Original Article

Factorial model of motor fitness of junior forms' boys

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Abstract:
The purpose of the research is to determine factorial model of 7-9 years old boys' motor fitness. Material and methods: in the research 7 years old boys (n=22), 8 years' age (n=27) and 9 years' age (n=29) participated. For determination of informative indicators of boys' motor fitness factorial analysis by 21 testing indicators was carried out. Results of research: in factorial model of boys' motor fitness the most important are backbone and shoulder joints' mobility; complex manifestation of motor potentials; coordination of movements. The most informative indicators of 7 years' boys were indicators of the following tests: index mark (0.976), side circles with stick (0.942), 30 meters' run (0.910), frequency of arms' movements (0.880) and static stance on one foot (0.874). For 8 years' boys the most informative indicators o were indicators of the following tests: index mark (0.982), side circles with stick (0.918), 30 meters' run (0.837), long jump from the spot (0.840), 300 meters' run (0.746). The most informative indicators of 9 years' boys were indicators of the following tests: side circles with stick (0.984); index mark (0.979); static stance on one foot (0.865); shuttle run 4x9 meters (0.826); seize of Dietrich's falling down stick (0.830). Conclusions: factorial analysis permitted to determine model of children's motor fitness. Informative tests for pedagogic control of boys' motor fitness were specified. We received information, required for taking decisions in control of physical education and for working out of effective programs of children's and adolescents' physical training.
Key words: factorial analysis, informative indicators, simulation, motor fitness, boys.

Introduction

The problem of school age children's motor fitness and health improvement is rather hot in Ukraine and in Europe that is witnessed by the data of domestic (Kozak, Korobeinikova, & Korobeinikov, 2002; Korobeynikov, & Korobeynikova, 2003; Peleshenko, 2013; Andrieieva, Sainchuk, 2014; Iermakova, 2014; Yermakova, 2015) and foreign scientists (Jagiełło, Kalina, & Tkaczuk, 2004; Cieślicka, Napierała, 2009; Sobyanin, & Scherbin, 2012; Stankiewicz, Cieślicka, Kortas, Iermakov, 2012; Paczuski, Cieślicka, 2013).

Improvement of children's and adolescents' health and increase of heir workability depend on optimal motor functioning, ensured by physical education in school (Baltsevych, 2000; Krutsevych, Bezverkhnya, 2010; Malinauskas, & Emeljanovas, 2013; Nosko, Nosko, 2014). Rather important with it, is selection of adequate tests for detection of motor activity level, which would be sufficiently objective and reliable (Zaporozhanov, Borachinski, 2012; Latyshev, 2013). Besides, consideration of individual bents and children's potentials for their further selection for sport functioning are important (Platonov, Zaporozhanov, 1990; Zaporozhanov, 2013).
One of conditions of schoolchildren's motor functioning's increasing is organization of pedagogic control at physical culture lessons (Cieślicka et al., 2009; Khudolii, Ivashchenko, 2013; Ivashchenko, Khudolii, Yermakova, Pilewska, Muszkieta, & Stankiewicz, 2015; Ivashchenko, Yermakova, Cieslicka, & Zukowska, 2015) and in conditions of sport trainings (Dmitruk, Adamczyk, Cieślicka, Napierała, Wasielewska, 2008; Khudolii, Iermakov, 2011; Cieslicka et al., 2012; Adashevskiy, Iermakov, Firsova, 2013; Khudolii, Ivashchenko, 2013; Lotfali, Navid, Mostafa, Ali, 2013; Tereschenko, Otsupok, Krupenio, Levchuk, Boloban, 2013; Khudolii, Ivashchenko, 2014; Potop, & Cretu, 2015).
Effectiveness of pedagogic control depends on presence of object of control and informative indicators, characterizing changes in his (her) state. In recent publications it was noted that simulation is an effective method of obtaining of new information about possibilities of current and finalizing control. Its basis is testing of children's and adolescents' motor fitness (Khudolii et al., 2013; Khudolii, Ivashchenko, 2014).
One of methods of statistic simulation is factorial and discriminant analysis. These methods are rather widely used for substantiation and choosing of tests in sport activity (Geoffrey, Broadhead, Church, 1982; Gert-Jan, Benjamin, 2011; Milić, Milavić, Grgantov, 2011; Lulzim, 2012; Gulbin, Croser, Morley, Weissensteiner, 2013) and at physical culture lessons (Dorita, Pienaar, 2011; Khudolii et al., 2014; Ivashchenko et al., 2015;

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Ivashchenko, Yermakova, 2015). Such approaches permit to select tests by indicators of their reliability and informative potential (Khudolii, Miroshnychenko, 2012; Zaporozhanov, 2013). In different editions this opinion is expressed by other specialists as well (Jagiełło, Kalina, Tkachuk, 2001; Lidor, Côté, Hackfort, 2009; Levandovskaya, & Prusik, 2014; Logan, Robinson, Rudisill, Wadsworth, Morera, 2014; Pedersen, 2014).

