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Latent structure of pre-school children's body power

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Abstract
The aim of the study was to determine the latent structure of the group of motor manifestations, which are under control and dominant influence of the mechanism of energy regulation. The measurements were performed on a sample of 180 boys and girls from four kindergartens in Rijeka. The battery consists of 24 motor measurements with the following characteristics; suitable for the motor knowledge and abilities of the pre-school children, the complexity of conducting the tests was as low as possible and small amount of necessary equipment to carry out the tests. Seven factors were extracted using the GK criterion. According to the hypothesis some of the extracted factors have confirmed its existence, such as factor of explosive power, dynamic power and static endurance. It is necessary to make some modification of some measure instruments for static endurance as well as to test its on larger sample. This experimental study is contribution to a very small number of studies in Croatia on the sample of preschools children. The conclusions of this study are contributing to the results of the different former studies concerning the anthropological characteristics of the children at the age of 5 and 6. In the end, it is important to emphasize the complexity of this experimental study with the key terms, preschool children and measurement process of power, as well as at the same time the necessity of effective collaboration with parents, principal and kindergarten teachers, physical education teachers, doctors and pedagogues, who have also taken part in this experimental study.

Key words: **pre-school children, new measurements, strength, latent structure**

Sažetak
Latentna struktura relativne snage djece predškolske dobi utvrđena je primjenom novokonstruirane baterije mjernih instrumenata relativne tjelesne snage. Izmjereno je ukupno 180 djece iz četiri vrtića u Rijeci. Primjenjena je baterija od 24 mjerna instrumenta koja su primjerena motoričkim znanjima i sposobnostima predškolaca, jednostavnog izvođenja i uz vrlo mali broj pomagala i rekvizita. Uz primjenu GK kriterija izolirano je 7 faktora. Na osnovu rezultata potvrđena je opstojnost prema akcionom tipu snage faktora eksplozivne snage, faktora dinamičke snage i statičke izdržljivosti. Mjerne instrumente relativne statičke snage potrebno je doraditi i testirati na većem uzorku ispitanika. Provedeno eksperimentalno istraživanje predstavlja doprinos malobrojnim istraživanjima provedenim na uzorku djece predškolske dobi u Hrvatskoj. Zaključci ovog istraživanja pridonose dosadašnjim spoznajama o antropološkim obilježjima djece u dobi od 5. i 6. godina. Kompleksnost istraživanja prostora snage na uzorku predškolcima ističe potrebu kvalitetne suradnje voditelja mjernog postupka, roditelja djece uključenih u mjerni postupak, ravnatelja i odgojitelja u vrtićima u kojem se istraživanje izvodilo te kineziologa, pedagoga i liječnika koji su također bili uključeni u ovo istraživanje.

Ključne riječi: **predškolci, novi mjerni instrumenti, tjelesna snaga, latentna struktura**

Introduction

According to Malina (2004), children show considerable increase in performance in skills between 5 and 8 years of age (running speed and shuttle run) and a steady, more gradual increase in performance in others from 5 years of age through childhood (e.g. jumping, throwing and strength). Motor performance depends on muscular strength and it improves linearly with age from early childhood. Different studies (Rajtmajer 1990, Živčić and Hraski 1995., Bala, 1999. 2003., Mišigoj-Duraković 1999., Malina 2004, Trajkovski Višić, 2004, Živčić et al. 2008, De Privitellio 2006 and 2009) have confirmed the following; 1. Muscular strength increases gradually during early childhood and 2. Gender differences in average strength are small but consistently favour boys for running, jumping and throwing. Popović et al. (2006) determined the trend of the development of pre-school children motor abilities on the sample of 609 boys and 587 girls. The results of seven motor tests with regard to children's gender and age (age groups defined at six-month intervals) were analyzed. The trend of the development of motor abilities is of the same intensity regarding the sex and has the progressive development regarding the age. The results point at the uniqueness and interconnectedness of motor abilities, i.e. the influence on the one ability has a direct impact on the development of other abilities (7). Planinšec (2001) established the relation between motor dimensions and cognitive abilities in boys and girls of 5. 5 years of age. General cognitive and motor abilities were estimated on the sample of 189 girls and 203 boys applying RAZKOL tests. The connection between cognitive abilities and dynamic strength, balance and speed of simple movements has been found in girls while in boys the relation between cognitive abilities and dynamic strength did not show statistically significant results. In addition, the same author has established the motor types of 6-year-old boys (6). On the sample of 242 boys 28 motor tests were measured intended to estimate the coordination of the whole body, arms and shoulder area, agility, explosive power, dynamic power, movement frequency and balance. The analysis of the results confirmed the existence of general motor ability characterized by information and energetic movement components, and on the basis of which three groups of motor types of boys were obtained based on Ward's method application. The first type was characterized by better results in the overall motor space, especially in

