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DEFINITION OF 17 AGED WOMEN'S MOTOR SKILLS – IN REGARD TO THE METHODOLOGICALLY MORE RATIONAL AND MORE EXACT FACTOR PROCEDURES

Original scientific paper

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Abstract

The study included 210 respondents with application of 7 manifest motor variables (tests) for certain motor skills assessment: balance; movement frequency; rhythmic structure; explosive strength; flexibility; general strength; coordination. The results provided from the manifest motor variables were processed by the following statistical methods: basic descriptive statistical indicators, inter-correlation of the motor tests; factor analysis by the Hotelling method of main components and oblique solutions of promax factors with parallel projections, inter-correlation of isolated promax factors. In the studied sample of respondents three motor factors were isolated. According to the phenomenological approach, the first factor can be defined as integrated skills for rhythmic structure, explosive strength, elasticity and static strength. The second factor can be defined as balance and segment speed skill, and the third one as a coordination skill. In respect of the functional approach, the first factor can partially be defined as a part of the general factor system for energy regulation, and the second and third factors can be placed in the general factor system for central movement regulation.

Keywords: *motor tests, factor analysis, female, motor coordination*

INTRODUCTION

The anthropological status of entities, among the other, has been defined first of all by their motor skills, and determined by the genetic factors, and in this context by the sex and age differences, as well as by the impact of the environmental factors including physical activities and activities in the training process.

In parallel, the motor skill condition is important for a success in a number of sport and physical movements. Therefore, knowledge acquiring is necessary about the motor skill condition of different sex and age entities. The higher knowledge level provides more efficient programming of sport physical movements and achievemnt of more successful transformation, as well as better results achievemnt.

Accordingly, achievement of of better sports results means production of a successful diagnostics of the motor skills condition with certain sex and age characteristics of the entities. In this respect, different sex and age entities can be defined by lower or higher quantitative sports results, but at the same time, they can show a different latent structure of their motor skills.

Such differences can also be present in entities of different ethnic, geographic and socio-economic milieus, and in entities determined by the kind and size of the sample of respondents, as well as by the training process impact, etc.

Therefore, it is reasonable to acquire information with regard to the latent structure condition with the respondents, whose samples have been drawn from different endogenous and exogenous environments.

In so far practice, studies have been conducted connected with analysis of the students' motor skills. Among them, some more significant studies can be mentioned.

Kurelic and associates (1975) conducted one of the most significant studies in the factor structure definition of anthropo-metric and motor dimensions in a number of sub-samples of respondents from both sexes aged 11 to 17. The study included application of 56 manifest variables, 38 of which aimed for the motor skills assessment. One of the sub-samples consisted of 423 female respondents aged 17. In the study data processing a number of uni-variant and multi-variant methods were applied, as well as a factor analysis. The results of the factor analysis showed that, according to the functional approach, which is probably one of the first used by the study authors, existence of two general factors was defined (conditionally named as a mechanism of central movement regulation and energetic regulation mechanism.) Within these mechanisms, two motor factors have been isolated in each of them.

Similar study with a big sample of respondents and exclusively large number of motor variables was conducted by Gredelj, Metikosh, Hoshek and Momirovic (Gredelj, Metikoš, Hošek & Momirović) in 1975. The study included 693 male respondents aged 19 to 27. The respondents completed 110 tests for the latent motor structure assessment. Motor variables were factorized first, second and third level. The first level defined 24 factors, the second six factors, and the third level defined the general factor. The factor nomination was carried out according to the functional approach.

A study including factorization of 74 motor tests with 208 students in second and third year of physical culture studies was conducted by Metikosh, Prot, Hofman, Pintar & Oreb in 1989. The results of the study analized through a phenomenological factor approach, showed preconcentred existence of 10 motor latent dimensions (coordination, realization of rhythmic structures, balance, movement frequency, movement speed, precision, flexibility, strength, explosive strength, general strength) and a functional latent dimension (durability).

The study of a big sample of respondents (1240), both male and famele aged 11 to 18, with application of certain multi-variant methods, as well as factor multi-variable analysis and with treatment of 27 motor variables, was conducted by Naumovski and associates (2003). In the study of 330 female respondents within the subsample, according to the phenomenological factor approach, were isolated 7 motor factors: precision, balance, dynamo-metric strength, flexibility, statistical strength, rhythmic structure and coordination.

The aforementioned studies included application of factor methods with similar, but also different factor procedures which from the methodological aspect have a proper meaning. Regardless of the sex and age of involved respondents in the studies, they can be treated with a sufficient methodological adequacy and kinship with the sub-

ject of our study. In this way, the results of the studies are a significant contribution for more complete understanding and implementation of the conclusions and recommendations of our study.