The mentioned researches witness about demand in working out of methodological approaches to solution of problem of motor functioning and pedagogic control of children and adolescents.

So construction of motor fitness's factorial model is of practical importance for taking decisions in controlling of physical education and working out of effective programs of children's and adolescents' physical training.

Material & methods

The purpose of the research is to determine factorial model of 7-9 years old boys' motor fitness.

The methods of the researches were as follows: factorial analysis was used as method of simulation. In planning of the research we used conceptual approaches to working out of scientific researches in physical education and sports (Ashmarin, 1978; Krutsevych, 1985; Filin, Rovnij, 1992; Khudolii et al., 2014).

Testing program included well known tests (Liakh, 2000; Sergiienko, 2001; Khudolii, Ivashchenko, 2014). For assessment of boys' motor fitness we registered results of motor tests (see table 1). In the research 7 years' old boys (n=22), 8 years' old boys (n=27), and 9 years' age boys (n=29) participated.

The study protocol was approved by the Ethical Committee of H.S. Skovoroda Kharkiv National Pedagogical University. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

Results

For determination of informative indicators of boys' motor fitness's assessment we conducted factorial analysis by 21 testing indicators. Results of analysis are given in table 1.

Table 1. Matrix of factorial analysis of 7 years' old boys (n=22), 8 years' old boys (n=27), and 9 years' age boys (n=29). Method of rotation: Varimax, normalized by Kaiser.

N	Description of test	Age, years	Component 1	2	3	4	5	6	7	8	h^2
1	Static stance on one foot (sec.)	7						.889			.874
		8				-.682					.526
		9						.777	.420		.865
2	Walking by hexagon segments (steps)	7		-.467		.462		.321			.729
		8					.689				.530
		9				.656					.496
3	30 meters' run (sec.)	7						-.463	.739		.910
		8			.880						.837
		9			-.646	-.376					.637
4	Long jump from the spot (cm)	7				.842					.734
		8	.514				.652				.840
		9				.798					.707
5	300 meters' run (min)	7	-.308				.797				.861
		8		.484	.371		.344	.423			.746
		9			-.750						.636
6	Chin ups in mixed hanging (times)	7			-.618	.335			-.383		.696
		8		-.325	-.747						.754
		9	-.382			.653					.730
7	Shuttle run 4x9 m (sec.)	7							.775		.762
		8			.822						.713
		9				-.323			-.826		.826
8	Rising in sitting position during 1 minute (times)	7		.383		.740					.817
		8			-.696			-.320			.716
		9				.645					.556
9	Torso bending from sitting position (cm)	7	-.478	-.392	.312						.666
		8	.370		-.358			.624			.703
		9					.767				.737
10	Distance between hands and heels (cm)	7	.942								.983
		8		.961							.973
		9		.976							.969
11	Height, (cm)	7			.899						.877

№	Indicator	Age	1	2	3	4	5	6	7	8	h²
		8			.905						.857
		9	.357	.531		.407	-.420				.865
12	Index mark (bridge)	7	.967								.976
		8		.974							.982
		9		.986							.979
13	Bridge with straighten legs (points)	7	-.966								.972
		8		-.977							.984
		9		-.959							.960
14	Width of hold (cm)	7		.912							.960
		8	-.929								.937
		9	.964								.977
15	Distance from acromion to acromion (cm)	7	.516	.456					-.399		.725
		8	.338		.809						.804
		9				.804					.907
16	Index mark of mobility in shoulder joints	7		.920							.918
		8	-.947								.961
		9	.952								.981
17	Side circles with stick (points)	7		-.924							.942
		8	.919								.918
		9	-.958								.984
18	Frequency of arms' movements (times)	7					.933				.880
		8					.751				.672
		9		.760							.774
19	Combinations of arms' torso and legs' movements (points)	7			-.402			.482		-.485	.803
		8			.369	-.389	.403				.575
		9	-.300		.568		.326				.676
20	Walk along straight line after 5 rotations (cm)	7								.812	.739
		8		-.401		-.314	.488				.501
		9					.862				.814
21	Seize of falling Dietrich's stick (cm)	7	-.355	.541	-.329			-.437			.743
		8						.769			.672
		9		.397			-.624	-.339	.342		.830
	Full lumbar dispersion, %	7	17.66	17.02	9.475	8.874	8.617	8.596	7.229	6.172	83.648
		8	25.88	13.48	12.67	10.42	7.63	7.04			77.142
		9	15.77	15.47	12.16	11.39	10.16	9.21	6.35		80.505

Notes:
⊠ - no component.

