STRUCTURE OF ENDURANCE ABILITIES OF RUNNING IN CHILDHOOD

Hana Dvořakova

Charles University in Prague, Czech Republic

Izvorni znanstveni članak
UDK: 796.42
Primljeno: 14.4.94.
Prihvaćeno: 10.5.95.

Abstract:

Endurance abilities to run eleven different distances has been studied in 5,5 - 6,5 year old preschool children. Four groups of factors identified by confirmatory factor analysis have been interpreted as: speed-, short-, intermediate- endurance and endurance to run time-limited tests. However, a general background factor of over-all running ability has been fitted in a second-order simplex factorial structure indicating possible transfer between the first three abilities. The validity of the time-limited tests (6-min, 12 min runs) differ from the distance limited ones in preschool children, hopefully for psychological reasons.

Key words:: *preschool age, difference of abilities, validity of running tests*

Sažetak

STRUKTURA SPOSOBNOSTI IZDRŽLJIVOSTI TRČANJA U DJETINJSTVU

Sposobnosti izdržljivosti za trčanje na jedanaest različitih udaljenosti proučavane su kod 5,5 - 6,5 godišnjaka. Četiri grupe faktora identificirane konfirmatornom faktorskom analizom interpretirane su kao: brzinska izdržljivost, izdržljivost na kratke staze, izdržljivost na duge staze, te izdržljivost trčanja vremenski ograničenih testova. Međutim, opći pozadinski faktor sveukupne sposobnosti trčanja bio je postavljen u jednostavnu faktorsku strukturu drugog reda koja ukazuje na mogući transfer između prve tri sposobnosti. Vrijednost vremenski ograničenih testova (trčanje od 6 minuta, 12 minuta) je različita od testova na određene udaljenosti kod djece iz vrtića i to vjerojatno iz psiholoških razloga.

Ključne riječi: *predškolska dob, izdržljivost, testovi trčanja*

Zusammenfassung

STRUKTUR VON AUSDAUERFÄHIGKEITEN BEIM LAUFEN IN KINDHEIT

Die Ausdauerfähigkeiten beim Laufen auf elf verschiedenen Strecken wurde auf dem Muster von 5,5 bis 6,5jährigen Kindern aus dem Kindergarten untersucht. Vier Gruppen von Faktoren wurden mittels der bestätigenden Faktorenanalyse wie folgt interpretiert: Schnelligkeitsausdauer, Ausdauer beim Fliegerrennen, Ausdauer beim Mittelstreckenlaufen und Ausdauer während der zeitlich begrenzten Tests. Jedoch wurde der generelle Hintergrundfaktor der gesamten Lauffähigkeit in eine einfache Faktorenstruktur des zweiten Grades gestellt und zeigte einen möglichen Transfer zwischen den ersten drei Fähigkeiten. Die Validität der zeitlich begrenzten Tests (Laufen in Dauer von 6 und 12 Minuten) unterscheidete sich von der Validität der räumlich begrenzten Tests bei den Kindern aus dem Kindergarten, hoffentlich aus psychologischen Gründen.

Schlüsselwörter: *Vorschulalter, Unterschied zwischen den Fähigkeiten, Validität von Lauftests...*

1. INTRODUCTION

Physical fitness is an important part of well-being, especially as a prevention of the so-called civilization diseases. Aerobic endurance exercise - very often consisting of running of jogging - is well known as one of the most effective means of fitness workout. To include aerobic exercise like running into everyday habits it is useful to start during early childhood and take the advantage of the fact that spontaneous physical activity is a natural part of children's life. Moreover, a series of research stud-

ies show that preventive care of cardiovascular diseases is more and more urgent during childhood (Rutenfranz et al. 1991, malina 1990 etc.). Authors agree on the opinion that it is possible to influence the risk factors positively even in preschool children (cf. Montoy 1985, Thorland and Gilliam 1981).

Stimulation of the development of endurance during early childhood is found useful not only for its preventive effects but it also creates a basis for the future full development of other abilities in maturity (Bingman 1980).

Recent studies have found that the abilities that are based on the general aerobic endurance matur sooner then those determined by anaerobic processes (Maček & Vavra 1971, Sonkin & Zajceva 1990 etc.). Children are able to activate the aerobic mechanism of their body more easily than the anaerobic one (Sallis 1987, Rutenfranz et al. 1991). But on the other hand there really are some negative aspects of endurance training if it is improperly applied to children.

The other questions of endurance activities in children can be seen in relationship between physiological ability and the leve of skill in running or in influence of psychological qualities by children in this age.

