EFFECT OF MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES ON THE DEVELOPMENT OF COORDINATION ABILITIES OF BOYS AGED 11-12

Veroljub Stanković[1] and Julijan Malacko[2]

[1] Faculty of Sport and Physical Education in Leposavić, University of Priština
[2] Faculty of sport and physical education, University of Novi Sad, Novi Sad, Serbia

Abstract

For a sample of 125 boys, aged 11 $\pm$ 6 months, a system of 30 variables was applied, of which six were criterion variables of coordination abilities, 12 predictor variables of morphological characteristics and 12 predictor variables of motor abilities, with the aim of using regressive analysis to determine the impact of predictor variables on criterion variables. The results showed that the system of predictor variables of morphological characteristics and the system of motor abilities have a statistically significant effect on all individual criterion variables of coordination abilities at a level of .00 (p =.00). Of individual morphological variables the greatest impact on variables of coordination of the body have variables of shoulders width, volume and fold of the stomach, and the greatest impact on the coordination of arms and legs have variables of body height and volume of upper leg. The biggest impact on the individual variables of body coordination have the motor variables of foot tapping on the wall, standing long jump, throwing a medicine ball by lying flat and running 20 m from a high start, and on the coordination of arms and legs variables of running 20 m from a high start, sit-ups and back extensions. The general conclusion is that morphological characteristics and motor abilities have a major influence in the development and expression of co-ordination abilities of boys of this age.

Key words: *coordination abilities, morphological characteristics, motor abilities, effect, boys*

Introduction

There is no doubt that the coordination abilities represent the most complex area of human motor skills. Although the area has relatively large quantity of information, the main problem is in the fact that there is still few congruent information collected and processed by valid and reliable mathematical and statistical procedures. Data processing, which was mainly implemented with substantial measurement error, and only to a lesser extent with the main subject of measurement, did not allow anything else except broadcasting suspicious theories and speculations, often devoid of any scientific basis. In the last 30 years much has been done to construct a reliable measuring instruments and to systematically analyze the structure of anthropological space (Popović, 1993; Momirović, Wolf & Popović, 1999; Malacko & Popović, 2001). In previous research the majority of authors studied the problems of the structure of morphological characteristics and motoric abilities, that is identification of latent structures by which these properties are defined (Gredelj, Metikoš, Hošek & Momirović, 1975; Kurelić, Momirović, Stojanović, Sturm, & Radojević Viskić-Štalec, 1975; Malacko & Stanković, 2009). Almost equal attention was paid to research relationship between morphological characteristics and motor abilities (Kurelić, Momirović, Mraković & Sturm, 1979) and the lowest amount of research exists in the area of motor coordination and its relationship with other segments of anthropological status (Hošek-Momirović, 1981), as well as univariant and multivariate influences of certain segments of anthropological features of coordination capabilities (Malacko, 2005).

Analyzing the current research in determining the exact coordination capabilities (Hošek-Momirović, 1976) one finds the phenomenon with which most authors agree, and this indicates that the coordination represents motor ability of performing very complex motion structures. Here, we almost all face difficulties in differentiating the performance of complex motion structures and other motor skills, especially those that have been previously defined in the exact manner, such as power, speed, balance, and flexibility. The emergence of a significant stake in the variability of intellectual abilities of tests of coordination can be added here (Kirkendall & Gruber, 1970; Stanković & Malacko, 2008).

The aim of the research

The aim of the research consisted of identifying statistically significant multivariant and univariant relations and impact of predictor morphological variables and variables of motor abilities on the criterion variables, system coordination abilities of boys aged 11-12 in order to form the rational procedure, on the one hand, in carrying out the sports-orientation and selection, and on the other hand, optimal planning, programming and implementation of control on the efficiency and effectiveness of educational and training content.

Methods

The sample of participants consisted of 125 boys aged 11-12. The sample of variables consisted of 30 variables, of which six criterion variables of coordination skills, 12 predictor variables of morphological characteristics and 12 predictor variables of motor skills.

