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The factor structure of motor abilities in male students

by

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The research was conducted on 1150 students of Polytechnic University in Gliwice aged from 20 to 23 years. The main aim of the study was to evaluate the structure of motor potential. The diagnosis included 20 motor variables and 5 somatic parameters. During statistical analysis four factors were extracted: motor, energetic and coordination, flexibility and somatic. Authors underlined weak informative value of coordination tests and multilevel structure of motor potential of male students.
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Introduction

One of the basic research tasks, related to motor potential area, includes the identification of its significant elements (motor abilities), the description of their internal structure and construction of valid diagnostic tools. The solution of these problems should create scientific background for objective evaluation of humans' motor potential possibilities as well as the determination of more efficient methodological and training procedures in developing them in physical education and sport training.

In literature, there is only a few works related to structure of motor abilities, in their full energetic and informative dimension, especially in subjects of different age. Until now, the majority of research projects were focused on children and youth at school age, without sport experience (Fleishman 1964, Filipowicz and Turewski 1977, Szopa 1988, Mynarski 1995). More often the research experiments were aimed at determination of specific structure of coordination i.e. energetic (Mynarski 1994) or coordination ones (Hirtz 1985, Raczek and Mynarski 1992, Juras and Waskiewicz 1998).

According to this, the main aim of this work was to recognize the specific components of motor abilities structure, in their full energetic and coordination area in adult male subjects with average level of motor fitness. The students of Silesian Polytechnic University in Gliwice were chosen as typical to the population and natural structure of motor abilities.

Material and methods

The research was conducted on 1150 student of Polytechnic University in Gliwice aged from 20 to 23 years. The main aim of the study was to evaluate the structure of motor potential. The diagnosis included 20 motor variables and 5 somatic parameters. In evaluation a motor test battery was used (Hirtz 1985, Ljach 1998, Raczek et al. 2002) including the following abilities:

1. Energetic
   a) speed – 30 m and 50 sprints,
   b) strength – pull-ups, standing broad jump and overhead 2 kg medicine ball throw,
   c) endurance – 6-min. run
   d) strength-endurance – bent arm hanging on the bar, sit-ups in 30 s,
   e) agility – 3x10 m shuttle run and 5x3m shuttle run
   f) flexibility – forward bend
2. Coordination

a) static balance – one leg stand
b) dynamic balance – turns on the gymnastic bench
c) motor adjustment – forward and backward jumps
d) movement combining
e) speed of reaction – stopping the ball
f) space orientation – target march, run to numbered balls,
g) sense of rhythm – set rhythm run,
h) kinesthetic differentiation – target throws.

Basic anthropometric measurements were also performed including: body mass and height, BMI index, chest circumference and body fat which are strongly related with human motor potential development.

The inner structure of students in area of motor abilities was determined on the basis of Hotteling's main components factor analysis with Varimax rotation (Szopa 1988).

Results

It was determined that inner structure of motor abilities in male students consists of 4 factors which explain 53,9% of total common variance (tab. 1). First factor includes test with high factor loadings ($r_{tk} \geq 0,70$) evaluating all basic abilities with energetic background: speed, agility, strength, endurance (30 and 50 m runs, 3x10m shuttle run, standing broad jump, pull-ups, medicine ball throw, 6 min. run). Relatively high factor loading was extracted for body height. This factor explaining almost half of total common variance (29,98%) was determined as "energetic abilities". The integrating elements of this factor are undoubtedly energetic processes (anaerobic and aerobic) which forms basis for motor fitness.

Second factor (14,36%) includes somatic variables: body mass (0,86), BMI (0,95)and chest circumference (0,79). This factor was identified as "body structure".

Third factor of structure of tested subjects potential (5,63%) extracts only one test evaluating joint flexibility (forward bent, $r_{tk}=0,77$) and was identified as "spine flexibility". The individual extraction of this factor is probably related to specific diagnostic procedure used in this test in light of anthropometric and functional measures.

The last, fourth factor (3,97%) includes test, which in general should evaluate the level of specific aspects of coordination: space orientation (march to target, $r_{tk}=0.61$), kinesthetic differentiation (throws to target, $r_{tk}=0,55$), sense of dynamic (turns on gymnastic bench, $r_{tk}=0,51$) and static balance (one leg stance, $r_{tk}=0,43$).