Uncertainty among teachers of physical eduction and low level of knowledge about children's physiological capacity, psychological influence and other factors related to endurance training limit its efficient use in everyday school practice. For these reasons it seems useful to state more precisely what the "endurance" workout is at preschool age level and which criteria can be used to evaluate the endurance abilities of different kinds. Basically, these questions are directly related to a more general diagnostic and measurement problem of identification of the endurance abilities in children of this age.

2. AIMS OF THE RESEARCH

The purpose of this research was to investigate possibilities of distinguishing among different types of endurance abilities of running and to identify their structure. Additionally, from a more practical viewpoint of testing, such findings should contribute to a better test construction and validation through establishing the factor validity of the test of running.

3. METHODS

3.1. Run tests

To collect data on possible structure of run in extend from speed to ednurance abilities the battery of eleven run tests was used. the battery contained tests representing the desired domain of speed to endurance abilities:

1. nine distance run tests - from 20 m to 1000 m

2. two time limited tests - 6 min and 12 min of running.

3.2. The sample

The investigated group of 56 preschoolers consisted of 32 boys and 24 girls aged between 5.5 and 6.5 years with the mean age of 6.2 years. The group was created as targeted nonrandom sample of 2 kindergartens in the housing estate urban area, south of Prague, the capital of Czech Republic.

3.3. Statistical methods

The correlation matrix of eleven tests was analyzed by confirmatory factor analysis program, GECOFA. The minimization procedure by ordinary least squares has been applied to minimize the function representing the fit of hypothesis. Fit of a factor structure hypothesis to given correlation matrix was assessed by the following fit indexes:

RMSR - Root Mean Square Residual whichexpresses the average residual correlations in the correlation matrix which were not explained by the hypothesis, typically it should be very close to zero to indicate good fit, or say less then .05

maximum residual - should be lower than or close to .10

Bentler's delta - should be higher than or close to .90.

Some further details on this topic can be found in McDonald 1985.

4. RESULTS

Almost all correlation coefficients between eleven tests (Tab. 1) have been found to be highly signifi-

cant on .01 level, only two of them dropped to the level lower than .05 level. These mutual high relationship also supports the idea of possible general ability present in all tests.

Table 1: Correlation matrix representing mutual validity of the eleven tests (+ .05 significance, the others .01 significance)

TESTS	20 m	50 m	100 m	300 m	400 m	500 m	600 m	800 m	1000m	6 min	12 min
20 m	1.00										
50 m	.70	1.00									
100 m	.80	.83	1.00								
300 m	.59	.82	.70	1.00							
400 m	.71	.84	.76	.87	1.00						
500 m	.42	.60	.58	.78	.73	1.00					
600 m	.58	.74	.63	.95	.88	.80	1.00				
800 m	.53	.61	.59	.76	.68	.64	.75	1.00			
1000m	.30+	.50	.29+	.71	.56	.61	.68	.56	1.00		
6 min	-.48	-.49	-.40	-.65	-.63	-.57	-.71	-.53	-.45	1.00	
12 m	-.37	-.52	-.37	-.71	-.63	-.67	-.76	-.59	-.49	.88	1.00

The leading idea of the kind of general factor of an overall "ability to run" motivated us to test several structural hypotheses contraining the general factor of the first order together with a different composition of further factors. But such structural hypotheses were found to be inacceptable. Finally, we have found an acceptable fit of a multiple four factor hypothesis with four group factors that were substantially correlated. This solution is presented in Tab. 2.

Table 2: Four factor solution with correlated factors

TESTS	F1	F2	F3	F4
20 m	.788			
50 m	.980			
100 m	.874			
300 m		.952		
400 m		.918		
500 m			.829	
600 m			.991	
800 m			.798	
1000m			.665	
6 min				.918
12 m				.963

	F1	F2	F3	F4	
F1	1				Fit indexes:
F2	.89	1			RMSR: .033
F3	.74	.98	1		Largest residual: .14
F4	.53	.74	.77	1	Bentler's delta: .890

a) Factor loadings

b) Factor correlations

Pursuing the idea of general running ability factor- now supported by high correlations between the group factors in Tab. 2 (b) we continued by the second order factor analysis. The fit of the second order general factor to the factor correlation matrix in Tab. 2 (b), however, was not good. But, finally we reached quite a good fit by assuming the second order general factor accompained by a "simplex effect". Actually, we fitted the Guttman's simplex model (with a general factor) to the intercorrelations between the four first-order factors. The "simplex effect: here can be so interpreted that in addition to the general factor, which explains a large portion of the correlations, an effect of a "transfer between the neighbors" is also present. Here it is based on an idea that the relationships between the neighbor abilities (F1 and F2; F2 and F3) is stronger then the general factor could explain. See Tab. 3 and Fig. 1.

