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COMPARISON OF SOME ANTHROPOMETRIC MEASURES AND MOTOR ABILITIES BETWEEN ALPINE AND SPORT CLIMBERS

INTRODUCTION

Mountaineering as a sport is divided into five disciplines, which are: ice climbing, rock climbing, combined climbing, Himalaism and ski mountaineering. Mountaineers used to be universal. They climbed rocks, ice and took part in expeditions into the Andes and the Himalayas. They could achieve top results in all disciplines of mountaineering. Nowadays, the demands in top mountaineering are so extreme that specialization is necessary in order to achieve a top result. Instead of a homogenous group of mountaineers, we speak about different groups of athletes (Mesarič, 1987). Similarly, although much faster, developed sport climbing. Sport climbers started in natural environment on natural rock walls and later moved to artificial walls. Sport climbers started to compare themselves, which soon led to organized competitions. In 1985, the first larger international sport climbing competition took place in Italy (Leskošek, 1990). Modern sport climbing includes rock climbing (a number of possible ways of climbing a route) as a non-competitive discipline and competitive sport climbing, which includes lead, speed and boulder climbing. Sport climbers, as well, are becoming specialists for single disciplines.

In order to be able to realize their demanding goals mountaineers as well as sport climbers had to start with carefully planned training. Especially in the training of sport climbers, mobility and strength are emphasized. Next to coordination, they are the major motor abilities in climbing (Jereb, 1991; Dolenc, 1993; Goddard in Neumann, 1993). The effects of training is constantly monitored by means of tests (Leskošek, 1990), which are carried out once or twice a year within the frame of common survey of the Slovenian national teams. In the last years, a need has been expressed for the introduction of very objective tests, especially in the field of strength, where laboratory tests are preferred. (Ulaga, 1994). Undoubtedly, however, anthropometric characteristics of climbers are important for successful climbing. (Watts, 1999) Each kilogram of overweight can be crucial (Mejovšek, 1994). The anthropometry of the Slovenian climbers is surveyed with standard procedures (Bravničar, 1987).

In both sports, the major movement is climbing, the way of achieving the final result (climbing a route) can, however, be quite different. Considering different goals in achieving a sport result it can be concluded, that they differ in anthropometric measures and in motor abilities. The results of the comparison of anthropometric measures and motor abilities of mountaineers and sport climbers could serve for checking the selection of a sport branch and for redirection of climbers from one branch to another.

METHODS

The pattern of variables

Anthropometric survey was presented by 5 variables, 2 measures and 3 indexes, while motor mobility was presented with 6 variables and strength with 8 variables. All variables are parts of a battery of tests, which are used in regular testing of mountaineers and sport climbers at the Faculty of Sports in Ljubljana.

- ◆ The group of anthropometric measures consisted of:

(AT) body weight, (AV) body height (AMASTINP) body fat mass, (AMISINP) part of muscular mass in a body and AKOSTINP-part of bone mass in a body. All parts of body mass are calculated according to a formula developed by Mateigka (according to Bravničar 1987).

- ◆ The group of mobility tests consisted of:

MGARZP-arm-twist with a stick, MGATPK-bend and touch on a bench, MGGONLB- active side lying leg raises (Hips), MGGNLP- active straight-leg raise, MGPNCR-straddle hide split and MGPNZBS-frog pose.

- ◆ The group of strength tests consisted of:

MMRDT45-sit-ups, MMSRSP-hand squeeze, MMSRSPR-hand squeeze/100, SMEVPREP-move from one to another 1.5 and 2.5 cm big grip up and down changing hands at climbing board, SMMSBLOK-90° bent one arm hang, SMMVESA-one arm hang on minimal grip, SMMVISIP-arm hang on 1.5 cm big grip and SMVRABC-arm hang at 45°, 90° and 180° consequently until fatigue.

The pattern of subjects

The first group consisted of 12 Slovenian sport climbers, members of A, B and young national teams. The second group consisted of 11 selected Slovenian top mountaineers (Table 1).

The subjects had to meet the age requirement (in the year of testing reaching at least 18 years of age), high quality level (all sport climbers had to be members of the national team, all mountaineers had to have the status of a top athlete in the Slovenian categorisation scheme) and regularly training for at least three years. On the day of the survey, they were all in the preparation stage of the training process and in good health. The survey protocol was as follows: anthropometry, maximal arm strength, endurance in arm strength, mobility, torso strength, maximal finger strength and endurance in finger strength. All measurements were taken in one day.

