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THE LATENT DIMENSIONS OF SELECTED MORPHOLOGICAL AND MOTOR VARIABLES IN SKI JUMPERS

INTRODUCTION

The purpose of the present study was to establish a factorial structure in a selected sample of morphological and motor variables as well as identify the parameters of ski jumpers' push-off power in execution of a vertical jump in laboratory conditions. The push-off power receives the most research attention in the training process [2, 3]. Ski jumper's movement is a complex and difficult motor task, which in terms of motor behaviour requires a high level of strength, co-ordination, accuracy, balance, spatial orientation, visualisation, boldness, courage etc.

METHODS

The research was conducted on a sample of 70 ski jumpers, members of the Slovene cadet, junior and senior national ski-jumping teams. The sample included almost all elite Slovene ski jumpers. The set of variables consisted of 14 morphological and 21 motor variables. The characteristics of ski jumpers' push-off in laboratory conditions were examined by means of 8 biomechanical variables of push-off power. Ski jumpers executed a vertical jump from a specific in-run position on a Kistler Force Plate. Based on the achieved and calculated take-off parameters, the following variables were selected for the purpose of this research: push-off height, push-off time, ratio between push-off height and time (also called index of take-off explosive power) and acceleration of the first part of push-off (also called index of explosive power of the first part of take-off). The morphological aerodynamic index shows the ratio between the ski jumper's body surface area and their body mass. The morphological take-off index shows the ratio between the ski jumper's body height and their leg length. The

measurements were taken on 10 October 2005. The factor analysis was made on the basis of the Principal Component Analysis.

RESULTS

The results of the research are given in Table 1. On the basis of the factor analysis, eight factors were ruled out. The first dominant factor was FACTOR OF VELOCITY POWER, accounting for 28.9% of the total variance.

The variables of the push-off explosive power formed a homogeneous structure. According to the scale of factor loading, the following variables were predominant in this factor: index of explosive take-off power (0.63), acceleration of explosive power of the second part of take-off (0.84) and velocity of take-off (0.86). On the second factor which may with good reason be called the FACTOR OF MORPHOLOGICAL LONGITUDIONALITY the projections of morphological variables of longitudinal dimension of body were dominant.

In the third, more specific factor called FACTOR OF MORPHOLOGICAL AERODYNAMICITY, the projection of morphological aerodynamic index (0.92) was prevalent. A high factor saturation was also seen in body mass (-0.67) and body mass index (-0.93). In the fourth FACTOR OF FLEXIBILITY OF SKI JUMPERS, accounting for 7.1% of total variance, the variables of motor flexibility prevailed. In the fifth factor FACTOR OF EXPLOSIVE POWER OF TAKE-OFF variables of starting acceleration in push-off were dominant. The projection of the variable Ski-jumping morphological take-off index (0.67) was strongly prevalent in the sixth FACTOR OF SKI-JUMPING MORPHOLOGICAL TAKE-OFF INDEX. In the seventh FACTOR OF

BALANCE OF SKI JUMPERS, accounting for 3.2% of total variance, the variables of motor balance prevailed. In the last factor which may be called the FACTOR OF

COORDINATION AND MOTOR VELOCITY the projections of the basic motor variables were dominant.

Table 1. Structure of factors of the selected morphological and motor variables of ski jumpers and parameters of their push-off power, n=70. Part One

