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# Monitoring of Cross-Country Skiers by Means of an Expert Model of Potential Performance

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**A B S T R A C T**

*On the basis of expert knowledge, an expert model of potential performance covering the motor, morphological, psychological, and sociological subspace was constructed (MMPS). The scores of variables were obtained by application of the computer program Sport Measurement Management System (SMMS). In the subjects included in measurements, trends of the obtained average scores of variables were established through various competition categories and age periods. The sample of subjects consisted of 48 cross-country skiers in three competition categories. Fluctuations in development in individual age periods are larger in the motor and morphological subspace. In the psychological subspace, an upward trend of average scores can be noticed, while the sociological subspace is not subjected to any essential changes in different age and competition categories. Monitoring of cross-country skiers across all three competition categories showed that in these age categories there are periods which owing to laws of development do not allow uniform progress. Therefore, the principle of individuality must be taken into account especially in planning the transformation process.*

***Key words:*** *cross-country skiing, potential performance, expert modelling, longitudinal monitoring*

## Introduction

The basic goal of every top-level athlete is competition performance which manifests through good result. Top-level sport is becoming more and more an economic category which can hardly afford any larger slips. The work with the young is, of course, an even more tricky matter. Faults in these age categories are also questionable from the moral and ethical aspect; hence, many are already aware of possible detrimental consequences of introducing children into intensive sport competitions whose rules are written by adults. This is exactly why – or perhaps only why – the transformation process should not be merely a shortened programme according to which the grown-ups work.

Modern scientific findings say that a good quality process of the preparation of athletes can be guided only via a model. This model should be based on the actual athlete's competition result, as well as on the effects of all individual and interrelated dimensions of the psychosomatic status[1]. The sense of modelling lies in the advance information on how the system would probably behave if the initially selected, limiting conditions of the model happened. Of course, models must be practical and expedient, and correspond to the reality[2].

Multiparameter modelling is understood as a process of evaluation. The theory of such decision-making offers a formal basis for the construction of a model, where the fundamental issue is the connection of scores by individual parameters into an overall score. To master these problems, expert modelling can be used.

The most desirable effects of the transformation process on the psychosomatic status or its part are achieved when there comes to agreement between the demands of »top-level quality« of the selected sport in a given age period and the nature of an individual athlete. It can be argued that performance of an athlete depends on the state of all model dimensions representing the linear combination of performance (equation of performance specification) in a given age period.

The subject of the present research was focused on the study and evaluation of competition performance in cross-country skiers by means of an expert model of potential performance in three competition categories (older boys, younger juniors, and older juniors). The selection of basic dimensions, which are systematically interconnected in the structure of the performance model, was

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carried out in the motor and morphological subspace (primary potential dimensions) and in the psychological and sociological subspace (tertiary potential dimensions). In all selected subspaces, the knowledge base was written in the formalism which could be used for application in the SMMS program. The whole structure of elementary and derived variables was written in the form of a uniform hierarchically arranged tree.

## Methods

### *Participants*

The sample of measured subjects consisted of cross-country skiing competitors from three competition categories: older boys – STDKI (born in 1989 and 1990, n=17), younger juniors – MLMCI (born in 1987 and 1988, n=17) and older juniors – STMCI (born in 1985 and 1986, n=14 subjects). All subjects were included onto the final list of SLO_FIS points in the 2003/2004 season.

### *Instruments*

In the potential model of competition performance (MMPS: motorics, morphology, psychology, sociology), 64 independent variables are included. A detailed description of the variables and the measurement protocol are available from the authors at the Faculty of Sport in Ljubljana.

Variables of the motor subspace: long jump from standing (MMENSDM), triple jump from standing (MTRSK), balance frontally (MSRKF), balance sagitally (MSRKS), tapping with hand (MTAPRO), Cooper's test – 2400 m (MSCT), 20-m sprint – high start (MEMTEK), 60-m run (MMENS60), polygon backwards (MPON), eight with bending (MKAOSP), side steps (MKVS), hang with elbows bent (MSMIZT), trunk lifting on Swedish gymnastic bench (MSDTSK), jumps over Swedish gymnastic bench (MSPSK), bent hangs on parallel bars (MSSNB), bending forward on bench (MTPK), heavy ball throw (MEMMED).