Coordination variables: 1. Body coordination-*seconds:* **PTJ** - passing through and jumping over, **AGA** - agility in the air, **OCB** - obstacle course backwards, 2. *leg-hand coordination* – seconds: **S3B** - slalom with three medicine balls, **S2B** - slalom by kicking two balls, **HDR** - hand dribbling. *Morphological variables: 1.* Dimensions of the skeleton*:* **BOH** - body height – mm, **SHW** - houlder width – mm, **PGW** - pelvis girdle – mm, 2. Body mass: **BOM** **-** body mass *body mass and volume* – kg, **FOC** - forearm circumference – mm, **UPC** - upper arm circumference – mm, **THC** - thigh circumference – mm, **CAC** - calf circumference – mm, **WAC** - waist circumference – mm, **UAS** - upper arm skinfolds, 3. *Subcutaneous fatty tissue* – mm, **SUS** - subscapular skinfold – mm, **ABS** - abdominal skinfold – mm. *Motor variables: 1.* Frequency of movement*:* **HTA** - hand tapping - repetitions, **FTA** - foot tapping – rep., **FTW** - foot tapping against the wall – rep., 2. Explosive strength: **SLJ** - standing long jump – cm, **MTL** - medicine ball throw from supine lying – cm, **20R** - 20m running from the standing start – seconds, 3. Strength endurance: **ASB** - all-out declined sit-ups off the bench – rep., **AHB** - all-out hyperextension on the box – rep., **UCB** - undergrip chin-ups on the bar – rep., 4. Flexibility: **BFB** - bent forward on the bench – cm, **SSR** - straddle sit-and-reach – cm, **SCB** - shoulder circumduction backwards with a stick – cm. For each applied variable the following the central and dispersion parameters were calculated: M - arithmetic mean, Min - minimum value and max - the maximum and S - standard deviation. Normality of distribution of variables was tested using Sk – skewnes and Ku - kurtosis. To calculate the influence of morphological variables and motor system variables (such as system predictor variables) on the coordination abilities of the individual variables (such as criterion variables) regression analysis was applied.

Results

Analyzing Table 1, it is clearly evident that most of applied variables do not deviate significantly from normal distribution (Sk - skewnes is marked with *). In the space of co-ordination skills an exception represent variables of passing through and jumping over (Sk = 2.45) and obstacle course backwards (Sk = 1.25), which values are grouped around small (better) values, and in the space of morphological characteristics abnormal distribution show variables of body volume- the forearm volume (Sk = 1.04) by increased the volume of the belly (Sk =- 1.10) toward reduced values, while the variables fatty tissue - upper arm skin fold (Sk = 1.31), skin fold back (Sk = 1.95) and abdominal skin fold (Sk = 1.35) move towards smaller (better) values. In the area of motor skills all applied variables are normally distributed, since their values go below one standard deviation. Determinating the impact of predictor system of variables of morphological characteristics and motor abilities (Table 2) on the individual criterion variables of coordination abilities, the results

showed that the applied predictor systems have statistically significant correlation (multivariant effect) on all the individual criterion variables of coordination skills at a level of .00 (p =. 00).

Table 1: The basic statistical parameters and their discrimination

Variables	M	min	max	S	Sk	Ku
Coordination variables						
PTJ	1623.94	963.00	4200.00	521.58	2.45	8.31
AGA	601.44	.00	1007.00	139.59	**-.34***	5.44
OCB	1771.80	954.00	3900.00	541.39	1.25	2.04
S3B	5040.87	3422.00	6500.00	524.01	**.05***	.99
S2B	7108.90	5693.00	9000.00	532.96	**.32***	.93
HDR	1016.35	800.00	1259.00	115.84	**.17***	-.92
Morphological variables						
BOH	1464.08	1335.00	1620.00	69.40	**.37***	-.61
SHW	298.56	255.00	350.00	20.07	**.22***	-.21
PGW	22.73	18.00	30.00	2.33	**.71***	.41
BOM	40.84	25.00	75.00	10.00	**.96***	.77
FOC	210.88	170.00	305.00	21.78	1.04	2.23
UPC	215.56	165.00	310.00	30.24	**.71***	.06
THC	458.12	345.00	670.00	62.61	**.70***	.04
CAC	300.56	225.00	420.00	36.10	**.89***	.82
WAC	664.36	102.00	920.00	121.12	-1.10	5.94
UAS	6.82	2.00	23.00	3.97	1.31	1.77
SUS	5.69	2.00	26.00	4.25	1.95	5.10
ABS	8.16	2.00	31.00	6.36	1.35	1.42
Motor variables						
HTA	23.37	17.00	33.00	2.82	**.34***	.30
FTA	18.99	14.00	24.00	1.82	**-.12***	.28
FTW	17.84	10.00	24.00	2.24	**.01***	1.37
SLJ	153.89	82.00	190.00	18.24	**-.79***	1.58
MTL	592.40	425.00	825.00	71.26	**-.17***	.47
20R	394.73	320.00	490.00	33.65	**.34***	.09
ASB	4.39	.00	14.00	2.58	**.42***	.70
AHB	15.28	1.00	30.00	5.87	**-.15***	-.31
UCB	1.38	.00	4.00	.96	**.03***	-.74
BFB	28.80	11.00	41.00	6.23	**-.42***	.13
SSR	364.28	100.00	575.00	90.93	**-.02***	-.00
SCB	50.26	30.00	95.00	10.14	**.96***	2.19