Methods of data processing

- The normality of the distribution of the results was tested with the Kolmogorov-Smirnov test,
- Canonical discriminant analysis was used for the identification of differences between sport climbers and mountaineers in single monitored parameters. Statistical

significance of the differences was tested with Wilks's lambda, with hi-square test was tested the significance of the battery of tests.

Data was processed with a statistical programme package SPSS for MS WINDOWS version 6.0. All processing was made separately for morphology, mobility and strength. The reason we made this decision was in small subject sample and large number of variables.

RESULTS AND DISCUSSION

Basic statistical characteristics of the sample

The average height of sport climbers, who were the subjects in this research, was 1756.2 mm and the average weight was 62.89 kg (Table 2). Low body weight is needed for successful rock climbing in demanding routes or climbing difficult routes in competitions. Mejovšek (1994) studied the relation between body weight and height with the success in sport climbing. He analysed six world cup competitions and world championships in 1993 and found out that the average height of the athletes, who qualified for the finals, was 1748.8 mm and weight 59.84 kg.

Average height of the Slovenian sport climbers is very similar to the finalists in the world cup. They slightly differ in body weight. The members of the Slovenian national team were, in average, for three kilograms heavier than the finalists in those competitions. Other scientists also got similar results. Watts et al. (1993) measured an average height of 1778 mm and weight of 66.6 kg in 21 athletes who qualified for semi-finals in an international competition. Those, who qualified for the finals had the same average height and slightly lower average weight. These results show great significance of body weight for the achievement of a good result. Booth et al. (1999) measured six climbers capable of climbing routes of stages 6b do 7a. They were in the average 1757 mm high and weighted 62.6 kg.

Body weight was an anthropometric measure that differentiated the majority of mountaineers (69.25 kg) from sport climbers (62.89 kg) (Table 2). Mountaineers have to wear heavy rucksacks. During this activity legs gain muscle mass and body weight is increased. As alpine rock climbers wear rucksacks also during climbing, they need higher muscle mass of the entire body. The differences in body weight are even higher in a comparison of sport climbers and himalayists. Twenty participants of an international expedition to Everest had an average height of 1791.67 mm and average weight of 77.16 kg prior to the expedition (Burnik in Leskošek, 1999).

Finger and hand grip is of a special importance in sport climbers (Jereb, 1988), of a little less importance in mountaineers. This way the differences in hand and finger strength could be anticipated.

In mobility tests we expected sport climbers to have better results. Poor mobility prevents the use of special climbing technique (Dolenc, 1993). In two tests, better results were achieved by the mountaineers. They were better in active straight-leg raise and side lying leg raises (Hips), where active muscle mobility is shown. Muscles actively contribute to the achievement of better result. Sport climbers achieved better results in

other mobility tests, which is shown in table 2. They have a high correlation with success mostly in sport climbing.

Analysis of structural differences between sport climbers and mountaineers

Differences in anthropometric measures

Discriminant function shows statistically significant ($P < 0.05$) differentiation between sport climbers and mountaineers (Table 3). Placement of climbers along the discriminant function is correct in 82.61% (Table 4). Two sport climbers and two mountaineers were incorrectly placed (Table 4). In sport climbers, discrepancy from the group in tests AMASTINT in AMISINT appeared. One sport climber was constitutionally more similar to the mountaineers, while another had lately less training due to school activities, which was shown in the mentioned anthropometric indexes. In mountaineers, the largest difference was shown in the results of the AKOSTINP test. Both mountaineers achieved top results with regard to other members of the group. One mountaineer had also other anthropometric measures similar to sport climbers

Differences in mobility

Discriminant function shows statistically significant ($P < 0.01$) differentiation of sport climbers and mountaineers (Table 3). These can be confirmed by high result of the success of placement of climbers on the discriminant function (91.3%) (Table 4). From the centroids it is shown that two sport climbers had positive values, which classify them among the alpine rock climbers. Both athletes originated from the environments in which there was no expertly led sport activity and due to the poor knowledge of the importance of training contents, they do not give enough emphasize to mobility. One of them was also a mountaineer, which can also be a reason for poor mobility results. In four tests out of six his results were closer to those of the mountaineers than to sport climbers.

Differences in strength

In the case of strength, discriminant function did not statistically significantly divide sport climbers from mountaineers ($P = 0.14$) (Table 3). The calculated parameters of discriminant function (Table 3), however, show there were differences between them. The right placements on the discriminant function are high as well (82.61%). Two sport climbers were classified into the group of alpine rock climbers, and two alpine rock climbers into the group of sport climbers (Table 4). Both sport climbers achieved poor results in the finger grip test, especially in test SMMVESA-one arm hang on minimal grip. This variable is closely related to the success in climbing routes, which depends more on the maximal finger grip strength than on the finger grip endurance. Finger grip endurance is more important in longer mountaineering routes. One of the mountaineers was at the same time a successful sport climber and had lately followed mostly sport climbing goals. The results of the second alpine rock climber were nearly in all strength tests better than the averages of his colleagues, which is why he is placed among the sport rock climbers on the discriminant function.