### *Variables of the psychological subspace:*

Special psychological abilities: fluid intelligence (FLUIDINT), function of encouragement (FUNVZPOD), function of control (FUNKONTR); motivation or dynamic component of personality: performance (success) based on work (USPEZDEL), performance (success) irrespective of work (USPNGDEL), motive of power (MOC), positive competition motivation (POZITIVN), negative competition motivation (NEGATIVN), self-motivation (SAMOMOT); personality traits: neuroticism (NEVROTIC), spontaneous aggressiveness (SPONTAGR), depressiveness (DEPRESIV), irritability (RAZDRAZL), sociability (DRUZABN), self-control (OBVLADAN), reactive aggressiveness (REAKTAGR), inhibition (ZAVRTOST), sincerity (ODKRITO), extroversion (EKSTRAV), emotional lability (EMOCLAB), masculinity (MASKULIN), endurance (VZTRAJNO), competition anxiety (TEKMANKS), anxiety as personality trait (ANKOSLAS).

Variables of the morphological subspace: body height (ATV), body weight (ATT), length of upper limbs (ADZGO), length of lower limbs (ADSPO), circumference of relaxed upper arm (AON), chest circumference (AOPR), thigh circumference (AOS), elbow diameter (APKOM), shoulder width (ASR), pelvis width (ASM), knee diameter (APKOL), abdominal skinfold (AKGT).

Variables of the sociological subspace: education of mother (SIZOBRM), education of father (SIZOBRO), conditions for training (PDOBPOG), good expert work (PDOBSTDE), good organisation of club (PDOBORG), involvement of mother in sport (PSPAKTM), involvement of father in sport (PSPAKTO), function of mother in club (IKLFUNM), function of father in club (IKLFUNO), position of mother at work (IDELMSM), position of father at work (IDELMSO).

### *Procedure*

Measurements were carried out in March 2004. Tests of motorics were carried out by the subjects in the sports hall and on the athletic running track. The data were processed with the SPPS software package and program Sport Measurement Management System (SMMS), 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 (MMPS) in the form of a decision-tree was developed. The model covered motor, morphological, psychological and sociological subspaces of the psychosomatic status of competitors.

Normalisers for all elementary variables (tests) in the MMPS model were set up (positional configuration). 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. 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 value of the utility function for some points[3], 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 MSCT variable – Cooper's test 2400 m (see also Table 1: e.g. 504 : 8 means that time 504 s, achieved in this test, has received the numerical score 8 – very good).

**TABLE 1**
AN EXAMPLE OF SETTING UP THE NORMALISERS FOR THE MSCT VARIABLE

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Value of variable | 480 | 492 | 504 | 515 | 530 | 537 | 554 | 820 |
| Score of variable | 10 | 9 | 8 | 7 | 5 | 4 | 2 | 0 |

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

In evaluating individual variables, experts have in mind a vision of top creativity in this sport (champion model) and at the same time, significant long-term development characteristics of an athlete. The expert's score becomes thus far-reachingly useful. In this way, »longitudinal« treatment of the athlete is attained and a corresponding universal model of potential performance is created as athletes go through various development, age and competition periods during their transformation process.

Decision rules for all nodes in the MMPS model were set up (dimensional configuration). This is the value of a hypothetical contribution (in %) of each individual variable to competition performance at the respective node of the MMPS 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 MMPS model yields the sum 100.

By the SMMS program, scores for all variables at all levels in the MMPS 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: $Svr = (Snr_1 \times P) + (Snr_2 \times P) + \ldots + (Snr_n \times P)$. Legend: 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).

To establish differences between competition categories of subjects as regards scores at the highest levels of the MMPS model, a T-test for independent samples was used.

## Results

### *Construction of the MMPS model*

Table 2 shows the structure of the MMPS model at the highest levels and as an example also part of the structure in the motor subspace (energy component of movement). Given is also an example of evaluating the potential competition performance of the subject at the shown levels of the MMPS model.

### *The analysis through various competition categories*

By the SMMS program, numerical scores at the highest level were calculated for individual subspaces of the MMPS model for the subjects of three competition cate-