movement speed, agility, dynamic power and arm coordination. The second type achieves the average results of motor efficiency, and the third lower motor efficiency especially in dynamic power, whole body coordination, agility, arm coordination and balance.
In Croatia there is a small amount of studies on the sample of pre-school children. In addition, we can notice the lack of studies which provide analysis and structure of pre-school body power. The reasons for this can be explained by the following facts: 1. The lack of adequate and effective organisation as well as co-operation between different subjects responsible for sports programmes in kindergarten, 2. A small number of reliable and valid motor tests which are suitable for pre-school children, 3. A small percentage of kindergartens with adequate sports infrastructure (gym, playground, etc.) as well as 4. Unsatisfactory proportion of kindergarten teachers with regard to high number of pre-school children in one group. There are just a few and unsystematic investigations of power segment in pre-school children. The purpose of the research is to determine the latent structure of the group of motor manifestations, which are under control and dominant influence of the mechanism for the regulation of excitation duration.

Table 1. Abbreviations and descriptions of the tests applied in the muscle activity measurement

Topological groups	Tests of explosive power	Tests of dynamic power	Tests of static endurance
Hand and arm area	MFEBLD - Throwing the tennis ball from the standing position	MRAZGP – chins, supinated grip, pull up until your chin reaches the bar	MSAIVZ – hold on by the chin up on the bar
	MFEBMD - Seated medicinal ball throwing from the chest	MRASUS push ups, with back support	MSAUPP – hold on with forward support by hands, and by feet on the wall (position hand stand)
	MFEBML - Throwing 1 kg medicinal ball from lying on back	MRASUK push ups, on the knees	MSAIUZ – push up hold with back support
Trunk		MRAMPT- sit ups, 30 seconds	MSAIVPZ – pull up hang
		MRAMPN – lying on the back, raise the legs	MSAIZZ – extension, hold arms below the chin
		MRAZAK – extensions	MSAIZS – seating position, back support by hand, rise up and hold the legs up the floor
Legs	MFESVM standing jump up (Sargent test)	MRAČUČ – squats	MSAIZC – half – squat – hold
	MFE20V sprint	MRASTEP- rise up on the step bench	MSAIZU – standing on the toes, hold as high as possible
	MFESDM Standing long jump	MRABPO – side jumps	MSAIZN – in the prone position, lift up and hold extend legs

Methods

Subjects
Measurements were carried out on 180 pre-school children, aged 5, participants in extracurricular sports program which has been organized in four kindergartens in Rijeka. The tested children were participants in the classes of the four kindergartens in Rijeka and regularly attended extracurricular sports program during school year 2008/2009.

Variables
The applied variables were selected mainly from the gymnastics school programme carried out with the aim to determine the latent structure of the motor manifestations which are under control and dominant influence of the mechanism for regulation of excitation duration. Its manifestation characteristics are explosive, dynamic and static way of performance. The whole battery of 24 motor measurements (Table 1) has the following characteristics; they were suitable for the assessment and motor knowledge of the pre-school children, the complexity of conducting the tests was a low as possible and a small number of necessary instruments (tools) carrying out the tests. The results in the tests for measuring the explosive power is number of centimetres or seconds depend of the task and for measuring the dynamic power is the number of repetitions per 30 seconds. For each static way of performance we recorded for how long a child held the correct position in seconds.

Data processing methods
The basic descriptive statistics was computed. The parameters of central tendencies (mean value), range and standard deviation, results of distribution (SKEW and KURT), multiple correlation (SMC) for each measurement which were measured three times, reliability (Cronbach Alpha) and coefficients between the items (F) with the first measurement main items were estimated. The exploratory factor analysis was carried by an orthoblique rotation and the number of factors defined by the GK criterion. The confirmatory factor analysis was provided by ML method and by the program LISREL 8.5.

