THEORETICAL MODEL OF MOTOR PERFORMANCE IN PRIMARY SCHOOL CHILDREN

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- childhood
- structural model
- motor coordination
- physical fitness

Abstract:
Introduction: Structural models of motor abilities were formerly framed for the adults and mechanically applied for child population without their empirical verification. Framing of a hypothetical model of motor abilities and explanation of its inner relations contribute to actualization of theoretical bases inevitable for definition of education goals mainly in terms of their more precise operationalization.**Aim**: The purpose of the study was to identify a structural model of motor and somatic indicators in primary school children. **Material and methodology**: Participants of the research were 213 elementary school children from the region of the East Slovakia with a mean age of 7.40 ± 0.25 years. To determine the level of physical fitness and somatic indicators children performed Eurofit test battery items (Adam et al. 1988). Motor coordination was evaluated with the Kiphard-Schilling body coordination test, Körperkoordination-Test-für-Kinder (KTK) (Schilling, Kiphard 1974). Within the frame of explorative factor analysis the method of Principal Components Analysis was applied. **Results and discussion**: The variance of motor performance in the examined group of children is explained to a large degree by "somatic" and "coordination" factors. However, the physical fitness variance of children is explained to a large degree by complex factors which are filled by the variables representing both energy and information components. **Conclusions**: The presented theoretical model of motor and somatic indicators in girls and boys can be regarded as scientifically justified theoretical starting point for the selection of diagnostics during this development period not only in the context of school yet in relation to the choice of the sport talents.

INTRODUCTION

Primary education represents an open and a dynamic system in which the foundations of lifelong learning are formed and it is a process of acquiring literacy, of mediating the basic cultural skills, and of cultivating the children's personality. Current and perspective changes of primary education are oriented towards strengthening of a personality developing notion respecting development possibilities of a child and stimulating its individual reserves.

The research studies of motor abilities of child population are characterized by substantial variability of applied test batteries with diverse level of validity, reliability, and sensitivity. The analysis shows that their acceptability is often complicated in relation to specificity of motor ontogenesis. Progressive somatic and functional development of an organism as consequence of natural biological development as well as undefined motor skills represent significant attributes of examination of motor skill during this development period. In such connection accented must be also specification whether the increase of performance of a child is result of natural growth or motor learning. Somatic development is probably one

of the crucial factors conditioning motor performance of children. Considerable heterogeneity of motor competences of children in the course of this development stage presumably reflects differences of neuromuscular maturing, physical development, social and cultural context in which an individual appears to be as well as of diverse opportunities for motor activity (Malina et al. 2004; Williams 2004).

Motor performance as a multidimensional concept cannot be defined and characterized through a single motor ability. Multidimensionality of the structural model of motor abilities was, however, initially formulated for adult population and mechanically transformed for child population (Lämmle et al. 2010).

Already at eight years of age the structure of motor abilities of children can be regarded as similar to the structure of an adult (Měkota, Novosad 2005). Factor analysis proves better definition of motor abilities with advancing age and at the same with motor development which follows also from out research results.

Some methodological approaches emphasise systematization on the basis of taxonomy of motor abilities and other are focused on differentiation of components of fitness related to health. It is clear that comparison of differently selected approaches is rather complicated.

AIM

The aim of the paper is to determine a theoretical model of motor and basic somatic indicators of primary school aged children.

MATERIAL AND METHODOLOGY

Participants of the research were 213 elementary schoolchildren from the region of the East Slovakia with a mean age of 7.40 ± 0.25 years. Totally 104 7-year-old children (54 girls) and 109 9-year-old children (55 girls) performed all items and were involved into statistical analysis. Parents and children were informed about the aims of the research project and gave their written consent.

Body mass was measured using a digital scale (Omron HN-286; Kyoto, Japan) and body height with a portable stadiometer (Harpenden, Holtain Ltd.; UK). Values were recorded to the nearest 0.5 kg and 0.1 cm, respectively. Five skinfolds were measured with a skinfold caliper (GIMA; Italy) and body mass index (BMI) was calculated [BMI = weight (kg)/height (m^2)].

To determine the level of physical fitness, children performed Eurofit test battery items (Adam et al. 1988). Children performed nine test items: Sit-and-reach (SR) - joint flexibility of the trunk, Standing broad jump (JUMP) - explosive power of lower limbs, Hand dynamometry (HD) - static strength of dominant hand, Sit - ups in 30 seconds (SUs) - dynamic, endurance strength of abdominal and thigh muscle, Bent arm hang (BAH) - static, endurance strength of muscle of upper limbs, Shuttle run 10 x 5 m (SRUN) - running speed with direction changes, Endurance shuttle run (ERUN) - running endurance ability.