NAME OF FACTOR	M	S.D.	F1	F2	F3	F4	F5	F6	F7	F8
1. FACTOR: VELOCITY POWER										
SMABAVO – Vertical push-off height (cm)	47.5	5.9	0.86	0.02	0.00	-0.10	-0.06	0.02	0.04	-0.18
HODR – Velocity of take-off (m/s)	3.0	0.2	0.86	0.02	0.00	-0.12	-0.07	0.02	0.05	-0.17
SMISSKA – Special motor-morphological index of take-off	243.9	17.3	0.86	0.00	0.34	-0.11	-0.01	0.08	0.04	-0.18
FPOPR – Acceleration in take-off in the second part (m/s ²)	7.3	0.9	0.84	-0.22	-0.12	0.25	0.00	-0.14	-0.10	0.13
EKSPLO – Index of explosive power of take-off	78.9	9.3	0.63	-0.14	-0.16	0.14	-0.49	-0.03	-0.09	0.03
POSP – Acceleration of take-off (m/s ²)	7.8	0.9	0.63	-0.14	-0.16	0.14	-0.51	-0.03	-0.10	0.03
MMEN3SM – Elastic power in triple jump (cm)	833.9	51.1	0.57	0.26	-0.12	-0.21	-0.07	0.12	-0.08	-0.26
MMENSMDM – Horizontal jump length (cm)	264.9	17.1	0.55	0.36	0.01	-0.22	-0.02	0.13	-0.18	-0.26
2. FACTOR: MORPHOLOGICAL LONGITUDINALITY										
ADN – Right leg length (cm)	90.5	3.8	0.04	0.99	0.02	0.03	0.05	-0.08	0.01	0.08
ADS – Right thigh length (cm)	42.0	2.2	-0.06	0.90	-0.14	0.02	0.07	-0.21	0.01	0.05
ADV – Absolute body height (cm)	225.8	8.3	-0.01	0.87	-0.03	-0.00	0.08	0.18	-0.13	-0.03
ADR – Right arm length (cm)	79.8	3.3	-0.24	0.85	-0.03	0.04	-0.09	0.16	-0.02	-0.08
ADG – Right shank length (cm)	42.8	2.0	0.09	0.84	0.19	-0.02	0.03	0.19	-0.09	0.06
AV – Body height (cm)	176.5	6.1	0.01	0.77	-0.07	-0.07	0.05	0.35	0.09	0.01
3. FACTOR: MORPHOLOGICAL AERODYNAMICITY										
INDPLOV – Aerodynamic index	1013.6	58.2	-0.01	-0.04	0.92	0.02	0.18	0.15	-0.02	-0.01
BMI – Body mass index (kg/m ²)	19.7	1.3	0.06	-0.18	-0.93	0.06	-0.06	0.08	0.06	-0.06
MMISSK – Basic motor-morphological index	1303.9	85.8	0.27	0.15	0.89	-0.16	0.03	-0.12	-0.15	-0.07
AOS – Right thigh girth (cm)	52.7	2.9	0.09	0.06	-0.72	0.14	-0.08	0.34	0.12	-0.03
MORIND – Morphological index of rotation	112.2	8.0	-0.06	-0.60	0.69	0.01	0.11	0.16	-0.03	-0.07
AT – Body mass (kg)	61.6	5.9	0.03	0.44	-0.67	-0.01	-0.00	0.29	-0.02	-0.06
MOC – Power of take-off (W)	1911.7	240.3	0.43	0.35	-0.53	-0.06	-0.02	0.24	0.01	-0.16
SUN – Impulse of the push-off force (Ns)	194.8	24.5	0.43	0.35	-0.52	-0.06	-0.02	0.24	0.02	-0.16
4. FACTOR: FLEXIBILITY OF SKI JUMPERS										
MGGOLS – Ankle flexibility (angle degrees)	43.8	4.6	0.12	-0.17	-0.07	-0.81	0.22	-0.14	-0.24	0.25
MGGTPKR – Relative index of flexibility	251.0	20.9	-0.02	0.12	0.21	-0.75	-0.24	0.15	0.16	-0.22
MGGTPK – Flexibility of hips (cm)	62.7	5.7	-0.04	-0.01	0.17	-0.70	-0.21	0.26	0.09	-0.26

Table 1. Structure of factors of the selected morphological and motor variables of ski jumpers and parameters of their push-off power, n=70. Part Two