The top Slovenian mountaineers and sport climbers differ in the majority of tested parameters. The differences can be due to the type of training or proper branch selection. It can be concluded that specialization is necessary for a good result. Specialization can be emphasized with planned training activity, acquisition of knowledge in this field and with introduction of new disciplines in alpine as well as sport climbing.

REFERENCES

- (1) Booth, J., Marino, F., Hill, C., Gwinn, T. (1999). Energy cost of sport climbing in elite performers. *British Journal of Sports Medicine*. 33: 14-18.
- (2) Bravničar, M. (1987). Antropometrija (priročnik za študente Fakultete za telesno kulturo in trenerje). Fakulteta za telesno kulturo, Ljubljana.
- (3) Burnik, S., Leskošek, B. (1999). Some Anthropometric Changes On Extreme High Altitude. V: N. Messenger, W. Patterson, D. Brook (Ur.) *The Science of Climbing and Mountaineering*. Chapter 6. Human Kinetics Software, CD-ROM.
- (4) Dolenc, A. (1993). Pomen razvoja gibljivosti za optimalno izvedbo plezalne tehnike. Diplomsko delo. Fakulteta za šport, Ljubljana.
- (5) Goddard, D., Neumann, U. (1993). *Performance Rock Climbing*. Mechanicsburg, Pennsylvania: Stackpole Book.
- (6) Jereb, B. (1988). Vpliv električne stimulacije na vzdržljivost v moči prstov na rokah pri športnih plezalcih. Diplomsko delo. Fakulteta za telesno kulturo, Ljubljana.
- (7) Jereb, B. (1991). Vpliv športnega plezanja na motorične sposobnosti in antropometrijske mere pri starejših pionirjih. Seminarska naloga. Fakulteta za šport, Ljubljana.
- (8) Leskošek, B. (1990). Navodila za meritve športnih plezalcev. Fakulteta za šport, Ljubljana.
- (9) Leskošek, B. (1990). Nastanek in razvoj športnega plezanja. *Šport*, 38 (3-4), 11-13.
- (10) Mejovšek, M. (1994). Biti lahek in plezati dobro? Komisija za alpinizem pri PZS, Ljubljana. *Alpinistični in športno plezalski razgledi*, XV. 45, 34-35.
- (11) Mesarič, V. (1987). Relacije med alpinisti, alpskimi smučarji in smučarskimi skakalci v prostoru nekaterih antropometričnih in motoričnih testov. Fakulteta za telesno kulturo, Ljubljana.
- (12) Ulaga, M. (1994). Odvisnost sile potega od pokrčenosti roke. Diplomsko delo. Fakulteta za šport, Ljubljana.
- (13) Watts, P. B. (1999). *Physiological Aspects of Difficult Sport climbing*. V: N. Messenger, W. Patterson, D. Brook (Ur.) *The Science of Climbing and Mountaineering*. Chapter 6. Human Kinetics Software, CD-ROM.
- (14) Watts, P. B., Martin, D. T., Durtschi, S. (1993). Anthropometric profiles of elite male and female competitive sport climbers. *Journal of Sports Sciences*. 11:113-117.
- (15) Watts, P. B., Newbury, V., Sulentic, J. (1996). Acute changes in handgrip strength, endurance, and blood lactate with sustained sport climbing. *Journal of Sport Medicine and Physical Fitness*. 36:255-260.

Table 1: basic data on the subjects.

	Average age	Average Climbing experience	Average weight in pt with RP	Average weight in pt with NP
Sport climbers	24 years	6,5 years	10,5 points	6,3 points
Mountaineers	30,6 years	12,5 years	7,1 points	5,2 points

Legend: RP=red point route (with previous acquaintance), NP=on side route (without previous acquaintance). Numbers in columns RP and NP mean average difficulty stage expressed in points. Marking: (6c=1 point, 6c+=2 points, etc. to.....8b+=12points).