Motor coordination was evaluated with the Kiphard-Schilling body coordination test, Körperkoordination-Test-für-Kinder (KTK) (Schilling, Kiphard 1974). The test battery includes the following items: Backward balance (BWB), Hopping obstacles (HO), Laterally jumping (LJ), Sideways moving (SM). The motor quotient (MQ) adjusted for age and gender was calculated using the four items.

Within the frame of explorative factor analysis the method of Principal Components Analysis/PCA was applied. Interpretation of the detected factors is based on the assessment of factor burdens, correlations among the individual factors and original variables. Factor burdens of ≥ 0.60 are considered to be high. Vice versa, the burdens of ≤ 0.40 are by majority of authors viewed as the low ones (Costello, Osborne 2005) although this value was within the research context regarded as the limit one. However, determination of the limit value

depends on nature of data and on theoretical context. The data were processed in the software IBM SPSS Statistics Version 20.

RESULTS AND DISCUSSION

The complex of motor abilities represents a multidimensional and complicated phenomenon. To understand its core and inner relations inevitable is to reduce, to select, and to determine dominant components, to isolate them from less important ones and to formulate hypothesis that the examined spheres can be adequately explainable right through these components – factors. Despite certain methodological and interpretational difficulties the application of factor analysis may be regarded as suitable means allowing the studied issue to be viewed in more detail.

The results of factor analysis in the group of girls and boys at the age of seven years are shown in tab. 1. Factor 1 participates in the explained variance to the extent of over 21% and can be defined as the "somatic" one. It is filled by all somatic parameters which were included into the analysis. Presence of the indicator of static strength (HD) might be explained by its dependence on these parameters that was indicated also by correlation analysis. High values of communalities of body weight (BW), of thickness of skinfolds (SUM 5SFs), and of BMI imply that the variables filling the factor are explained well by means of the respective theoretical model. Factor 2 as well as Factor 3 they both identically represent the "coordination" factors. Either of the factors is filled exclusively by the coordination indicators and similar is also their percentage participation in the explained variance (Factor 2 – 12.83 % and Factor 3 – 12.15 %). The three particular factors explain almost the half of the entire variance although, with the exception of static balance, the condition indicators do not represent their part. Factor 4 can be defined as the "strength-endurance" one with the participation in the explained variance within the extent of almost 12 %. Factor 5 represents the "complex" factor with the participation of almost 10% in the explained variance. Low communality of variables filling the factor points out their lower communicative value within the frame of factor model. Certain generality of a factor can be related to it. Generally high factor score of the individual variables filling the factors from 1 up to 4 prove stability of the theoretical model.

Table 1 Factor analysis (factor score and communality) in girls and boys at the age of 7 years

Indicator	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
BT *(n)*					0.78	*0.66*
PT *(s)*		-0.46				*0.60*
SR *(cm)*					-0.51	*0.53*
JUMP *(cm)*				0.85		*0.77*
HD *(kg)*	0.66					*0.57*
SUs *(n)*				0.55		*0.80*
BAH *(s)*					-0.52	*0.60*
SRUN *(s)*					0.61	*0.61*
ERUN*(n)*				0.75		*0.67*
BWB *(n)*		0.78				*0.54*
HO *(n)*		0.71				*0.69*
LJ *(n)*			0.72			*0.69*
SM *(n)*			0.77			*0.70*
MQ			0.60			*0.99*
BW *(kg)*	0.93					*0.91*
BH *(cm)*	0.78					*0.68*
SUM 5SFs *(mm)*	0.78					*0.75*
BMI *($kg.m^{-2}$)*	0.85					*0.78*

According our results, physical development seems to be one of the key factor influencing the motor performance at this age. D´Hondt et al. (2013) reported, that BMI predicts motor coordination performance with an explanatory variance up to almost 38%.

The theoretical model which was abstracted in this research examination is to a large degree congruent with several existing research results. On the basis of own studies of factor structure of motor and somatic indicators Pišot (1999) assumes that in 10-11-year old children the highest participation in common variance is observed from part of speed-coordination indicators, somatic development, explosive power, and endurance.