This factor was described as “motor coordination abilities”. The integrating element in this factor was the informative processes. It should be underlined that this factor explains only 4% of total common variance and factor loading are also relatively low. It shows relatively weak informative (valid) value of coordination tests.

Discussion

Presented above empirical results generally confirm existing data from other authors, which on the basis of dominant predispositions creating motor abilities, divided them into two basic groups:

a) energetic – determined by energetic processes and morpho-logical features,
b) coordination – determined by cognitive and informative processes (Gundlach 1968, Schnabel 1973, Roth 1982, Mynarski 1995, and others).

Large amount of subjects and wide range of diagnosing tools allowed for empirical confirmation of this fundamental assumption in a proper way. Research projects conducted on asmaller amount of subjects ended up with a more complicated inner structure of motor abilities. As independent factors were extracted energetic abilities with aerobic background (endurance) and anaerobic (speed and muscular strength, as well as specific aspects of coordination (Filipowicz and Turewski 1977, Szopa 1998, Szopa and Watroba 1992, Mynarski 1995).

The extraction in structure of factor identified as “body structure” is difficult to interpret logically, because somatic variables are treated as predispositions of energetic abilities, and should be included in the factor explaining thees tests (as in case of body height). However, the factor “body structure” was extracted as independent in former works on motor abilities structure (Pilicz 1986, Szopa 1988, Szopa and Watroba 1992). The extraction of factor “spine flexibility” shows specific character of this ability in light a motor tests, and necessity of describing it as morpho-logical predisposition of motor abilities (Szopa 1988, 1998).

Resuming, the structure of motor potential in male students was separated into two areas with complex character (motor abilities) and two with more specific character (morpho-logical functional predispositions of motor abilities). It confirms the proposed concept “Cracow school of antropomotorics” about multilevel structure of motor potential (Szopa 1988, 1998). Low percent of common variance explained by the factor “coordination abilities” shows, those diagnostic tools used in evaluation of coordination are far from valid. It may be

also confirmed by a low value of total common variance explained by all factors (53, 95).

Table 1. The factor structures of motor fitness in student of Polytechnic University in Gliwice (n=1150)

Parameter	Percent of common total variante 53,95%			
	29,98%	14,36%	5,63%	3,97%
	factor 1	factor 2	factor 3	factor 4
Body height	,655317	,241379	-,327405	,103241
Body mass	,380426	**,860496**	-,153487	,057238
BMI	,067904	**,959890**	,029566	,008481
Chest circumference	,262744	**,794995**	-,019755	-,003346
Body fat	-,360642	,626476	-,127350	-,029524
Endurance 6 min run	**,668356**	-,077830	,017501	,128406
50 m sprints	**-,811433**	-,010993	,047970	,006001
30 m sprints	**-,820277**	-,024176	,025346	,125354
Sense of rhythm	-,647907	,066393	-,161687	,204054
Shuttle run 3x10m	**-,790986**	-,031993	-,018246	,141973
Shuttle run 5x3m	-,619259	-,051558	-,122000	,133290
Space orientation	-,417694	-,010365	,000425	,308811
Standing broad jump	**,825314**	,044702	,028099	-,048302
Back jump	,643647	,030288	,107052	-,071931
Bent arm hang on the bar	,588321	-,408451	,192102	,019697
Pull-ups	**,737873**	-,069850	,163889	,030665
Sit-ups in 30 s	,596299	,114214	,277345	-,087494
Forward bent	-,040699	,062292	**,771971**	,033394
Overhead 2 kg medcine ball throw	**,761534**	,478695	-,006158	-,019911
One leg standings	-,035860	,123936	-,462846	**,429722**
Turns on gymnastic banch	,028933	-,104323	,132094	**-,508915**
Stopping the ball	-,501553	-,084301	,091384	,210123
Target march	,017489	-,072648	-,049394	**,606622**
Target throws	,145618	-,019010	-,204796	**-,551219**
Movement combining	-,234010	,197168	-,366625	,030456

Conclusions

1. Only two typical motor factors may be extracted in this research i.e. energetic and coordination ones, what confirms generally existing concepts of structure of human motor potential.
2. Energetic ability factor explains significantly a larger area of common variance (29,98%) in comparison to the coordination one (3,97%).
3. The flexibility and somatic variables extracted in independent factors as predispositions to many abilities probably on the basis of measurement specificity.
4. The control of motor preparation of adults should include specific elements from energetic and informative area of human motor potential.

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