Based on the results of so far studies, as well as on the empiric and speculative surveys, the main goal of this study was to establish factor structure of some less numerous motor tests with the phenomenological and empiric and speculative surveys with females aged 17 in methodologically more rational, but still enough exact procedures. This goal derives the following special goals for establishing:

• The number of isolated factors of the respondents.

• Saturation of each motor test in the structure of each motor factor.

• Meaningful degree for interpretation of the isolated motor factors.

• Correlation of the isolated motor factors.

METHODS

The study included 210 female respondents. All of them attended regular physical education classes and sports activities. They were subjected to 7 manifest motor variables (tests) for their motor skills assessment.

The applied motor tests were aimed for the following motor skills assessment: flamingo (FLA) – for balance; hand tapping (TRA) – for movement frequency; non-rhythmic tapping (NEUR) – for rhythmic structure; long jump from a spot (SKD) – for explosive strength; deep forward bend on a bench (PRET) – for flexibility; knuckle hang up (VIS) – for general strength, ground mobility (PTLO) – for coordination.

Results obtained from the manifest motor variables were processed by the following statistical methods: Basic descriptive statistical indicatiors (these indicators have not been provided in the study due to the limited space); Motor tests inter-correlation; Factor analysis with the Hotteling principal components method; Oblique promax factor solutions in parallel projections; Inter-correlation of isolated promax factors.

RESULTS

The Table 1 shows that all correlation coefficients valued over 0.14 are statistically significant at the 0.05 level. Half of them are with a negative, and the other half are with a positive omen. These characteristics of the inter-correlation coefficients pointed to the conclusion for a meaningful extraction, that is respectively a coexistence of different motor factors.

It is evident in the Table 2 that according to the Guttman & Kaiser criterion three statistically significant components (H) have been isolated. It stems from the values of the first three characteristic roots (λ), that are bigger than 1.00. The percent of the valid first component variant (23,54) is relatively similar to the percent of the second principal component valid variant (22,63), whereas the third principal component has a sharp drop and has a considerably lower percent (15,53).

Table 1. Inter-correlation of the motor tests results

Tests	FLA	TRA	NEUR	SKD	PRET	VIS	PTLO
FLA	1,000	-,349	,103	-,099	-,262	,019	-,040
TRA	-,349	1,000	-,232	,032	,108	-,069	,098
NEUR	,103	-,232	1,000	,226	,118	,206	-,173
SKD	-,099	,032	,226	1,000	,350	,213	-,006
PRET	-,262	,108	,118	,350	1,000	,062	-,064
VIS	,019	-,069	,206	,213	,062	1,000	,072
PTLO	-,040	,098	-,173	-,006	-,064	,072	1,000

Table 2. Characteristic roots (λ) and percent (%) of the valid principal component variant

Principal components (H)	Lambda (λ)	Percent	Cumulative percent
1	1,648	23,54	23,540
2	1,582	22,63	46,143
3	1,085	15,53	61,646
4	,793	11,34	72,981
5	,675	9,642	82,623
6	,652	9,319	91,941
7	,564	8,059	100,000

Table 3. Significant principal components (H) and communalities (h^2)

	Principal components			
Tests	H1	H2	H3	(h^2)
FLA	-,425	,633	,121	,596
TRA	,183	-,741	,009	,583
NEUR	,413	,630	-,103	,579
SKD	,747	,128	,114	,587
PRET	,730	-,151	-,216	,602
VIS	,405	,325	,586	,613
PTLO	-,090	-,300	,811	,755

The isolated principal components in the Table 3 have statistically significant saturations, and they move from 0,630 to 0,811. All three principal components can be interpreted meaningfully. The communalities (h2) have similar values, and the ground mobility test (PTLO) has a higher value (.755) than the others. Therefore this test is one of the most valid one in the system of other treated tests.

However, as it is well known the Hotelling's principle components do not provide enough exact possibilities for complete explanation of the factor structure of the treated manifest variables. Therefore, it is necessary for these components to be transformed in such positions that would allow the structure to be defined better and more exactly.

Varimax factors have not be presented in the text of this study because they, as orthogonal projections, indicate only correlation between tests of the isolated latent dimensions, and not of the causal impact of the tests on those dimensions, such as the case with the parallel projections of the oblique rotations in the factor analysis. Accordingly, the correlation should not be identified with the causal relevance, because in that way wrong conclusions could be made in respect of the studied phenomena, and at the same time it does not provide sufficienly exact prognosis for transformations that are aimed to be determined in the phenomena space (Bala, 1986). Therefore, the analysis and definition of the varimax matrix factors also are not quite exact indicators.

Actually, the varimas matrix does not proved a complete meaningful interpretation of the real factor structure of the treated manifest variables. Therefore, the varimax transformation of the principle components usually is not used (there is no sense, since it provides unreal results) in the physical education and sports activities phenomena. The disuse derives from the orthogonality and independence of those phenomena. This is supplemented by the factor where the physical education and sports activities phenomena are greatly dependent, inter-causal and sub-assumptive.

