CONGRUENCE BETWEEN PHYSICAL FITNESS EVALUATION AND THE RESULTS OF MOTOR ABILITY TESTS PERFORMED BY MEMBERS OF THE ARMED FORCES

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Abstract

The study aimed to examine a test battery with the existing physical fitness evaluation and compare it with the results of the evaluation of motor abilities. The scores (depending on the result, age and gender) for each motor ability test were used to determine the types of statistical groups which were then compared with the existing physical fitness evaluation groups. The sample of subjects consisted of 83 members of the Slovenian Armed Forces who fully performed all three tests: push-ups, sit-ups and a 3,200-m run. The subjects were divided into four age groups. The sample of variables included the number of points achieved in the push-up, sit-up and running tests. The classification in the groups was based on the K-means clustering method, whereas Ward's criterion function was used as a similarity measure in the classification. Three statistical groups were obtained and their typology was determined based on the characteristics of the final cluster centres: 'performing excellently', 'underperforming in terms of endurance' and 'underperforming in terms of strength'. The typology of statistical groups points to a combining of the strength and endurance tests with those subjects with poor motor abilities and an unequal distribution of motor abilities in the selected test battery. A bivariate analysis was conducted to compare the types of statistical groups with the physical fitness evaluations and to thus establish congruence. The finding was that a direct comparison was impossible due to the characteristics of the clusters, with the exception of subjects with a high level of physical readiness. The comparison revealed inequality in the tests of strength and endurance in terms of evaluating physical fitness, owing to which the evaluation could be misleading and might fail to yield realistic results of physical readiness. Moreover, it also raised the question of whether the structure of the evaluated motor abilities was sufficient for evaluating physical fitness where only two dimensions were being compared. The resulting incongruence puts into question the selected test battery and physical fitness evaluation criteria and therefore also the validity of the points system. Among other things, an examination of the distribution of subjects into age groups by type of statistical group and by physical fitness evaluation revealed that motor abilities diminished with age irrespective of the fact that age was taken into account in the points system.

Key words: test, motor abilities, physical readiness, physical fitness, soldier

Introduction

The armed forces constitute a special area of human life and work where the working conditions are specific and involve high levels of mental and physical strain (Berčič, 1980). In the army, tasks can be associated with extremely high, prolonged mental strains which demand from a member of the armed forces a high level of physical readiness and a top mental condition. Even though the physical readiness of soldiers plays an important role in the performance of their duties, many armed forces in the world deal with problems of their members not regularly engaging in a sport (Tkavc & Karpljuk, 2006).

The purpose of sport in the Slovenian Armed Forces and the pertaining evaluation of motor abilities, as an element of the contents and tasks, is based on general and specialised guiding principles. The general ones relate to sport since, with time, the positive aspects of exercise have contributed to sport becoming an ever more important factor of every man's life. The positive aspects of sport exercise are essentially achieved when a sport activity follows the principles of sport recreation and fulfils its purpose and objectives (Tkavc, 1999). In the army, members are required to demonstrate special physical fitness which exceeds the level typical of sport-recreational activities. Therefore, in the army sport exercise aimed at maintaining health is both the basis and the prerequisite for the appropriate physical readiness of each individual member (Tkavc, 2004b). The main purpose of sport in the army is to provide for appropriate and overall psychomotor development of army members so that they – being healthy, strong, vigorous and capable of working and learning – can participate in activities in their environment and withstand the pressures of today's pace of living and the requirements of the military profession (Jošt, 1994). The motor abilities of an individual and a unit are some of the basic elements of combat readiness (Karpljuk, Žitko, Rožman, Suhadolnik, & Karpljuk, 2001). Soldiers who are not physically ready cannot fully discharge their duties in line with the army's general mission. The army tests the level of physical readiness by evaluating motor abilities. Last but not least, one of the most demanding conditions in the army is the physical fitness of its members (You and the APFT, 1987).