Analysis of **7 years' old boys** showed eight factors, which explain 83.648% of total dispersion of indicators (see table 1):

• Factor 1 (informative potential 17.66%) correlates to the largest extent with indicators of flexibility. Indices of bridge's fulfillment are 0.967 and mark in points for it - 0.966. The factor was called backbone mobility.

• Factor 2 (informative potential 17.02%) correlates to the largest extent with indicators, characterizing mobility in shoulder joints (0.920), side circles with stick (-0.924). The factor was called mobility in shoulder joints.

• Factor 3 (informative potential 9.475%) correlates to the largest extent with height (0.899) and characterizes boys physical condition. It is called "physical condition".

• Factor 4 (informative potential 8.874%) correlates to the largest extent with indicators long jump from the spot (0.842) test "Rising in sitting position during 1 minute" (0.740). The factor was called speed power fitness.

• Factor 5 (informative potential 8.617%) correlates with the largest extent with test "frequency of arms' movements" (0,933). The factor was called quickness.

• Factors 6-8 (informative potential 8.596; 7.229; 6.172%% accordingly) correlate to the largest extent with indicators of tests "static stance on one foot" (0.889), "shuttle run" (0.775), "walk along straight line after 5 rotations" (0.812). They characterize coordination of movements. The factors are called coordination of movements.

Analysis of communities (h^2) permitted to find out that the most informative indicators of 7 years' age boys' motor fitness are: "index assessment" (bridge) (0,976), "side circles with stick" (0.942), "30 meters' run" (0.910), "Frequency of arms' movements" (0.880), "static stance on one foot" (0.874).

Thus, in factorial model of 7 years' old boys flexibility, speed-power and coordination fitness take the first place.

Analysis of **8 years' old boys** showed six factors, which explain 77.142% of total dispersion of indicators (see table 1):

Factors 1 (informative potential 25.88%) correlates to the largest extent with indicators, characterizing shoulder joints' mobility. Index mark of shoulder joints' mobility is - 0,947, side circles with stick - 0,919. The factor was called shoulder joints' mobility.

Factor 2 (informative potential 13.48%) correlates to the largest extent with indicators, which characterize flexibility. Assessment for fulfillment of bridge in point was -0,977. The factor was called backbone flexibility.

Factors 3 (informative potential 12.67%) correlates to the largest extent with tests: "30 meters' run" I (0.880), "shuttle run 4x9 m" (0.822), "chin ups on rope in mixed hanging" (-0.747), "rising in sitting position during 1 minute" (-0,696). The factor was called "complex condition of motor skills".

Factor 4 (informative potential 10.42%) correlates to the largest extent with body height (0.905). The factor was called physical condition.

Factors 5-6 (informative potential 7.63; 7.04% accordingly) correlates to the largest extent with test "frequency of arms' movements" (0.751) and "seize of falling Dietrich's stick" (0.769). The factors were called quickness.

Analysis of communities (h^2) permitted to find out that the most informative indicators of 8 years' age boys' motor fitness are: "index assessment" (bridge) (0.982), "side circles with stick" (0.918), "30 meters' run" (0.837), "Long jump from the spot" (0.840), "300 meters' run" (0.746).

Thus, in factorial model of 8 years' old boys flexibility and complex condition of motor skills take the first place.

Analysis of **9 years' old boys** showed seven factors, which explain 80.505% of total dispersion of indicators (see table 1):

• Factor 1 (informative potential 15.77%) correlates to the largest extent with indicators, characterizing shoulder joints' mobility. Index mark of shoulder joints' mobility was – 0.952 and side circle with stick– (-0.958). The factor was called shoulder joints' mobility.

• Factor 2 (informative potential 15.47%) correlates to the largest extent with indicators of flexibility. Index mark of fulfillment of bridge was - 0,959). The factor was called backbone mobility.

• Factor 3 (informative potential 12.16%) correlates to the largest extent with indicators of tests "frequency of arms' movements" (0,760) and "30 meters' run" (-0,646). The factor was called "quickness".

• Factor 4 (informative potential 11.39%) characterizes complex manifestation of motor skills. It correlates to the largest extent with indicators of tests: "long jump from the spot" (0.798), "walk on segments of hexagon" (0.656), "chin ups on rope in mixed hanging" (0.653), "rising in sitting position during one minute" (0.645). The factor was called complex condition of motor skills.