**TABLE 2**
PART OF THE STRUCTURE OF THE MMPS MODEL, WEIGHTS, NORMALISERS AND AN EXAMPLE OF EVALUATING THE POTENTIAL COMPETITION PERFORMANCE

| Test code | Weights | Normalisers | Potential comp. performance Competitor »A« | | |
|---|---|---|---|---|---|
| | | | RES | f(x) | SCORE |
| URMPU | 100 | | | 7.13 | very good |
| ├─ Morphology | 24 | | | 6.53 | good |
| ├─ Sociological characteristics | 14 | | | 7.89 | very good |
| ├─ Psychology | 26 | | | 7.67 | very good |
| └─ Motor abilities | 36 | | | 6.85 | good |
| ── ├─ Energy comp. of movement | 24 | | | 7.14 | very good |
| ── ── ├─ Excitation duration | 16 | | | 8.35 | very good |
| ── ── ── ├─ Endurance power | 6.6 | | | 7.30 | very good |
| ── ── ── ── ├─ Repetitive power | 5.2 | | | 6.83 | good |
| ── ── ── ── ── ├─ MSPSK | 1.9 | 8:0, 24:2, 26:4, 27:5, 29:7, 31:8, 33:9, 42:10 | 33 | 9.00 | excellent |
| ── ── ── ── ── ├─ MSSNB | 1.6 | 1:0, 10:2, 14:4, 16:5, 18:7, 20:8, 22:9, 25:10 | 12 | 3.00 | satisfactory |
| ── ── ── ── ── └─ MSDTSK | 1.7 | 0:0, 12:2, 15:4, 17:7, 19:9, 21:10 | 18 | 8.00 | very good |
| ── ── ── ── └─ Static power | 1.4 | | | 9.06 | excellent |
| ── ── ── ── ── └─ MSMIZT | 1.4 | 0:0, 56:2, 65:4, 85:7, 102:9, 120:10 | 103 | 9.06 | excellent |
| ── ── ── └─ Running endurance | 9.4 | | | 9.08 | excellent |
| ── ── ── ── └─ MSCT | 9.4 | 480:10, 492:9, 515:7, 530:5, 537:4, 554:2, 820:0 | 491 | 9.08 | excellent |
| ── ── └─ Excitation intensity | 8 | | | | |

URMPU – universal reduced model of potential performance, 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 3**
ANALYSIS OF THE DIFFERENCES BETWEEN COMPETITION CATEGORIES IN THE SCORES AT THE HIGHEST LEVELS OF THE MODEL

| | STDKI : MLMCI | | MLMCI : STMCI | | STDKI : STMCI | |
|---|---|---|---|---|---|---|
| | t | sig (t) | t | sig (t) | t | sig (t) |
| URMPU | –3.23 | 0.00** | –5.12 | 0.00** | 8.53 | 0.00** |
| Motor abilities | –2.99 | 0.01** | –3.97 | 0.00** | 6.73 | 0.00** |
| Morphology | –2.78 | 0.01** | –5.20 | 0.00** | 8.44 | 0.00** |
| Psychology | –1.50 | 0.14 | –1.78 | 0.09 | 3.10 | 0.00** |
| Sociological characteristics | 0.69 | 0.49 | –1.25 | 0.22 | 0.36 | 0.72 |

**$p<0.01$, URMPU – universal reduced model of potential performance, older boys – STDKI (born in 1989 and 1990, n=17), younger juniors – MLMCI (born in 1987 and 1988, n=17) and older juniors – STMCI (born in 1985 and 1986, n=14 subjects)

gories on the basis of dependent determination of weights. The differences in the obtained scores between the subjects of these three groups were established (Table 3).

In the score of the highest level (URMPU), all three competition categories differ between one another statistically significantly. Statistically significant differences between all categories are only in the score of the subspaces of motorics and morphology. In the psychological subspace, statistically significant differences can be noticed only between older boys and older juniors. Sociologically, all three competition categories are very homogenous, therefore there are no differences between them as expected.

### *The analysis through varying chronological age of competitors*

In planning the training process from the aspect of laws of development, it is necessary to also take into account the specifics of the chronological age of competitors. They provide a more detailed picture of the status of an athlete. In the continuation, we use average numerical scores, which merely show upward and downward trends by individual age periods but not also the actual quality of the subjects. The latter can be expressed only after the transformation of the numerical score into the attribute score that must be determined for individual competition categories.

Table 4 shows arithmetic means and standard deviations of the numerical scores obtained on the most important elementary and aggregated variables of the MMPS model, for which on the basis of expert findings of individual science disciplines we are of the opinion that they are the carriers of the most important information in planning the performance.

### *Trend of the average scores at the highest levels of the MMPS model*

The average final score (URMPU) shows an upward trend (Figure 1). A very similar trend can also be established in motor abilities. The most abrupt increase in the average URMPU scores and motorics can be noticed between the 14th and 15th year, and between the 16th and 17th year of age.

