses (MASE).

In the final score of psychological abilities and properties (OC_PSIH), the two competitors were near each other. However, qualitative differences in favour of the competitor B can also be noticed in this subspace. In special psychological abilities (SPECPSSP), the competitor A attains, however, higher values, yet, in cross-country skiing, they are less important than the dimension of motivation. At all three motivation nodes (SPLSTMOT, TEKMOT, SAMOM), the competitor B received substantially higher values. Within these nodes, the following variables: performance (success) attained at work (USPEZDEL), positive motivation (POZITIV), and self-motivation (SAMOMOT) are the essential predictors of performance motivation [7,23]. As to personality, the two competitors differed in their sociopsychological properties (SOCPSLAS). The competitor A was slightly more extrovert (EKSTRAV), more dominant (REAKTAGR), less inhibited (ZAVRTOST). In the favour of the competitor A were also the scores at the node of competition properties (TEKMLAST). He suffers less from anxiety, is emotionally more stable and much less neurotic. Relaxedness and cheerfulness are in all probability the those components which helps him to compensate poorer motivation.

Within the scope of sociological subspace (Table 11), the largest differences between the two competitors were established in the educational structure of their parents (IZOBRAZBA). However, it is difficult to draw conclusions on the basis of this and other differences in the variables of the sociological subspace. This also applies to the consequential subsystem (POSL_PODSIS), within the scope of which the both competitors evaluated highly club work (KLUB_DELO). Good conditions for training, quality expert work and good organisation of the club environment are among the fundamental conditions necessary for the progress of competitors. The final score of the sociological subspace (OC_SOCIO) were very good in the both competitors.

The actual information obtained from the MFMPS model of potential competition performance suggests that the competitor B has potential to top-level performance in cross-country skiing at present, and even more promising in the long run. In the SLO_FIS points a smaller value means a better result. However, with proper planning of the transformation process in the long run and with taking into account this research, the competitor A can also still reach a top-level competition performance.

For an individual competitor, we usually begin to analyse the scores in the MFMPS model at the level of global potential competition performance. Then we proceed to lower levels. In carrying out such analysis, we look for the causes for such scores [14]. In the interpretation we proceed along the vertical to the lowest level, i.e. tests. In reaching conclusions however, we analyse simultaneous interactions between several factors at individual levels. In this way, good and weak points of the competitor can be seen. This is one of the major values of the MFMPS model. On the basis of this information, the coach must, however, make adequate corrections in the guidance of the transformation process for the competitor, to elevate his efficiency in a given period [13]. In this way, the coach can, with suitable means and methods of training, develop the performance factors having poorer scores, during which he must, however, take care that no deterioration in factors that were scored favourably in the model takes place. Without this information misguiding the training is great, especially, if the training groups are large, and the means and methods of training are similar for all. Such indirect prediction of competition performance is an efficient manner of monitoring the development of a competitor in the preparatory part of the season. The monitoring of the competitor with the expert modelling over a longer period can show us the trend in his development and indirectly also to show the quality of the sport training process.

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