The aim of verifying and evaluating the motor abilities of members of the Slovenian Armed Forces is to systematically check the level of motor abilities of those members assigned to military duties, thus serving as a basis for the Ministry of Defence's planning and implementing of sport activities (Instructions for evaluating motor abilities of employees of the Ministry of Defence assigned to military duties, 2002). Usually in the armed forces a failure to pass the test or fulfil the minimum criteria thwarts a member's development in terms of major personal aspects of a military post as they become ineligible for promotion and attendance at military training and/or schools and for command. In the Slovenian Armed Forces physical fitness is one of the aspects of the assessment of professional competence for military duties. The same tests and criteria for evaluating motor abilities apply to all members on active duty, candidates for contractual Reserve service and candidates for professional service in the Slovenian Armed Forces (Instructions, 2002). A motor test battery includes the push-up, sit-up and 3,200-m run tests. The times for the runs and number of sit-ups and push-ups that have to be achieved are based on gender and age. This battery of motor tests is designed for active personnel (infantry) in the US Army and also for the US Army National Guard (Dunn, Luther & Smith, 1994). Other branches use different tests. Those with a diagnosed medical condition can also conduct alternate tests, e.g. bike, swim, walk and other. The Slovenian Armed Forces also operates an alternative test for individuals with medical limitations, i.e. 3,800-m walk; however, this will not be dealt with in the present study.

According to the definition by Kurelič et al. (1979), a battery of motor tests consists of a complex of motor abilities selected for a special purpose. The results are evaluated using a point scale and the person's physical fitness is evaluated according to specific criteria. One can speak of motor task standardisation (Šturm & Strojnik, 1994) in terms of defined procedures for executing individual motor tasks as well as in terms of standardised results by converting them into points which constitute a physical fitness evaluation. The results are converted into points for each test separately using point tables. The achieved points criterion in each test and the sum total of the achieved points constitute a physical fitness evaluation (Tkavc, 2004b). They are similar to Dr. Cooper's point tables for evaluating aerobic capacity (1979) with which almost everybody dealing with those topics and researches in the field of physical tests is familiar.

In the present work, the problem was investigated using motor ability tests on the basis of the three US Army tests and a point scale on members of the Slovenian Armed Force. The study aimed to examine the test battery with the existing physical fitness evaluation and compare it with the results of the motor ability tests. The scores (depending on the result, age and gender) for each motor ability test were used to determine the types of statistical groups and compare them with the existing physical fitness evaluation groups.

Methods

Sample of subjects

The sample of subjects consisted of 83 members of the Slovenian Armed Forces who fully performed all three tests. None of the subjects had any medical limitations that would have required the use of the alternative walk test. The subjects were divided into four (4) age groups according to Cooper's classification (1979): 13 subjects in the under 29 years age group (15.7%), 43 in the 30 to 39 years age group (51.8%), 20 in the 40 to 49 years age group (21.4%) and 7 in the above 50 age group (8.4%). The point scale in the Instructions (2002) offers a classification in eight age groups; however, our subjects were divided into four age groups to allow for a higher number of subjects in each.

Description of the tests

Push-ups (PU): the subject assumes a front-leaning rest position by placing their hands on the ground in the width of their shoulders and performs the test by bending their elbows until their upper arms are parallel to the ground and returning to the starting position. The objective and result of the exercise is the maximum number of correctly performed repetitions in 120 s.
Sit-ups (SU): the subject lies on their back with their knees bent at a 90-degree angle and raises their upper body forward to the vertical position, with their arms crossed across their chest and hands resting on the opposite shoulders. A sit-up is completed when the elbows touch the thigh and the body returns to the starting position until the shoulder blades touch the ground. The objective and the result of the event is the maximum number of correctly performed repetitions in 120 s.
3,200-m run (3200MR): the subjects conduct this event in groups of a maximum of 16. The objective of the exercise is to run a distance of 3,200 m as fast as possible. The result is the time spent completing the course, measured with a stopwatch in whole seconds.

Evaluation

The results of the PU, SU and 3200MR tests are evaluated using a point scale and based on gender and age, where the sum total of points yields the physical fitness evaluation for each individual. Each of the three tests is evaluated using a 100-point scale. The evaluation 'highly

fit' requires a score of a minimum of 80 (eighty) points in each test and the overall score of the three tests of a minimum of 250 points. The evaluation 'fit' requires a score of a minimum of 50 (fifty) points in each test and the overall score of the three tests of a minimum of 180 points. In the event the minimum number of points in the test, i.e. 50, is achieved and the overall score of the three tests is 150, the evaluation is 'partly fit'. A failure to meet this criterion results in the evaluation 'unfit' (Instructions, 2002).