The average score of morphological suitability shows, generally, an upward trend. Between the 15th and 16th year, a slight fall-off trend is evident. Between the 16th and 17th year, a considerable jump in the average score of morphology can be noticed, which as a result means a rise in the competition performance in cross-country skiers.

The average score of the psychological subspace increases uniformly through all years selected. No dramatic increasing in the average score relative to the age period of the subjects can be noticed anywhere. The trend of the average final score of the sociological subspace is in accordance with the expectations. This score is not subject to age categories and is the highest among the scores of all studied subspaces.

### *Trend of the average scores of variables in individual subspaces of the MMPS model*

The trend of individual average scores of the main components of motorics is in accordance with the trend of the score of the motor subspace itself. The average scores of the energy component of movement and the duration of excitation (ENKOGI and TRAEKS) have a similar trend as in motorics. Involved is a declining trend between the 13th and 14th year, and between the 15th and 16th year (Figure 2).

The information component of movement (INKOGI) shows, however, a constantly growing trend (Figure 3). Within the information component of movement, a different trend of the scores of the variables of coordination (KOORD) and regulation of synergists (REGSIN) can be noticed at the end of the period of younger juniors (16th year) in comparison with other periods.

In the psychological subspace, the scores of the both dimensions of general performance motivation (USPEZDEL, USPNGDEL) differ considerably (Figure 4). While the score on one motivational form decreases strongly, the score on the other one increases strongly. The average score USPEZDEL is rather too low for a favourable motivational basis of performance in cross-country skiing.

Up to the age of 16, the trend of the average score in the competitive motivational field (NEGATIV, POZITIV) is rather unstable (Figure 4). Competition motivation,

**TABLE 4**
TREND OF THE SCORES OF MODEL VARIABLES OF HIGHER RANK IN THE MMPS MODEL RELATIVE TO THE AGE OF COMPETITORS

| | STDKI | | MLMCI | | STMCI | |
|---|---|---|---|---|---|---|
| | 13 year | 14 year | 15 year | 16 year | 17 year | 18 year |
| Test Code | X±SD | X±SD | X±SD | X±SD | X±SD | X±SD |
| URMPU | 3.8±0.4 | 4.1±0.6 | 4.6±0.8 | 4.8±0.7 | 6.0±0.6 | 6.4±1.1 |
| ├ Motor abilities | 2.3±0.6 | 2.2±0.6 | 3.2±1.4 | 3.2±0.9 | 4.8±1.1 | 5.5±1.8 |
| ├ ENKOGI | 2.2±0.6 | 1.8±0.5 | 2.9±1.5 | 2.7±0.8 | 4.6±1.0 | 5.7±2.1 |
| ├ TRAEKS | 2.5±0.8 | 1.7±0.5 | 2.8±1.4 | 2.7±1.0 | 4.0±1.1 | 6.2±2.6 |
| └ INTEKS | 1.5±0.5 | 1.9±0.9 | 3.2±2.2 | 2.5±0.6 | 6.0±2.4 | 4.8±2.1 |
| └ INKOGI | 2.6±0.8 | 3.1±1.0 | 3.8±1.5 | 4.3±1.8 | 5.0±1.8 | 5.1±1.4 |
| ├ REGSIN | 2.3±0.3 | 3.0±1.2 | 3.6±1.3 | 3.2±1.4 | 5.0±1.9 | 5.3±1.4 |
| └ KOORD | 2.8±1.1 | 3.1±1.4 | 3.9±2.0 | 5.0±2.2 | 5.0±1.9 | 4.9±1.7 |
| ├ Morphology | 2.5±0.9 | 3.2±1.3 | 4.3±1.5 | 4.2±1.4 | 6.6±1.5 | 7.0±1.0 |
| ├ Psychology | 5.0±0.7 | 5.6±1.1 | 5.7±0.9 | 6.2±0.9 | 6.5±0.8 | 6.6±1.1 |
| ├ MOTIVAC | 5.4±1.6 | 5.8±1.6 | 5.3±1.0 | 6.3±1.9 | 5.9±1.2 | 6.5±1.5 |
| ├ SPLSTMOT | 6.1±0.9 | 5.6±2.3 | 5.4±1.3 | 6.3±2.7 | 6.0±1.6 | 7.0±1.3 |
| ├ USPEZDEL | 5.4±1.4 | 5.5±2.8 | 4.7±1.4 | 6.3±3.0 | 5.3±2.4 | 7.3±2.2 |
| └ USPNGDEL | 8.0±2.1 | 5.8±2.8 | 7.2±3.0 | 6.3±2.7 | 7.7±1.2 | 6.4±2.5 |
| └ TEKSTMOT | 6.0±1.7 | 5.9±1.8 | 5.2±1.5 | 6.2±2.2 | 5.5±1.4 | 6.3±1.8 |
| ├ POZITIV | 5.5±2.3 | 5.3±2.9 | 4.2±2.3 | 5.7±2.7 | 5.8±2.1 | 6.8±2.4 |
| └ NEGATIV | 7.5±2.0 | 6.4±2.5 | 6.2±2.5 | 7.4±2.1 | 4.2±1.4 | 4.7±1.9 |
| └ OSEBLAST | 4.7±0.4 | 5.9±1.1 | 6.2±1.1 | 6.5±0.7 | 7.1±0.6 | 6.8±1.7 |
| ├ SPSTRLAS | 4.7±0.9 | 6.0±1.4 | 6.3±1.3 | 7.0±0.9 | 7.4±0.3 | 6.8±1.9 |
| ├ SOCPSLAS | 4.5±1.6 | 5.6±1.5 | 6.7±2.1 | 6.3±1.7 | 6.2±1.8 | 6.4±1.5 |
| └ TEKMLAST | 4.9±0.9 | 6.0±1.2 | 5.8±1.4 | 6.2±1.1 | 7.2±0.8 | 6.9±1.9 |
| └ Sociology | 7.3±0.9 | 7.4±1.0 | 6.8±0.4 | 7.6±0.8 | 7.4±0.6 | 7.5±0.7 |