M – arithmetic mean, min, max – min. and max.,
S - standard deviation, Sk - skewness, Ku - curtosis

Individual (univariant) statistically significant impact of variables on criterion varable of coordination skills is as follows: A. *Morphological variables:* **PTJ** (passing through and jumping over)**:** SHW - shoulder width (p=.01), WAC – waist circumference (p=.00), ABS – abdominal skinfold (P=.04), which means that examinees with narrower shoulders, smaller waist circumference and smaller abdominal skinfold had better results concerning body coordination; **AGA** (agility in the air)**:** WAC – waist circumrerence (p=**.**00), which means that examinees with smaller waist circumference had better results concerning body coordination; **OCB** (obstacle course backwards): SHW - shoulder width (p=.00), which means that examinees with narrower shoulders had better results concerning body coordination; **S3B** (slalom with three medicine balls): BOH – body height (p=.00), THC – thigh circumference (p=.03), which means that examinees with lower body height and smaller thigh circumference had better results concerning arm and leg coordination. B. *Motor variables:* **PTJ** (passing through and jumping over)**:** SLJ – standing long jump (p=.00), MTL - medicine ball throw from supine lying (p=.01) and 20R - 20m running from the standing start (p=.01), which means that the better results in the

coordination of the body were the examinees with higher values in the variables of explosive motor power; **OCB** (obstacle course backwards): FTW - foot tapping against the wall (p=.03), SLJ – standing long jump (p=.00) and 20R - 20m running from the standing start (p=.04), which means that better results in the coordination of the body were the examinees with higher values in the variables frequency of motor movements and explosive force; **S3B** (slalom with three medicine balls): ASB - all-out declined sit-ups off the bench (p=.02) and AHB - all-out hyperextension on the box (p=.02), which means that the better results in the coordination of the arms and legs were respondents with higher value repetitive motor variables in power; **S2B** (slalom by kicking two balls): 20R - 20m running from the standing start (p=.00), which means that the better results in the coordination of the arms and legs were respondents with higher values in the motor variables of explosive strength of lower extremities.

Table 2: Impact of the whole system of predictor morphological and motor variables on the criterion

Variables	PTJ	AGA	OCB	S3B	S2B	HDR
	β,t (p)	β,t (p)	β,t (p)	β,t (p)	β,t (p)	β,t (p)
Morphological variables						
BOH	0.20	0.15	0.68	.00*	0.37	0.13
SHW	.01*	0.07	.00*	0.52	0.89	0.81
PGW	0.71	0.82	0.26	0.42	0.97	0.95
BOM	0.06	0.76	0.10	0.17	0.88	0.06
FOC	0.76	0.29	0.51	0.96	0.27	0.52
UPC	0.44	0.82	0.90	0.65	0.26	0.65
THC	0.78	0.27	0.99	.03*	0.10	0.56
CAC	0.70	0.11	0.94	0.07	0.50	0.19
WAC	.00*	.00*	0.54	0.23	0.10	0.51
UAS	0.18	0.54	0.25	0.91	0.06	0.77
SUS	0.67	0.49	0.12	0.93	0.79	0.37
ABS	.04*	0.30	0.19	0.72	0.94	0.93
R_o^2	0.62	0.66	0.46	0.26	0.25	0.25
R_o	0.79	0.81	0.68	0.51	0.50	0.50
F	15.59	18.39	8.05	3.38	3.24	3.19
p	.00*	.00*	.00*	.00*	.00*	.00*
Motor variables						
HTA	0.82	0.58	0.97	0.14	0.37	0.15
FTA	0.40	0.24	0.53	0.14	0.16	0.78
FTW	0.18	0.44	.03*	0.64	0.97	0.11
SLJ	.00*	0.38	.00*	0.53	0.25	0.60
MTL	.01*	0.69	0.06	0.42	0.43	0.92
20R	.01*	0.49	.04*	0.99	.00*	0.07
ASB	0.88	0.49	0.29	.02*	0.39	0.10
AHB	0.49	0.60	0.35	.02*	0.52	0.22
UCB	0.19	0.08	0.06	0.06	0.09	0.68
BFB	0.27	0.63	0.51	0.70	0.66	0.50
SSR	0.94	0.36	0.21	0.66	0.06	0.50
SCB	0.16	0.61	0.15	0.13	0.10	0.62
R_o^2	0.57	0.21	0.54	0.40	0.39	0.42
R_o	0.75	0.46	0.73	0.63	0.63	0.65
F	12.55	2.57	11.16	6.22	6.16	6.99
p	.00*	.00*	.00*	.00*	.00*	.00*