Table 3: The second order simplex structure of the correlations in Tab. 2 (b) with a general factor and simplex-effect correlations between the neighbor group factors

Second order general factor loadings		Second order uniquenesses and the simplex effect correlations (underlined) between the neighbouring second order group factor				
			F1	F2	F3	F4
F1	.80	F1	.31			
F2	.86	F2		.31		
F3	.86	F3		.24	.31	
F4	.80	F4			0.7	31

Fit indexes: RMSR: .05

Bentler's delta: .997

5. DISCUSSION

Final structure of the abilities, as presented in Fig. 1. and Tab. 2, supports the hypothesis about four separate time ranges resulting in four factors. The assumption of an unidimensional over-all ability to run has been found to be unrealistic.

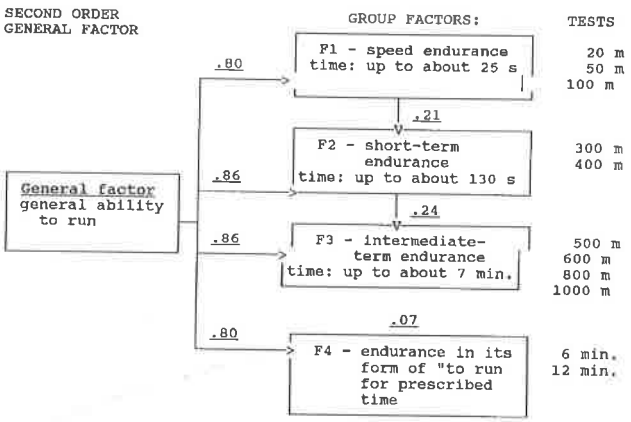
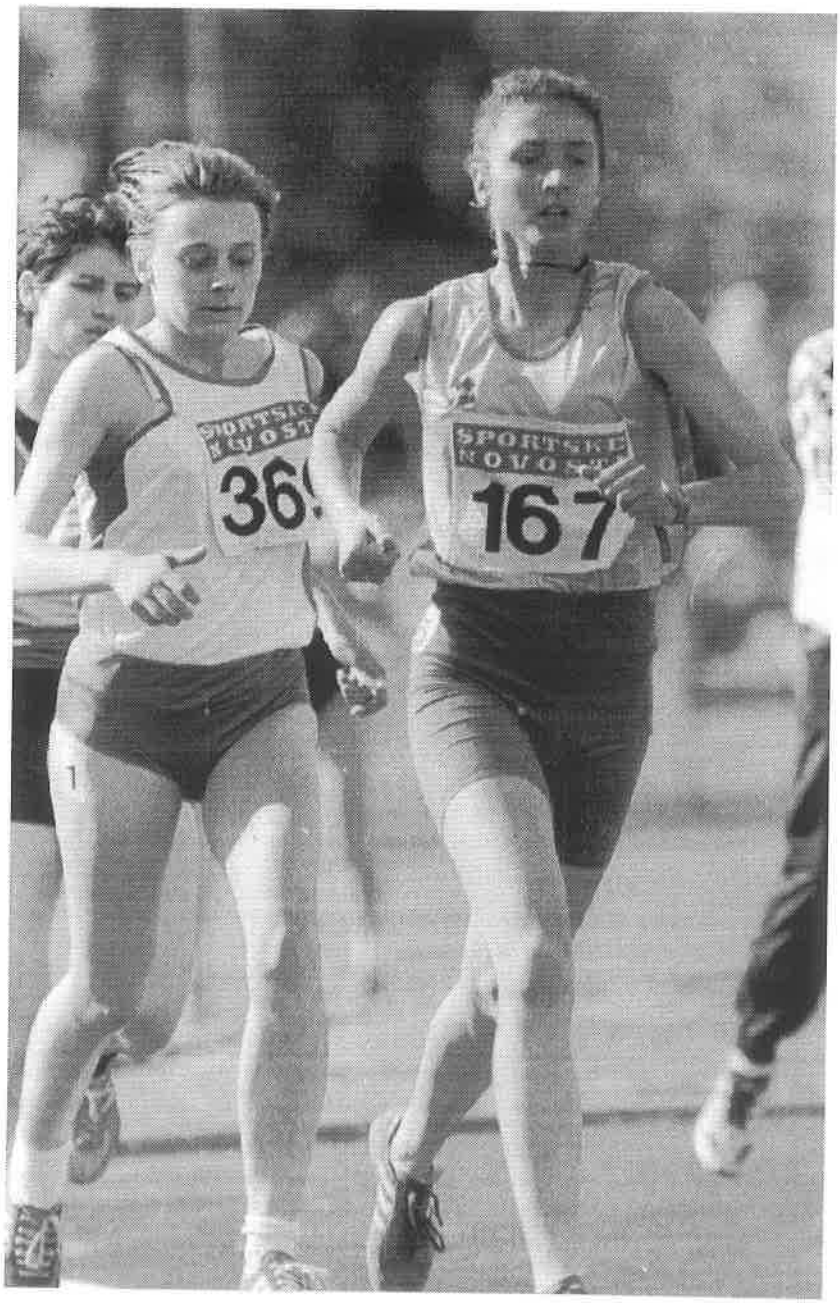