ENKOGI – energy component of movement, TRAEKS – excitation duration, INTEKS – excitation intensity, INKOGI – information component of movement, REGSIN – regulation of synergists, KOORD – coordination, MOTIVAC – motivation, SPLSTMOT – general performance motivation, USPEZDEL – performance (success) based on work, USPNGDEL – performance (success) irrespective of work, TEKSTMOT – competition motivation, POZITIV – positive competition motivation, NEGATIV – negative competition motivation, OSEBLAST – personality traits, SPSTRLAS – special structural traits, SOCPSLAS – sociopsychological properties, TEKMLAST – competition properties, older boys – STDKI (born in 1989 and 1990, n=17), younger juniors – MLMCI (born in 1987 and 1988, n=17) and older juniors – STMCI (born in 1985 and 1986, n=14 subjects)

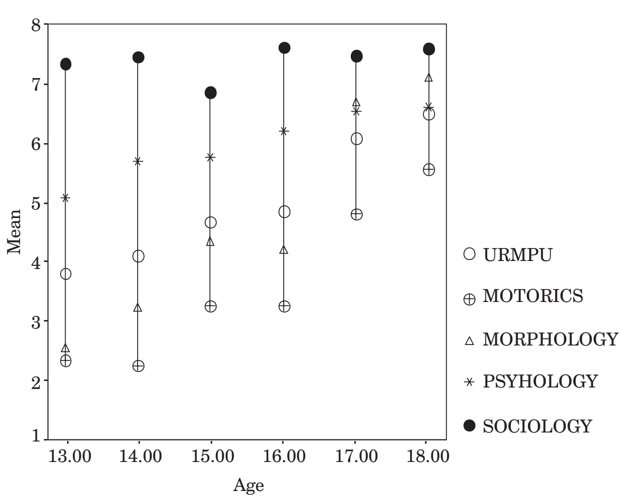


*Fig. 1. Trend of the average scores of all studied subspaces and the final score of potential competition performance (URMPU).*

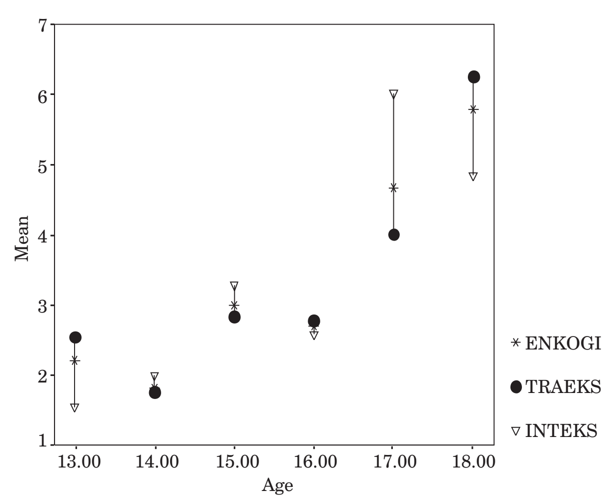


*Fig. 2. Trend of the average scores of the energy component of movement and its variables. ENKOGI – energy component of movement, TRAEKS – excitation duration, INTEKS – excitation intensity.*