β – individual impact of each standardized predictor variable on the criterion variable, t – testing of the significance of each predictor variable's individual impact on the criterion variable, p – the set level of statistical significance of each predictor variable's impact on the criterion variable p=.05-.00; R_o^2 – multiple correlation squared, or the predictor variables' system total variance; R_o – multiple correlations of the whole system of predictor variables with the criterion variable; F – testing of significance by means of F-ratios; p – the set of statistical significance of the impact of the whole system of predictor variables on the criterion variable p=.05.00.

Discussion and conclusions

Based on the testing of normality distribution of each applied variable it was found that 80% of variables have normal distribution (symmetric), which means the system was applied to variables of coordination abilities, morphological characteristics and motor abilities was adapted to boys age and their development level and ability, and were suitable for further processing and interpretation. Unlike the variables of coordination skills, where of six applied variables, four variables obtained normal (symmetric) distribution, in the system of morphological variables it was observed that the variables of body volume (forearm volume and scope of the abdomen) and fatty tissue (upper arm skinfold, subscapular skinfold and abdominal skinfold) the values were abnormally distributed. Considering that the values of fatty tissue are better if they are smaller it means that the majority of examinees possessed a small amount of fatty tissue, which is considered positive. Other morphological variables have satisfactory discrimination, which in this study is very significant, considering that this is a study of their association with motor abilities of coordination skills. The predictor system of motor variables all applied variables have satisfactory discrimination. Determinating the impact of especially predictor system of morphological variables and especially predictor system of motor variables on individual criterion variables of coordination skills, the expected results appeared, which are - the predictor system of variables in both spaces had a statistically significant multivariate relationship and the impact on all individual criterion variables at the level of .00 (p =. 00).

This means that the results were achieved in the coordination abilities thanks to a good selection and the overall level of predictor variables in both systems. Of individual morphological variables most influence on variables of body coordination have variables – shoulder width, thigh circumference and abdominal skinfold and on arm and leg coordination body height and forearm circumference. The biggest impact on the individual variables of body coordination have motor variables – foot taping against the wall, standing long jump, throwing a medical from lying and running 20 m from a high start, and on arm and leg coordination variables - running 20 m from a high start, all-out declined sit-ups off the bench and all-out hyperextension on the box. Based on the obtained and analyzed multivariant and univariant results in this study, in general terms it may be concluded, that they are fully satisfying and the expected results were obtained, and that to perform coordination abilities of boys aged 11-12 an optimal morphological development and motor ability developed is required on an integral basis. The assumption that the educational and sports activities for boys of this age was focused on the necessary integrity, balance and target efficiency and effectiveness was also confirmed.

Literature

Gredelj, M., Metikoš, D., Hošek, A. & Momirović, K. (1975). Model hijerarhijske strukture motoričkih sposobnosti: Rezultati dobijeni primjenom jednog neoklasičnog postupa za procjenu latentnih dimenzija. [A model of hierarchic structure of motor abilities: The results obtained using a neo-classical method for estimating latent dimensions]. *Kinesiologija*, Vol. 5 (5), pp. 7-81.

Hošek-Momirović, A. (1976). *Struktura koordinacije* [Structure of coordination]. Unpublished master's thesis. Zagreb: Fakultet za fizičku kulturu.

Hošek-Momirović, A. (1981). Povezanost morfoloških taksona sa manifestnim i latentnim dimenzijama koordinacije [Relation between morphological taxons and the manifest and latent dimensions coordination]. *Kineziologija,* No. 4, Vol. 11, pp. 5-108.