Pursuant to confirmative factor analysis Lämmle et al. (2010) observed that at the age from 6 to 17 years the dominant factors in structural model of motor abilities are strength abilities, coordination with accuracy demands, and consequently coordination under time pressure the part of which are speed abilities. Those are in fact at all times dependent on strength and coordination dispositions. The strength factor explains up to 94 % of variability of motor performance, the coordination under time pressure up to 53 %, the coordination with accuracy demands up to 41 %, the endurance up to 13 %, and flexibility only 5 %.

Barnett et al. (2008) observed that the motor and sport competences and the level of coordination abilities explain 18 % of variability of motor activity and 30 % of variability of motor performance. With certain reserve the knowledge indicates conditioning of motor activity as well as of motor performance by the level of motor skills and experience.

The flexibility is proved to dispose of specific position within the frame of structural model of motor abilities and its position in this model is relatively independent (Lämmle et al. 2010), which is similar to our research results. Motor performance of children can be defined as reciprocal interaction of factors with those having higher factor load are regarded as the key ones yet the factors with less considerable participation “contribute” to the explanation of multidimensional space of motor performance of children. Reduction of the examined space of motor performance to only one or two dominant components is inadequate, especially during the period of child age (Lämmle et al. 2010).

According to Ratmajer (1999) the variance at younger age categories is explained to a large degree by complex factors which are filled by the variables representing the energy and information component. Apparently defined factors are abstracted in higher age categories. The structure of motor abilities is affected by significant complexity in early age categories.

CONCLUSIONS

The application of multidimensional mathematic and statistic methods allowed us to include into research intention more complex identification of qualitative part of motor skills at younger school age.

Definition of the key dimensions of motor performance in case of child population enables comparison to be carried out within the scope of international measure despite the variability of application of diagnostic means. Framing of a hypothetical model of motor abilities and explanation of its inner relations contribute to actualization of theoretical bases inevitable for definition of education goals mainly in terms of their more precise operationalization. They enable the areas of motor performance, which are crucial for the conception and balanced intentional formation of child motor competences also in relation to health aspects of motor performance, to be determined.

The presented theoretical model of motor and somatic indicators in girls and boys can be regarded as scientifically justified theoretical starting point for the selection of complex of diagnostics during this development period not only in the context of school yet in relation to the choice of the sport talents.

REFERENCES

1. Adam, C. et al. (1988), *Eurofit. Handbook for the European test of physical fitness*, Council of Europe, Committee for Development of Sport, Rome.
2. Barnett, L. M., Morgan, P. J., Beurden, V. E., Beard, J. R. (2008), Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: a longitudinal assessment, *International Journal of Behavioural Nutrition and Physical Activity*, vol. 5, p. 40. doi: 10.1186/1479-5868-5-40.
3. Costello, A. B., Osborne, J. W. (2005), Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis, *Practical Assessment, Research & Evaluation*, vol. 10, no. 7.
4. D´Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I. Vaeyens, R., Philippaerts, R., Lenoir, M. (2013), A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers, *International Journal of Obesity*, vol. 37, no. 1, 61-67; doi:10.1038/ijo.2012.55
5. Lämmle, L., Tittlbach, S., Obeger, J., Worth, A., Bös, K. (2010), A two-level model of motor performance ability, *J Exerc Sci Fit*, vol. 8, no. 1, pp. 41-49. doi.org/10.1016/S1728-869X(10)60006-8
6. Malina, R. M., Beunen, G. P., Claessens, A. L., Lefevre, J., Eynde, B. V., Renson, R., Vanreusel, B., Simons, J. (1995), Fatness and physical fitness of girls 7 to 17 years, *Obesity Research*, vol. 3, no 3, pp. 221-231.
7. Měkota, K., Novosad, J. (2005), *Motorické schopnosti*, Univerzita Palackého, Olomouc [in Czech]
8. Pišot, R. (1999), Latent structure of six-and a-half year old girls motor space after partialisation of morphological characteristic. *Proceedings of the 6th Sport Kinetics Conference*, pp. 277-280, Faculty of Sport, Ljubljana.
9. Ratmajer, D. (1999), Latent structure of motor abilities of five and a half years old boys. *Proceedings of the 6 th Sport Kinetics Conference*, pp. 292 -294, Faculty of Sport, Ljubljana.
10. Schilling, F., Kiphard, E. J. (2007), *KTK. Körperkoordinationstest für Kinder*, Test GmbH, Göttingen: Beltz.
11. Williams, H. G., Pfeiffer, K. A., O´Neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., Pate, R. R. (2008), Motor skill performance and physical activity in preschool children, *Obesity*, vol. 16, no. 6, pp. 1421-1426. doi: 10.1038/oby.2008.214

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