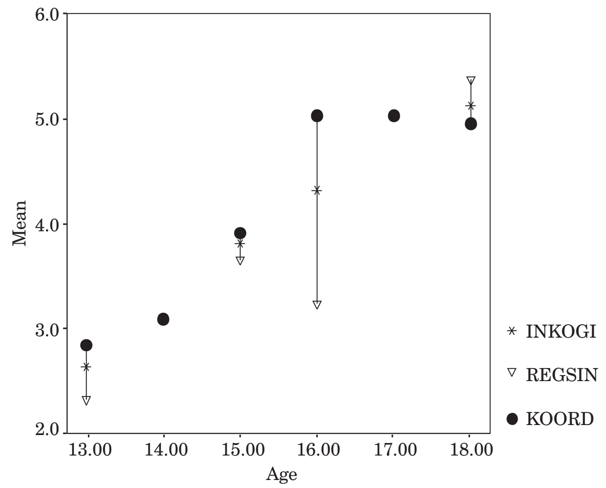


*Fig. 3. Trend of the average scores of the information component of movement and its variables. INKOGI – information component of movement, REGSIN – regulation of synergists, KOORD – coordination.*

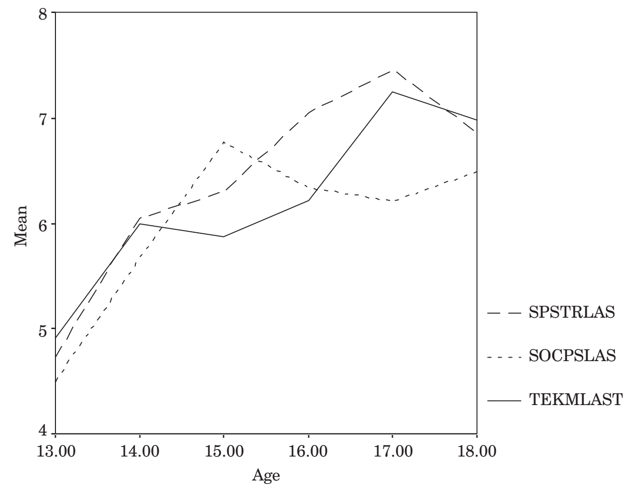


*Fig. 5. Trend of the average scores of personality traits variables in the psychological subspace. SPSTRLAS – special structural traits, SOCPSLAS – sociopsychological properties, TEKMLAST – competition properties.*

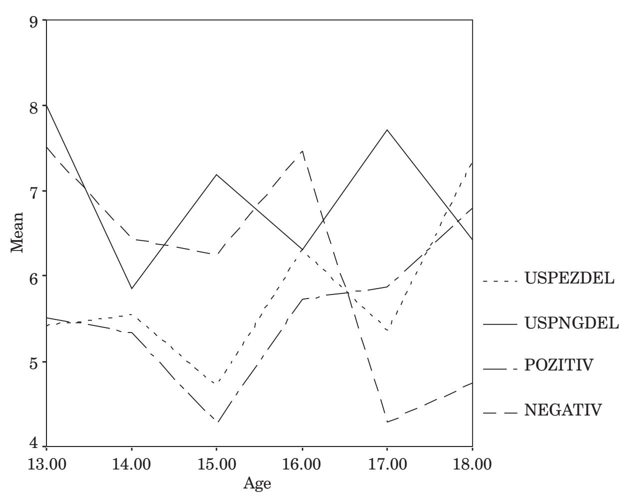


*Fig. 4. Trend of the average scores of variables of the motivational component of the psychological subspace. USPEZDEL – performance (success) based on work, USPNGDEL – performance (success) irrespective of work, POZITIV – positive competition motivation, NEGATIV – negative competition motivation.*

which is focused on the avoidance of failure and represents the negative component of competition motivation (NEGATIV), is at the age of 13 at first very high but afterwards it falls gradually. Then, between the 15th and 16th year, its rapid increase followed by a steep fall can be noticed. The score grows slightly again between the 17th and 18th year of age. The average score of positive motivation (POZITIV) shows a similar trend up the age of 16; later, however, the trend of this score is in accordance with expectations.