• Factor 5 (informative potential 10.16%) correlates to the largest extent with indicators of test "seize of Dietrich's falling stick" (0,905) and was called "quickness".

• Factors 6-7 (informative potential 9.21; 6.35% accordingly) correlate to the largest extent with indicators of tests: "walking along straight line after 5 rotations" (0.862), "static stance on one foot" (0.777), "shuttle run 4x9 m" (-0.826). The factors were called "coordination of movements".

Analysis of communities (h^2) permitted to find out that the most informative indicators of 9 years' age boys' motor fitness are: "side circles with stick" (0.984), "index mark (bridge)" (0.979), "static stance on one foot" (0.865), "shuttle run 4x9 m" (0.826), "seize of Dietrich's falling stick" (0.830).

Thus, in factorial model of 9 years' old boys coordination fitness and complex condition of motor skills take the first place.

In tables 2-3 we present generalizing information about dynamic of motor fitness factorial structure's changes, as well as priority indicators for their control for 7-9 years' old boys.

Table 2. Interpretation of factorial analysis results

Factors	Age		
	7 years	8 years	9 years
1	Backbone mobility	Shoulder joints' mobility	Shoulder joints' mobility
2	Shoulder joints' mobility	Backbone mobility	Backbone mobility
3	Physical condition	Complex condition of motor skills	Quickness
4	Speed-power fitness	Physical condition	Complex condition of motor skills
5	Quickness	Quickness	Quickness
6			
7	Coordination of movements		Coordination of movements
8			

Table 3. Informative indicators of 7-9 years' old boys' functional and motor fitness

Rank	Age		
	7 years	8 years	9 years
1	Index mark (bridge (0.976)	Index mark (bridge (0.982)	Side circles with stick (points) (0.984)
2	Side circles with stick (points) (0.942)	Side circles with stick (points) (0.918)	Index mark (bridge (0.979)
3	30 meters' run (0.910)	30 meters' run (0.837)	Static stance on one foot (0.865)
4	Frequency of arms' movements (0.880)	Long jump from the spot (0.840)	Shuttle run 4x9 m (0.826)
5	Static stance on one foot (0.874)	300 meters' run (0.746)	Seize of Dietrich's falling stick (0.830)

Discussions

The received results supplement the data about usage of factorial; and discriminant analysis for determination of structure of children's and adolescenta' motor fitness (Dorita et al., 2011; Gert-Jan et al., 2011; Milić et al., 2011; Lulzim, 2013). Like in works by Geoffrey et al. (1982), Khudolii and Titarenko (2010), Khudolii et al. (2012) we observed high prognostic potential of factorial analysis in determination of model and informative indicators of junior school age children's motor fitness.

Results of our research confirm the data of Zaporozhanov and Borachinski (2012). The authors stress that such approach permits to receive metric marks of measurements' reliability: stability, coordination and informative character of control data for current diagnostic and prognostication of children's sport potentials.

In previous work (Khudolii, Iermakov, & Prusik, 2015) by results of discriminant analysis we determined informative tests for end-to-end control of junior forms' boys' motor fitness. In end-to-end control of 7-8 years' old boys' motor fitness indicators of physical condition, quickness, endurance and coordination take the first place. In end-to-end control of 8-9 years' old boys' motor fitness the most important are indicators of power and speed-power fitness. The presented in tables 2-3 material witnesses that by results of analysis of motor fitness factorial model we can obtain useful information. Such information is required for taking decisions in controlling of physical education and for working out of physical training programs for children and adolescents.

So, factorial analysis permitted to determine model of motor fitness and specify informative tests for pedagogic control of them in every age group.

Conclusions:

In factorial model of 7-9 years old boys backbone and shoulder joints' mobility are the most important as well as complex manifestation of motor skills and coordination of movements.

The most informative indicators for 7 years' old boys are: "Index mark (bridge)" (0.976), "Side circles with stick" (0.942), "30 meters' run" (0.910), "Frequency of arms' movements" (0.880), "Static stance on one foot" (0.874).

The most informative indicators for 8 years' old boys are: "Index mark (bridge)" (0.982), "Side circles with stick" (0.918), "30 meters' run" (0.837), "Long jump from the spot" (0.840), "300 meters' run" (0.746).

The most informative indicators for 9 years' old boys are: "Side circles with stick" (0.984), "Index mark (bridge)" (0.979), "Static stance on one foot" (0.865), "Shuttle run 4x9 m" (0.826), " Seize of Dietrich's falling stick" (0.830).

Acknowledgement

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