Data-processing methods

The sample of variables included the points achieved in the PU, SU and 3200MR tests. The variables were standardised. Descriptive statistics included a calculation of minimum and maximum values, arithmetic means, standard deviation, kurtosis, skewness and the Kolmogorov-Smirnov test. The K-means clustering method was applied for the classification into groups. A classification was made into two, three and four groups. The purpose was to check whether the classification was the most appropriate, which is why two control classifications were additionally made. Ward's criterion function was applied as a similarity measure in the group classification. The most appropriate classification proved to be in three groups. The typology of the statistical groups thus obtained was determined on the basis of characteristics of the final cluster centres. A bivariate analysis was used to investigate the distribution of subjects by age group in terms of the types of statistical groups and the physical fitness evaluation. Moreover, the types of statistical groups were compared with the physical fitness evaluation and the congruence between them established. The statistically significant correlation between the types of statistical groups and the evaluations of physical fitness was verified using the ANOVA at an alpha risk of 5%.

Results

According to the descriptive statistics, the highest scores (100 points) were achieved in the PU, SU and 3200MR. The lowest score was achieved in the 3200MR (0), followed by the SU (48) and PU (58). The highest average was achieved in the PU (81.01), followed by the 3200MR (79.87) and the SU (78.59). The characteristic of the Kolmogorov-Smirnov test shows a normal distribution of variables (PU 0.191; SU 0.026; 3200MR 0.029). The characteristics of the final cluster centres of the classification in three clusters (Table 2) show above-average values for the PU, SU and 3200MR in Cluster 2. Cluster 1 recorded distinctive below-average values for 3200MR and below-average for the SU. In Cluster 3 all values were below average, especially in the PU and SU. According characteristics of each cluster we define three types of statistical groups. Subjects from all age groups were classified in all three statistical groups (Table 3) but not in the groups of physical fitness evaluation (Table 4). In terms of the type of statistical group (Table 3) the majority of subjects (38) were distributed in the group 'underperforming in terms of strength' (Cluster 3 according to the final cluster centres), 35 in 'performing excellently' group (Cluster 2 according to the final cluster centres) and 10 in the 'underperforming in terms of endurance' group (Cluster 1 according to the final cluster centres). In terms of physical fitness (Table 4) more than half the subjects were distributed among 'fit' (52), followed by 'highly fit' (25) and 'unfit' (6). A comparison of the physical fitness evaluations against the statistical groups reveals a low overlapping ratio (Table 5, Figure 1). The physical fitness evaluations overlap with the types of statistical groups (Table 5, Figure 1) in the following percentages: the evaluation 'unfit' overlaps with the 'underperforming in terms of strength' group to the extent of 16.7% and with the 'underperforming in terms of endurance' group to the extent of 83.3%; the evaluation 'fit' overlaps with the 'underperforming in terms of strength' group to the extent of 71.2%, with

'underperforming in terms of endurance' to the extent of 9.6% and with 'performing excellently' group to the extent of 19.2%; the evaluation 'highly fit' overlaps with 'performing excellently' group to the extent of 100%. A statistically significant correlation (0.000; statistical significance was set at the $p<0.05$ level) was established between the physical fitness evaluation and the types of statistical groups.

Table 1: Descriptive statistics

	Minimum	Maximum	Average		Std. Dev.	Skewness	Kurtosis	Kolmogorov-Smirnov C	
	Statistics	Statistics	Statistics	St. error	Statistics	Statistics	Statistics	K-S test	Char. of ND
PU points	58	100	81.01	1.53	13.895	.054	-1.411	1.084	.191
SU points	48	100	78.59	1.73	15.748	.145	-1.466	1.471	.026
3200MR points	0	100	79.87	2.22	20.208	-1.673	4.082	1.454	.029

Table 2: Final Cluster Centres

	Cluster		
	1	2	3
Achieved PU points	-.18799	.85249	-.73572
Achieved SU points	.06411	.82974	-.78111
Achieved 3200MR points	-1.91348	.70077	-.14190