Kirkendall, D. R. & Gruber, J. J. (1970). Canonical relationships between the motor and intellectual achievement domains in culturally deprived high school pupils. *Researsh Quarterly*, Vol. 41, No 4, pp 496-502.

Kurelić, N., Momirović, K., Stojanović, M., Šturm, J., Radojević, Đ. & Viskić-Štalec, N. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine*. [Structure and development of morphological and motor dimensions of youth] Beograd: Instutute of scientific research of Faculty of physical education.

Kurelić, N., Momirović, K., Mraković, M & Šturm, J. (1979). Struktura motoričkih sposobnosti i njihove relacije sa ostalim dimenzijama ličnosti [Structure of motor abilities and their relations with other personality dimensions]. *Kineziologija*, vol. 9, br. 1-2, pp. 5-20.

Malacko, J. & D. Popović (2001). *Metodologija kineziološko antropoloških istraživanja*. [Methodology of kinesiological and anthropological research] The third edition. Leposavić: Faculty of Physical Education, University of Priština.

Malacko, J. & Stanković, V. (2009). The latent structure of morphological characteristics of top handball, basketball and football players. *Sport Science*, 1: 111-116.

Malacko, J. (2005). Effects morphological caracteristics and motor abilities on sprint speed in boys of 11-12 years. *4rd International Scientific Conference on Kinesiology "Science and profession - challenge for the future"*,pp 90-93. Zagreb: Faculty of Kinesiology, University of Zagreb.

Momirović, K., Wolf, B. & Popović, D. (1999). Uvod u teoriju merenja i interne metrijske karakteristike kompozitnih mernih instrumenata [Introduction to theory of measurement and internal characteristics of composite measuring instruments]. 2nd edition. Faculty of physical culture, University of Priština.

Popović, D. (1993). *Programi i potprogrami za analizu kvantitativnih promena*. [The programs and sub-programs for the analysis of quantitative changes]. Priština: Faculty of Physical Education, University of Priština.

Stanković, V., Malacko, J. (2008). Relations between systems of motor, cognitive and connate variables of top-class handball players. *Kinesiologia Slovenica*, 3, vol. 14(33-44).

UTJECAJ MORFOLOŠKIH KARAKTERISTIKA I MOTORIČKIH SPOSOBNOSTI NA RAZVOJ KOORDINACIJSKIH SPOSOBNOSTI DJEČAKA 11-12 GODINA

Sažetak

Na uzorku 125 dječaka, uzrasta 11 godina ± 6 mjeseci, bio je primjenjen sustav od 30 varijabli, od toga 6 kriterijskih koordinacijskih sposobnosti, 12 prediktorskih varijabli morfoloških karakteristika i 12 prediktorskih varijabli motoričkih sposobnosti, s ciljem da se regresijskom analizom utvrdi utjecaj prediktorskih varijabli na kriterije. Rezultati su pokazali da prediktorski sustav morfoloških karakteristika i motoričkih sposobnosti ima statistički značajan utjecaj na sve pojedinačne kriterije koordinacije na raziniod .00 (p=.00). Od pojedinačnih morfoloških varijabli najveći utjecaj na varijable koordinacije tijela imaju širina ramena, obujam i nabor trbuha, a na koordinaciju ruku i nogu tjelesna visina i obujam natkoljenice. Najveći utjecaj na pojedinačne varijable koordinacije tijela imaju motoričke varijable taping nogom o zid, skok u dalj s mjesta, bacanje medicinke iz ležanja i trčanje 20 m iz visokog starta, a na koordinaciju ruku i nogu varijable trčanje 20 m iz visokog starta, podizanje trupa iz ležanja i zaklon trupa u ležanju. Opći je zaključak da morfološke karakteristike i motoričke sposobnosti imaju jako veliki utjecaj u procesu razvoja i iskazivanja koordinacijskih sposobnosti kod dječaka ovog uzrasta.

Ključne riječi: *koordinacijske sposobnosti, morfološke karakteristike, motoričke sposobnosti, efekti, dječaci*

Assoc.Prof. Veroljub Stanković, PhD
University of Priština
Faculty of Sport and Physical Education
38218 Leposavić, Dositeja Obradovića bb.
Tel: +381 (0)28 84 701
E-mail: veroljub.stanković@pr.ac.rs