Generally, the average score of all three main dimensions of personality traits grows with years (Figure 5). However, the direction of the trend of the scores of all three components is not the same. The trend of gradual increasing in the average scores is the most pronounced in the dimension of special structural properties (SPSTRLAS), which, however, falls slightly in the last year.

The universal (for all competition categories) reduced model of competition performance – MMPS – was elaborated for the needs of cross-country skiing. The positional configuration (normalisers) of the knowledge base was uniformly built. Thus, younger subjects obtained lower numerical scores in comparison with the older ones, which, however, considered developmentally, does not mean poorer suitability for this sport. On the basis of expert knowledge and findings of the present research, we can, at the end, round off the import of monitoring and give appropriate developmentally oriented attribute and numerical scores for individual competition categories (Table 5).

**TABLE 5**
SCORES OF COMPETITION POTENTIAL BY INDIVIDUAL COMPETITION CATEGORIES RELATIVE TO THE ATTAINED NUMERICAL SCORES IN THE MMPS MODEL

| | STMCI | MLMCI | STDKI |
|---|---|---|---|
| Excellent | 7.00–10.00 | 5.50–10.00 | 4.50–10.00 |
| Very good | 6.50–6.99 | 5.00–5.49 | 4.00–4.49 |
| Good | 6.00–6.49 | 4.50–4.99 | 3.50–3.99 |
| Satisfactory | 5.50–5.99 | 4.00–4.49 | 3.00–3.49 |

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, older boys – STDKI (born in 1989 and 1990, n=17), younger juniors – MLMCI (born in 1987 and 1988, n=17) and older juniors – STMCI (born in 1985 and 1986, n=14 subjects)

## Discussion

Coaches should know the current status of preparation of their competitors throughout their whole competition career and should direct the training process on the basis of that. It often happens that the patterns of training process are carried over also when competitors advance to a higher competition category and that only the loads change. Our analyses have shown that cross-country skiers differ statistically significantly among themselves relative to competition categories above all in the dimensions on which coaches have the largest influence (motorics) and indirectly on a rather large indivisible psychosomatic status represented by the final score of the model of potential performance (URMPU) in this analysis. The desired changes can, however, not be achieved by merely increasing the motor and cognitive loads.

Competition categories encompass cross-country skiers of different age categories (each consisting of two years); however, work in the categories normally takes place in a uniform way, irrespective of the chronological age of individuals. Despite an overall positive trend of gradual motor progress, a certain degree of stagnation of the motor score can, nevertheless, be observed between the 13th and 14th year, and the 15th and 16th year. The sample of subjects does, however, not allow any generalisations, but we may conclude that periods of accelerated physical development are involved owing to which, the learned motor patterns in the cortex break down and do not allow any larger progress in motor efficiency until new movement patterns are structured. This is the sign that loads are to be planned with a large degree of »psychological wisdom and caution«, and above all, selectively. In this period, giving up sport activities owing to mistakes of the grown-ups is very often. The reasons for the later abrupt progress (between the 16th and 17th year) can be sought in the fact that physical development is coming to an end, and partly also in larger demands of the environment since the final selection for admission to the top-level adult sport is involved.

If for the score of the energy component of movement (ENKOGI) we said that its trend is similar to the trend of the score of its superordinated component (OC_MOTOR), then in the information component (INKOGI), constant increasing in the average score is involved, which means that despite development, the cognitive demands of movement can increase, while the energy potential is often limited in the period of adolescence. It is also necessary to mention that up to the very age of 17, the average score of the information component of movement is higher than the average score of the energy component of movement. After that year, a radical change is noticed for the first time; the reason for it must be sought in lower (higher) abilities of the subjects in the both mentioned variables. Motor cortical patterns have been re-established; further development or performance of a cross-country skier depends to a much larger extent on the energy potentials.

It often happens that an almost invisible trend of growth in psychological dimensions is the reason for errors in the psychological preparation of competitors. Roberts and Treasure[4] say that the »folklore of training« (the same means of loading for all) increases mistakes in the motivational approach. We can probably agree with this statement and use it for the whole psychological subspace. Yet, it is also true that for correct reaction to information of psychological nature, proper psychological expertise – which in experts in practice is poor rather than good – is necessary.