Fig. 1: Structure of endurance abilities in running in preschool children

Separation of the four group factor corresponds to the classification of the according to their test time (or task duration) with means from 4.5 sec to 23 sec, or up to 100 m according to the test length or distance for the speed factor. The second factor (short-term endurance) is characterized by longer test time up to 2.1 min or by test lengtyh up to 400 m. The next factor (intermediate endurance) is loaded by 500 m up to 1000 m runs with duration between 2.6 and 6.4 min. This corresponds to the opinion on quite early differentiation of individual types of ednurance abilities in children.

A special role is to be ascribed to the two time-limited run tests, i.e. the 6-min and 12-min runs. Their specific place in the battery has also been confirmed by the finally fitted structural model, namely the second order simplex. In Tab. 3. one can find out substantial simplex coefficients between the neighbor endurance factors for factors F1 and F2, then F2 and F3 only, but not between F3 and F4. This can be interpreted in the way that there is a kind of interconnection or transfer between speed (F1) and short-term (F2) and intermediate-term (F#) endurance abilities - all of them measured by distance limited run tests. But there is actually a zero relationship (.07) of the F4 factor to its simplex predecessor, F3, as also expressed by a missing arrow from F3 to F4 in Fig. 1. As we have already discussed above, the difference is likely to be interpreted by different content validity and especially the face validity of psychological understanding of the test tasks in children of this age.

In general, the finally fitted structural model (Tab. 6, Fig. 1) indicates that endurance abilities in young children represent a rather more complicated system with mutual relationships. The identified ssecond-order general factor may still offer a common basis for developing endurance by running of any kind. If we accepted the simplex coefficients as indicators of a possible transfer between the three (or four) different neighbor kinds of endurance this finding could also be useful for suggestions in physical education practice in the children of this age.



6. CONCLUSIONS

Our study cupports the theory of early differentiation of the structure of running endurance abilities in children of about 6 years of age. The four factors were identified by confirmatory factor analysis which could be interpreted as: speed, short-, intermediate-, long-term run ednurance.

However a general background factor of over-all run ability has been fitted in a second-order simplex factorial structure indicating possible transfer between the first three neighbor distance run abilities. Time-limited tests (6-min, 12-min runs) have different validity from that of the distance limited ones in kindergarten children, hopefully for psychological reasons.

The findings also offer an idea for practical use that almost any kind of exercise including running will develop most kinds of endurance run abilities in some extent in kindergarten children. However, it can be recommended that children are to be stimulated to develop also the different above mentioned abilities separately.

We recommend the 600 m test as a good indicator of overall endurance run ability. The time-limited tests (6 min, 12 min runs) were not found appropriate for the use in preschoolers.

REFERENCES

1. Bingmann W. (1980): Wirkungen von reiningsbelastungen auf leistungsphysiologische Parameter des Schulkindes. *Theor. Praxis Körperkult.*, (7) 516-519.
2. Máček M., Vávra J. (1971): Cardiopulmonary and metabolic changes during exercise in children 6-15 years old. *J. appl. Physiol.,* (30) 202-204.
3. Malina R.M. (1990): Tracking of physical fitness and performance during growth. In: Beunen et al.: *Children and exercise.* Band 4, Stuttgart: Enke Verlag, 1-9.
4. McDonald R.P. (1985): *Factor analysis and related methods*. Lawrence Erlbaum Associates, Inc..
5. Montoy H.J. (1985): Risc indicators for cardiovascular disease in relation to physical activity in youth. In: *Children and Exercise* XI, Champaign, Kuman Kinetics, 1985, pp. 3-25.
6. Rutenfranz J., Ilmarinen J., Schmidt K.H., Hallier E., Killian H, Sallis J.F., McKenzie T.L. (1991): Physical education's role in public health. *Res. Quart. Exercise Sport.* 62, (2) 124-137.
7. Sallis J.F. (1987): A commentary on children and fitness: A public health perspective. *Res.Quart.Exerc.Sport,* (58) 326-330.
8. Sonkin V.D., Zajceva V.V. (1990): Vozrastnaja dinamika fiziceskich vozmoznostej skolnikov - bioenergeticeskij aspekt. (Growth dynamic of physical abilities of pupils - bioenergetic aspect. *Teor. Prakt. Fiz. Kult.*, (9) 38-40.
9. Thorland W.G., Gilliam T.B. (1981): Comparison of serum lipids between habitually high and low active preadolescents. *Med. Science Sport Exercise*, (13) 316-321.