NAME OF FACTORS	M	S.D.	FACTOR SCORE							
			F1	F2	F3	F4	F5	F6	F7	F8
1. FACTOR: EXPLOSIVE POWER OF TAKE-OFF										
STMOR – Starting acceleration in push-off (m/s ²)	2.03	0.7	0.09	0.07	0.02	0.04	-0.82	0.01	-0.05	-0.04
SPZ – Force ratio in the first and second parts of push-off (in %)	116.1	19.6	0.38	-0.05	0.08	0.27	0.81	-0.02	0.03	0.09
FPOZR – Acceleration in take-off in the first part (m/s ²)	6.4	1.0	0.28	-0.11	-0.06	0.01	-0.80	-0.02	-0.07	0.03
SMABATO – Push-off time in vertical take-off (s/1000)	393.8	32.0	-0.26	0.15	0.22	-0.24	0.69	0.05	0.18	-0.13
2. FACTOR: SKI-JUMPING MORPHOLOGICAL TAKE-OFF INDEX										
INDODSK – Ski-jumping morphological take-off index	195.1	4.7	-0.07	-0.67	-0.16	-0.15	-0.20	0.67	-0.15	-0.20
ADT – Trunk length (cm)	54.8	3.1	0.11	0.23	-0.12	-0.13	-0.05	0.61	-0.36	0.15
ASR – Shoulder width (cm)	38.8	1.9	0.13	0.21	-0.28	0.18	0.26	0.49	0.00	-0.37
ASM – Pelvis width (cm)	31.6	1.5	-0.01	0.34	-0.16	-0.16	0.00	0.58	0.00	0.19
3. FACTOR: BALANCE										
MRFRONT – Balance in frontal plane (s/10)	12.8	10.1	-0.04	0.06	0.22	0.04	-0.04	-0.01	-0.84	-0.04
MRSAGIT – Balance in sagittal plane (s/10)	17.6	10.5	-0.08	0.05	0.05	-0.01	-0.06	0.07	-0.78	-0.08
4. FACTOR: COORDINATION AND MOTOR VELOCITY										
MFE50 – Co-ordination in jumping (s/10)	4.9	0.4	0.03	-0.17	0.01	0.02	-0.04	0.01	0.23	0.69
MMRNPK3 – Repetitive leg power (rep.)	107.1	10.3	0.03	-0.07	-0.04	-0.16	0.07	-0.23	-0.08	-0.69
STAROST – AGE – years	17.4	2.5	0.18	-0.08	0.01	0.17	0.01	0.27	-0.05	-0.69
MHFNTD – Speed of right leg frequency (rep.)	35.9	3.4	0.22	-0.16	0.10	-0.02	-0.13	-0.11	0.06	-0.66
MKPOLN – Co-ordination of atypical movement (s/10)	6.5	0.9	-0.19	0.09	0.01	0.19	0.10	0.11	0.10	0.64
MHFNTL – Speed of left leg frequency (rep.)	34.5	3.4	0.02	-0.11	0.14	-0.16	-0.14	0.09	-0.09	-0.59
MKKROSP – Co-ordination in an “eight” (s/10)	15.7	0.6	-0.07	0.09	-0.01	-0.08	0.27	0.03	0.24	0.41
MMRTDT45 – Repetitive power of abdominal muscles (rep.)	19.4	2.5	-0.02	-0.10	-0.28	-0.22	-0.19	-0.32	-0.25	-0.36
% OF VARIANCE			28.9	20.2	12.3	7.1	5.4	3.6	3.2	2.5

DISCUSSION

The results of the factor analysis made on a sample of 70 Slovene ski jumpers, aged 15 years and more, showed that the manifest structure of 43 variables was reduced to eight latent factor dimensions. The results are interesting primarily because they reflect the specificity in expressing of individual factors, as it is conditioned by ski jumps i.e. their specific movement technique. The success rate in ski jumps is affected by the general motorics – velocity factor [1]. In analysing the push-off power in a ski jumper's take-off one has to consider the factor of explosive push-off power [2]. Explosiveness of take-off is particularly important in the first phase of ski jumper's push-off [4]. From the point of view of aerodynamics, the existence of two independent specific morphological factors has to be taken into account. Both specific morphological factors of ski jumpers have a strong impact on the execution of ski jumping technique. The morphological take-off index plays an important role in achieving rapid transition to flight. The morphological aerodynamic index plays an important aerodynamic role in the central phase of flight. Ski jumpers with a higher aerodynamic index show a

higher potential capacity for successful execution of the jump in the flight phase. This finding is of great importance for selection of talented jumpers and their training.

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