Results and Discussion
Characteristics of the applied tests
The basic descriptive statistics was computed. The mean value and standard deviation for the all applied tests were calculated and presented in the Table 2. According to the results in the Table we can conclude referring to the sensitivity and applicability of the tests applied. One of the criteria of the sensitivity of the tests is the range of the results: the measure was derived from the difference between the maximum and minimum results. The wide range of results on the entire sample of the tests suggests a very good sensitivity. It is important to emphasize that for some tests

such as MRAMPT - curl up, MSAIVZ – hold on by the chin up on the bar and MSAIZN – in the prone position, lift up and hold extended legs the minimum time was zero which was presented in the column of minimum results. Further analysis of the results could explain the reasons of that. Distribution of the results does not substantially deviate from the normal Gauss distribution, which satisfies the condition of the suitability of the exercise to the testees, since their differentiation is both in the zone of low and high results.

Table 2. Basic descriptive statistics

VARIABLES/ unit of measure	X	SD	Min.	MaX.	Skew.	Kurt.
MFEBLD cm	744.61	326.17	156.67	2283.33	1.27	2.84
MFEBMD cm	191.48	43.54	83.33	303.33	0.26	-0.24
MFEBML cm	95.38	39.11	28.33	231.67	0.81	0.73
MFESVM cm	15.49	4.41	5.00	28.33	0.48	0.22
MFE20V s	5.25	0.58	4	7.8	0.90	1.56
MFESDM cm	100.23	17.60	51.67	139.67	-0.13	-0.44
MRAZGP r	9.67	4.89	1	30	0.86	1.00
MRASUS r	12.22	4.95	2	27	0.46	-0.10
MRASUK r	18.29	8.95	1	49	0.90	0.49
MRAMPT r	13.01	3.55	0	22	-0.41	0.45
MRAMPN r	13.97	2.92	5	22	0.00	0.46
MRAZAK r	21.39	5.69	3	36	-0.37	0.17
MRACUC r	23.48	3.75	12	32	-0.36	0.20
MRASTEP r	13.52	2.59	5	20	-0.46	0.85
MRABPO r	16.58	6.27	5	32	0.28	-0.78
MSAIVZ s	11.31	9.54	0	48	1.98	4.20
MSAUPP s	41.64	22.93	8.41	202	2.35	12.47
MSAIUZ s	30.24	20.65	4	223	4.85	41.85
MSAIVPZ s	23.13	16.97	1	104	1.91	5.10
MSAIZZ s	38.13	20.47	7.64	120.19	1.13	1.37
MSAIZS s	36.16	24.53	5	187	2.48	9.84
MSAIZC s	52.91	33.52	9	180.21	1.36	2.24
MSAIZU s	76.63	44.64	15.09	336	1.72	5.98
MSAIZN s	48.64	97.16	0	794	5.87	37.56

cm r – repetition s - second

Results of the exploratory factor analysis

The eigenvalue of the principal components is presented in Table 3. The principal components exhausted 61.289 % of the entire system deviation while the rest of 38.711% can be considered as en error component. According to the applied Guttman-Kaiser criterion, 7 characteristics roots where principal component is made up of all applied tests. The first factor explains 25.61 % of the total variability, the second 9,24%, while the seven factor is the lowest 4,28%.

Table 3. Eigen value of the factors defined by GK criterion

Factor	Eigen Value	% Variance	Cumulative %
1	6.148	25.616	25.616
2	2.220	9.249	34.865
3	1.516	6.315	41.180
4	1.396	5.817	46.997
5	1.234	5.141	52.138
6	1.168	4.866	57.004
7	1.028	4.285	61.289
8	.938	3.906	65.196

The first orthobligue factor predominantly determines the tests of the explosive strength. According to the tables 4 the pattern of orthoblique factor the highest value have the all tests where kids have to throw different kinds of ball on different positions; MBEMBL - throwing 1 kg medicinal ball from lying on back, MFEBLD – throwing the tennis ball from standing position, MFEBMD – seated medicine ball, as well as the test for explosive strength such as MFE20V - sprint, MFESDM – standing long jump, MFESVM – standing jump up and one test for dynamic power MRAMPT – sit ups /30 sec.