Table 3: Distribution of age groups by type of statistical groups

		Age groups				Total
		up to 29	30-39	40-49	50+	
Types of statist. groups	Underperf.-strength	5	20	10	3	38
	Underperf.-endurance	1	4	2	3	10
	Performing excellently	7	19	8	1	35
Total		13	43	20	7	83

Table 4: Distribution of age groups by physical fitness evaluation

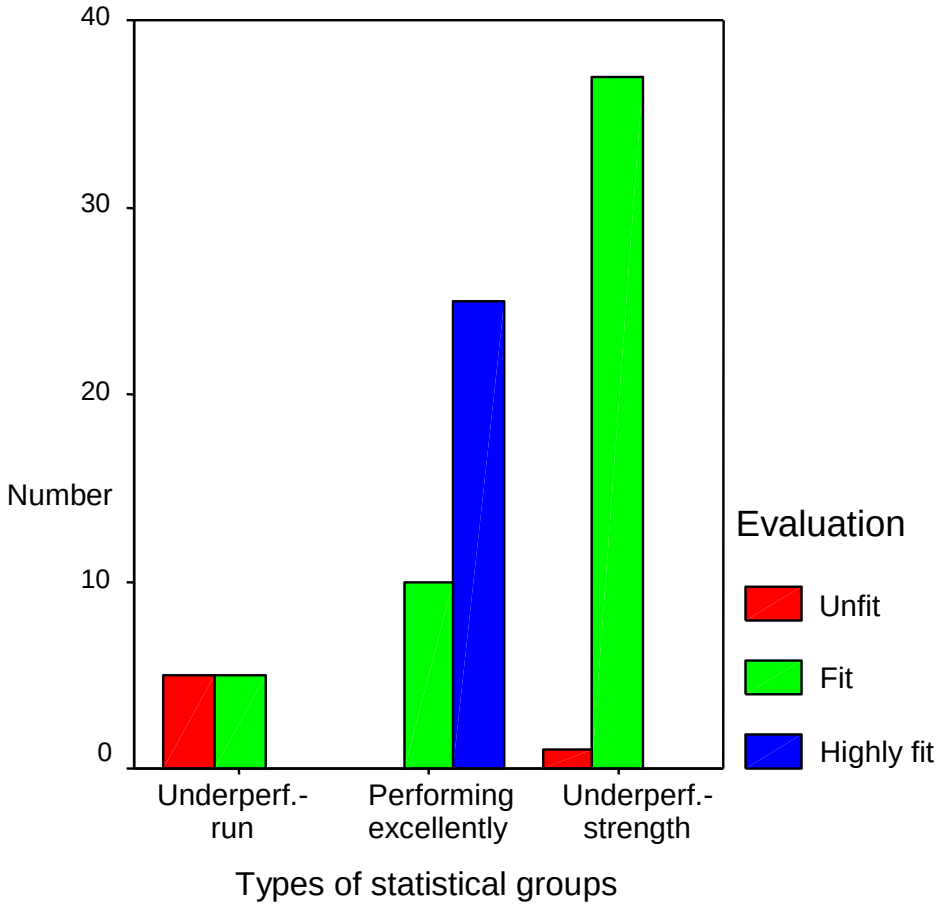
		Age groups				Total
		Up to 29	30-39	40-49	50+	
Physical fitness evaluation	Unfit		2	1	3	6
	Fit	8	28	12	4	52
	Highly fit	5	13	7		25
Total		13	43	20	7	83

Table 5: Comparison between the evaluation of physical fitness and types of statistical groups

			Types of stat. groups			
			Underp-S	Underp.-E	Perf. excel.	Total
Physical fitness evaluation	Unfit	Number	1	5		6
		% Types of stat. groups	2.6%	50.0%		7.2%
		% Phys. fitness evaluation	16.7%	83.3%		100.0%
		% Total	1.2%	6.0%		7.2%
	Fit	Number	37	5	10	52
		% Types of stat. groups	97.4%	50.0%	28.6%	62.7%
		% Phys. fitness evaluation	71.2%	9.6%	19.2%	100.0%
		% total	44.6%	6.0%	12.0%	62.7%
	Highly fit	Number			25	25
		% Types of stat. groups			71.4%	30.1%
		% Phys. fitness evaluation			100.0%	100.0%
		% Skupaj			30.1%	30.1%
Total		Number	38	10	35	83
		% Types of stat. groups	100.0%	100.0%	100.0%	100.0%
		% Phys. fitness evaluation	45.8%	12.0%	42.2%	100.0%
		% total	45.8%	12.0%	42.2%	100.0%