Thus, presentation of the varimax matrix is not indispensable and can be treated as a tautological approach in realization of the simple (parsimonius) structure of the analized factors obtained by the oblique solutions of the factor analysis.

For the reasons mentioned above, transformation of the varimax matrix also is not necessary for obtaining a parsimonius structure of

the varimax factors in oblique solutions of the orthogonal projections.

On the contrary, application of a certain criterion is necessary for transformation and presentation of the oblique solutions of the principle components (factors) in parallel projections, which are the most important basis for interpretation and definition of the isolated factors. This necessity enables real and methodologically correct simplest structure (it satisfies the parsimonius principle), pointing out not only the correlation degree between the manifest variables and statistically significant isolated latent dimensions, but also providing other relevant information. It particularly refers to the need for transformation application in definition of the latent dimensions in physical education and sports activities.

In practicing these activities, application of oblique transformation is most common with direct Jennrich and Sampson's oblimin criterion, 1966, and the Harris and Kaiser' oblique criterion, 1964 (according to Bala (Bala), 1986). However, the Hendrickson and White's oblique transformation procedure (1964) has been increasingly used lately. This procedure is an unlimited oblique angle procrustrean rotation, that is transformation which has got great popularity due to its simplicity (Fulgosi, 1979).

Table 4. Parallel promax factor projections

	Promax factors		
Tests	PF1	PF2	PF3
FLA	-,194	-,759	,015
TRA	-,050	,751	,135
NEUR	,568	-,409	-,215
SKD	,763	,156	,083
PRET	,615	,444	-,195
VIS	,566	-,211	,519
PTLO	-,060	,147	,854

Table 5. Promax factor inter-correlation

Factors	PF1	PF2	PF3
PF1	1,000	-,065	-,075
PF2	-,065	1,000	-,035
PF3	-,075	-,350	1,000

In the Table 4, parallel projections of the promax factors are presented. The data in this table are methodologically justified for meaningful interpretation of the isolated latent dimensions, and it can be concluded that the promax factors saturation in the tests is different in respect of the isolated principle components. The first parallel projection has four statistically significant saturations in the tests (non-rhythmic tapping (NEUR), long jump from a spot (SKD), deep forward bend on a bench (PRET) and knuckle hang up (VIS). The saturations of these tests are not completely identical with the saturations in the tests with the principle components (Table 3). Thereafter, the NEUR and SKD tests do not define determinately the first principle component. There is a similar coparative situation with the tests defining the second promax factor that is the second principle component. The SKD test of the second principle component does not have a statistically significant saturation. Only the third promax factor has statistically significant saturations in tests with the third principle component.

Based on the results provided in the tables 3 and 4, the three isolated factors can be defined more exactly and completely with parallel promax factor projections (Table 4). In this way, according to the phenomenological approach, the first factor can be defined integritated and meaningfully as a skill with rhythmic structure, explosive strength, elasticity and statistical strength. The second factor can be defined as a skill with balance and segment speed, and the third factor as a skill with coordination.

This situation for the isolated factors interpretation, among the other, is probably a result of a small number of selected and treated motor tests. It also refers to their definition and interpretation according to the functional approach, though according to it, the first promax factor could be partially defined in the general factor system for energetic regulation, and the second and third factors in the general factor system for central movement regulation.

It is obvious that provided results do not express a higher degree of clear and proper definition and interpretation of the isolated factors. However, in this sense, it should be taken into consideration that the purpose of the study was mainly methodologically oriented with intention to provide sufficient exactness and simpler rationality in the procedure for the factor structure determination of the respondents' motor skills.

In the Table 5, all inter-correlation between isolated factors are with a negative omen. Only correlation between the second and third factor is statistically significant, but also with a negative omen. It suggests that the isolated factors are self-sufficient and independent.

CONCLUSION

The analysis of the obtained results suggests that:

Three motor factors have been isolated with the studied sample of respondents.

According to the phenomenological approach, the first factor can be defined integritated as a skill with rhythmic structure, explosive strength, elasticity and statistical strength. The second factor can be defined as a skill with balance and segment speed, and the third factor as a skill with coordination.

According to the functional approach, the first factor could be partially defined as a part in the general factor system for energetic regulation, and the second and third factors in the general factor system for central movement regulation.

For full, more exact and meaningfull definition of the factor structure of motor skills (with the presented and necessarily reduced factor procedure), the number and kind of the manifest variables (tests) need to be increased, thus providing appropriate coverage of any hypothetical segment of the motor space.

For clearer definition of the factor structure with female respondents aged 17, a deeper analysis should be made of so far studies and additional studies should be conducted with application of a greater number of different factor procedures.

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