Considering the projection of measure instruments in the structure of orthobligue factor (Table 5), the significant projection has the measurements for dynamic power MRABPO – side jumps, MRAZAK – extensions, MRACUC – squats, MRAMPN – lying on the back, rise up the legs, MRASTEP – rise up on the step bench, MRAZGP – chins, MRASUK – push ups on the knees and two measurements for static endurance MSAIZVP – pull up hang and MSAIZZ – extension, hold arms below the chin. Respecting the higher projections of the above mentioned measurements on the fourth orthobligue factor, we may conclude that performing these measure instruments for relative body strength significantly depends on the initial level of power with the purpose to achieve better speed and performance as well as self-confidence and sense of safety performance.

The *first orthoblique factor* could be interpreted as the factor of *explosive power*.

The second orthoblique factor is determined by the tests of static endurance: MSAIZC – half- squat-hold, MSAUPP – hold on with forward support by hands and MSAIUZ – push up hold with back support and test MSAIVPZ – pull up hang which has significant but lower projection on this factor. The common feature for all these tests is the same action type of strength. Therefore, this factor can be interpreted as the factor of the *static endurance.* Two tests of static endurance define the third orthoblique factor: MSAIZN – in the prone position, lift up and hold extended legs and MSAIZU – standing on the toes, hold as high as possible. The others tests of static endurance have the lower projection in the Table 5, with the structure of orthoblique factor, while in the Table 4, of pattern orthoblique factors doesn't have any significant projection.

The common characteristic of these tests is probably the cause of the complexity and balance of the tests taking into account the position of the body during the performance and the necessity of activation of large muscle groups with the purpose to hold the right position as long as possible. In our opinion the third factor can be interpreted as the *dual factor of static endurance.*

The *fourth orthoblique factor* is explained by the homogenous block of tests concerning the action type of strength; MRAMPN – lying on the back, rise up the legs, MRAZK – extensions, MRABPO – side jumps, MRACUC – squats, MRASTEP – rise up on the step bench, MRAZGP – chins by supinated grip, MRASUS – push ups with back support and MRASUK – push ups on the knees. The *fourth factor* could be termed as the factor of *dynamic power.*

Only one test of static endurance dominantly explains the fifth orthoblique factor: MSAIZS – extension, hold arms below the chin. The test MSAIZZ – extension, hold arms below the chin has significant but lower projection.

With reservations, this factor could be interpreted as the *single factor of the static endurance*.

Sixth and seventh orthoblique factors explained less then 4,86% of the total variability. Because of lower projections of sixth and seventh orthoblique factors, these factors are difficult to explain comprehensibly.

Table 4. The pattern of orthoblique factor.

Variables	F1	F2	F3	F4	F5	F6	F7
MFEBML	**.811**	-.120	-.030	-.028	-.025	**.041**	.069
MFEBLD	**.769**	**.055**	-.061	.144	-.004	-.025	.104
MFEBMD	**.765**	**-.054**	.108	.021	.153	.013	.047
MFE20V	**-.592**	**-.061**	.181	.081	.144	.145	.184
MFESDM	**.543**	.011	-.171	-.287	-.038	**-.079**	.036
MFESVM	**.456**	.045	.172	-.165	-.117	**-.050**	-.145
MRAMPT	**.286**	.228	.102	-.286	.054	.155	-.155
MSAIZC	-.062	**.700**	.192	.030	.049	-.067	-.044
MSAUPP	-.004	**.398**	-.038	**-.093**	.015	**.044**	.227
MSAIUZ	.004	**.293**	-.089	**.066**	-.061	-.034	-.005
MSAIZN	-.042	-.019	**.812**	**.080**	.040	.001	-.020
MSAIZU	.023	-.011	**.315**	-.106	-.187	-.078	.225
MRAMPN	-.054	.006	.064	**-.612**	-.068	.071	-.015
MRAZAK	.107	.018	-.166	**-.606**	.037	.044	**.318**
MRABPO	.245	-.130	-.095	**-.603**	.099	-.103	.078
MRACUC	-.037	-.070	.006	**-.583**	-.127	-.190	-.074
MRASTEP	.199	.081	.044	**-.468**	.093	-.020	.034
MRAZGP	-.028	.183	.077	**-.414**	.118	-.265	.047
MRASUS	.078	**.332**	-.019	**-.334**	-.241	.016	-.160
MRASUK	.206	.061	.112	**-.220**	-.148	.077	-.082
MSAIZS	-.044	-.002	-.006	.046	**-.737**	.002	.055
MSAIVZ	.036	.002	.027	.013	-.005	**-.818**	-.043
MSAIVPZ	.054	**.331**	-.049	-.114	.018	**-.371**	**.367**
MSAIZZ	**.225**	.199	.183	-.026	-.238	-.072	**.542**