Table 2: basic statistical parameters and significance according to Kolmogorov-Smirnov test.

	vsi XA	vsi S.D.	s1 XA	s1 S.D.	s2 XA	s2 S.D.	MIN	MAX	K-S P
AT	659,35	62,08	628,92	53,07	692,55	55,29	532*+	790	0,99
AV	1763,87	40,96	1756,25	41,54	1772,18	40,59	1690	1831	0,99
AMASTINP	649,09	137,76	647,67	149,28	650,64	131,28	436*+	890	0,99
AMISINP	507,48	23,05	506,50	27,50	508,55	18,31	468*	556	0,99
AKOSTINP	242,26	14,16	250,58	12,95	233,18	9,11	218+	283*	0,46
MMRTDT.45	17,43	7,40	17,33	9,68	17,55	4,16	11	31*+	0,70
MMSRSP	460,78	50,02	457,33	54,66	464,45	46,78	390*	560+	0,81
MMSRSPR	703,91	96,99	733,25	116,84	671,91	59,32	601*	942*+	0,39
SMEVPREP	9,48	7,00	12,50	7,14	6,18	5,36	0	22*+	0,60
SMMSBLOK	11,83	9,36	15,66	9,46	7,64	7,57	1	29*+	0,40
SMMVESA	55,09	21,59	67,33	19,51	41,73	15,18	18	91*+	0,99
SMMVISIP	21,78	8,94	16,42	7,12	27,64	6,92	6*+	40	0,54
SMVRABC	7,96	2,55	9,08	1,98	6,73	2,61	3	13*+	0,72
MGARZP	74,83	18,16	65,00	16,84	85,55	13,10	30*+	109	0,93
MGATPK	55,52	7,35	56,75	9,32	54,18	4,40	41*	67*+	0,99
MGGNOLB	87,13	15,07	84,50	8,90	90,00	19,87	65	130+	0,52
MGGNPL	109,39	11,74	106,92	13,47	112,09	9,39	80*	129*+	0,78
MGPNCR	185,30	10,73	191,50	9,77	178,55	7,20	168	206*+	0,85
MGPNZBS	9,83	3,63	7,83	3,38	12,00	2,53	5*+	18	0,53

Legend: Basic statistical parameters (arithmetic means of all subjects all- XA, sport climbers-s1 XA, mountaineers-s2 XA and standard deviations of all subjects-all S.D., sport climbers-s1 S.D., mountaineers-s2 S.D.). Minimal (MIN) and maximal (MAKS) values of single variables for all subjects, and statistical significance according to Kolmogorov-Smirnov test of normality of distribution (K-S P). *-result of a sport climber. +-better result for the success in sport climbing.

Table 3: values of canonical and discriminant functions.

	Own value	% variance	Canonical correlation	Wilksova lambda	Hi ²	Stages of freedom	Statistical significance
A	0,9119	100	0,6906	0,5231	11,989	5	P<0,05
G	2,0688	100	0,8211	0,3258	20,183	6	P<0,01
M	1,0615	100	0,7176	0,4850	12,298	8	P=0,14

Legend: A-anthropometry, G-mobility in M-strength.

Table 4: distribution of placements on a discriminant function and centroids of groups.

	group	No. meas.	1	2	Together proper placements	Centroids of groups
A	1 sp. climbers	12	10 (83,3%)	2 (16,7%)	82,61%	,87
	2 mountain.	11	2 (18,2%)	9 (81,8%)		-,95
G	1 sp. climbers	12	10 (83,3%)	2 (16,7%)	91,30%	-1,32
	2 mountain.	11	0 (0%)	11 (100%)		1,44
M	1 sp. climbers	12	10 (83,3%)	2 (16,7%)	82,61%	-,09
	2 mountain.	11	2 (18,2%)	9 (81,8%)		1,03

Legend: A-anthropometry, G-mobility and M-strength.

COMPARISON OF SOME ANTHROPOMETRIC MEASURES AND MOTOR ABILITIES BETWEEN ALPINE AND SPORT CLIMBERS

The purpose of our study was to establish the differences in some anthropometric measures and motor abilities between mountaineers and sport climbers. Our sample consisted of 11 top mountaineers and 12 members of A and B national teams in sport climbing. The survey was carried out by means of a standard battery of tests. Anthropometric measures were represented by 5 variables, while motor abilities were represented by 14 variables. Motor ability tests were divided into two groups due to a large number of variables. Mobility was surveyed with 6 tests and strength with 8 tests. The data were processed with statistical programme package SPSS with the method of discriminant analysis. Discriminant analysis was made separately of anthropometry, mobility and strength.

Discriminant function statistically significantly divides mountaineers from sport climbers in anthropometric measures as well as mobility. In the field of strength, statistically significant differences between mountaineers and sport climbers were not indicated.

Keywords: mountaineering, sport climbing, morphology, motor abilities, differences (discriminant analysis).