In the dimension of general performance motivation it is not possible to give a common psychological developmental denominator which would encompass the whole scheme of falling and growing both of the motivation which is directed towards success attained with work (USPEZDEL), as well as the motivation focused on success irrespective of work (USPNGDEL). The confused situation in the competitive motivational field (POZITIV, NEGATIV) can be explained with an obvious inner insecurity and conflicts, which with the degree of involvement in sport even grow. Motives are in some way associated with the stimuli from the environment and arouse emotional states that lead to coming closer or avoiding the goal. With successes, cross-country skiers become more self-confident and the initial uncertainty changes to the motive for achieving success. In younger athletes, the experience of success is also associated with the fear how to succeed also in the future. Another reason for such a motivational development can be sought in the last year before the competitor advances from one into the next age category. As already found in motorics, the demands of the environment (coaches, parents) suddenly become larger to which fact competitors react very differently. Such a trend of competition motivation is, in fact, understandable, however it must not be an alibi for passive observation of the negative motivational developments.

Though between individual competition categories, an increase in the average scores of the socio-psychological properties (SOCPSLAS) and competition properties (TEKMLAST) can be noticed, it fluctuates within the categories relative to age. In the category of older boys (13 and 14 years), the both scores show an upward trend. The category of younger juniors (15 and 16 years) is marked by the search for own identity, hence also the resultant rise and fall in social and psychological properties. In the category of older juniors (17 and 18 years), the fall in competition properties can be attributed to the quality peak that has already structured in this category. This fluctuation is probably more a consequence of the characteristics of the sample than the consequence of laws of development. Nevertheless, the prediction of performance by means of personality traits is ungrateful since various tests and various methodologies are used for establishing personality traits. The opinions on the credibility of researches are divided[5]. However, as argued by Tušak and Tušak[6], small but important relations between performance and personality traits can be noticed if research work is carried out properly and correctly. Similar can be said for the trends of scores in individual competition categories and age periods.

In the sociological subspace, any other results could not be expected since both the positional and dimensional configuration do not allow any larger selectivity owing to smaller influence on performance in cross-country skiing. Interventions into the sociological sample of young competitors are, as a rule, not necessary, except by limited possibilities in extremely low score values.

## Conclusion

Our objective was to qualitatively evaluate a cross-country skier through different age periods joined into competition categories. In the thus formulated positional configuration (normalisers), the main goal of the transformation process is »top level quality« in the national category. The conversion of numerical scores into attribute scores allows us to see »top-level quality« also in other (younger and older) competition categories and to compare the subjective score (given by the coach) with the score obtained on any model variable. In this way, a competitor can be critically dealt with, while he himself can objectively follow the trend of his development. This is the method for fast and sufficiently good corrections of training programmes.

Monitoring and evaluating the performance of a cross-country skier should be the mission of every coach as this is the foundation for building the top-level quality in every sport. Each piece of feedback information must have the character of an immediate input into the system called the transformation process. By building the model(s) and evaluating the trend of scores through a given time cross-section, the sport profession is given a quality measuring instrument which ensures feedback and thus monitoring of the functioning of the whole system. The performance score pointed to the fact that in this age category there are periods which owing to development characteristics do not allow any major progress. Any exaggeration can lead to frustrating situations and can result in leaving cross-country skiing. By evaluating the numerical scores and tolerance in the dimensional and positional configuration, performance score was also admitted into the absolute category, while lower age categories were adequately descriptively evaluated.

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## PRAĆENJE SKIJAŠKIH TRKAČA POMOĆU EKSPERTNOG MODELA POTENCIJALNE USPJEŠNOSTI

## SAŽETAK

Na temelju stručnog znanja konstruiran je ekspertni model potencijalne uspješnosti koji uključuje motornu, morfološku, psihološku i sociološku razinu (MMPS). Ocjene za pojedine varijable dobivene su primjenom kompjuterskog programa Sport Measurement Management System (SMMS). Kod ispitanika uključenih u mjerenje, uspostavljeni su trendovi dobivenih prosječnih ocjena za pojedine varijable kroz različite natjecateljske odnosno dobne kategorije. Uzorak se sastojao od 48 skijaških trkača u tri natjecateljske kategorije. Fluktuacije u razvoju u pojedinim dobnim razdobljima veće su na motornoj i morfološkoj razini. Na psihološkoj razini, primijećen je rastući trend prosječnih ocjena, dok sociološka razina ne podliježe bitnim promjenama kod različitih dobnih odnosno natjecateljskih kategorija. Praćenje skijaških trkača kroz sve tri natjecateljske kategorije pokazalo je da u određenim dobnim kategorijama postoje razdoblja koja zbog zakonitosti razvoja ne omogućuju uniformno napredovanje. Stoga se u obzir mora uzimati individualni pristup, osobito prilikom planiranja procesa transformacije.