Table 5. The structure of orthoblique factor.

Variables	F1	F2	F3	F4	F5	F6	F7
XMFEBML	.807	.041	-.037	-.392	-.092	-.032	.110
MFEBMD	**.728**	.057	.079	-.330	.066	-.035	.096
MFEBLD	**.720**	.177	-.082	-.253	-.081	-.104	.167
MFESDM	**.702**	.207	-.133	-.559	-.146	-.204	.117
MFE20V	**-.661**	-.214	.160	.401	.237	.217	.094
MFESVM	.551	.196	.203	-.442	-.233	-.124	-.074
MSAIZC	.046	**.690**	.225	-.148	-.124	-.199	.076
MSAUPP	.128	**.443**	.001	-.197	-.084	-.104	.290
MSAIUZ	.036	**.292**	-.073	-.017	-.110	-.095	.043
MSAIZN	-.099	-.010	**.796**	.005	-.025	.037	-.022
MSAIZU	.119	.137	**.352**	-.223	-.252	-.162	.255
MRABPO	**.523**	.079	-.034	**-.686**	-.008	-.221	.142
MRAZAK	**.426**	.218	-.084	**-.652**	-.065	-.146	.368
MRACUC	**.264**	.135	.093	**-.601**	-.231	-.289	-.004
MRAMPN	**.247**	.156	.154	**-.592**	-.166	-.052	.020
MRASTEP	.436	.230	.100	**-.583**	-.037	-.146	.104
MRAZGP	**.223**	.331	.131	**-.494**	-.033	-.381	.156
MRASUS	**.317**	.456	.070	**-.482**	-.376	-.133	-.073
MRAMPT	**.433**	.289	.144	**-.447**	-.071	.053	-.099
MRASUK	**.327**	.165	.159	**-.355**	-.226	-.004	-.048
MSAIZS	.025	.151	.069	-.062	**-.723**	-.084	.057
MSAIVZ	.107	.186	.022	-.169	-.109	**-.812**	.110
MSAIVPZ	**.234**	.506	-.012	-.320	-.127	**-.539**	.501
MSAIZZ	**.351**	.415	.231	-.312	-.350	-.272	**.614**

Table 6. Correlation of orthoblique factors with the GK criterion.

F	1	2	3	4	5	6	7
1	1.00						
2	.18	1.00					
3	-.00	.06	1.00				
4	**-.49**	**-.26**	-.13	1.00			
5	-.11	**-.22**	-.11	**.17**	1.00		
6	-.09	**-.22**	.00	**.20**	.12	1.0	
7	.08	.16	.01	-.08	-.01	-.18	1.00

The correlation of orthoblique factors (Table 6) are within the range between .00 and .49 and have a positive and negative sign. The highest correlation is between the first and fourth factor, which suggests the complexity of the motor space for pre-school children, where the dynamic power expression depends of explosive power and vice versa. When we analyzed the correlation between the all isolated factors we can say that a range of various regulation mechanisms takes part in the realization of children's movements.

Conclusion

At the first level of factor analysis of measurement of children's power it is possible to predict the existence of primary factors of power divided according the way of performance into explosive power, dynamic power and static endurance.

The isolated factors are interpreted as; 1. Factor of explosive power, 2. Factor of static endurance, 3. Dual factor of static endurance, 4. Factor of dynamic power, 5. Single factor of static endurance. These results as well as the results of the studies which have been provided on the sample of pre-school children in Croatia can be a useful frame for monitoring process and methods for evaluation of children's achievements and expected results for 5-6 aged children.

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