Statistical significance of ANOVA: 0.000 (p<0.05)

Figure 3: Comparison between the physical fitness evaluation and types of statistical groups



Discussion

The existing assessment consists of four evaluations: highly fit, fit, partly fit and unfit. None of the subjects in our sample was evaluated as 'partly fit'. When the subjects were classified in groups, the most appropriate classification proved to be in three groups. Hence the most appropriate evaluation is considered to be a three-level evaluation. The evaluation 'partly fit' should be closely scrutinised and an analysis conducted to establish the number of soldiers falling into this category; on this basis it should be established whether this evaluation is at all rational. After all, considering the requirements of the military profession, a member of the army must be fit to perform their work. If a member fails to meet the criteria, they are unfit. Given the broad variety of tasks, some military duties require a high level of fitness and, given that the results are in fact within the range, the three-level evaluation is not only reasonable but probably also the most practical. The evaluation 'partly fit' could perhaps be used for classifying members of the army with medical limitations who perform alternative tests and are considered as falling outside the category of healthy and fit-for-army members.

According to the characteristics of the final cluster centres, there is a group with above-average values in the PU, SU and 3200MR (Cluster 2) demonstrating good physical readiness in terms of repetitive strength (hereinafter referred to as 'strength') and general aerobic endurance (hereinafter referred to as 'endurance'), which is why it was named 'performing excellently', as well as two groups which are non-homogeneous in terms of the characteristics of the final cluster centres in the PU, SU and 3200MR: Cluster 1 recorded average values in the SU but very below-average values in the 3200MR, which is why it was named 'underperforming in terms of endurance'; Cluster 3 recorded below-average values in the PU, SU and 3200MR and thus performed the worst of all three groups, with distinctively negative results in the PU and SU, which is why it was named 'underperforming in terms of strength'. The above speaks in favour of combining the tests of strength (PU and SU) and endurance (3200MR). The results confirm that the test battery includes two tests of strength and one of endurance. This finding can also be associated with the assertion of Karpljuk et al. (2001), namely that the nature of the evaluation of individual motor abilities basically differs in each test. Moreover, the classification shows an imbalanced representation of motor abilities (of individual tests) in the selected test battery, which means that the test of strength and the test of endurance are not equivalent in the physical fitness evaluation. The latter is also corroborated by the comparison of the physical fitness evaluations with the statistical groups. The evaluation of fitness is considered appropriate as the 'performing excellently' group overlaps entirely with the evaluation 'highly fit'. A point to make here is that perhaps the criteria are too high as the 'fit' members were also categorised in the 'performing excellently' group. Despite the average SU results, the 'underperforming in terms of endurance' group overlaps to the highest percentage with the evaluation 'unfit', due to the distinctively negative values in the 3200MR. This means that those subjects who were evaluated as 'unfit' mostly performed poorly in the run. Inversely, the 'underperforming in terms of strength' group overlaps to the highest percentage with the evaluation 'fit', even though it is the worst of all the groups due to average values in all three tests (PU, SU and 3200MR). This gives rise to several questions. Is it easier to meet the strength evaluation criteria than those for running? Or does the above only show the lack of proportionality, given that two tests of strength dominate the test battery? This clearly shows that the physical fitness evaluation could be misleading when assessing someone and might fail to yield realistic data concerning their physical readiness. This indicates incongruence in the evaluation points system, which further raises the question of whether information about physical readiness is truly obtained and whether one may speak of physical fitness if only two dimensions of the motor ability

structure are considered. Jošt and Agrež (1994) define seven primary motor abilities (strength, endurance, speed, flexibility, co-ordination, balance and precision), with strength and endurance being just two of them. Some authors do not classify endurance among motor abilities on the grounds that endurance is a general ability of every human being (Pistotnik, 2003). Endurance is a life-long ability as it is required throughout one's life (Bravničar-Lasan, 1996). Notwithstanding the above, the question arises of whether strength and endurance are the only abilities – even if they might indeed be the most important for a soldier – to be prioritised in the framework of the characteristics and requirements of the military profession. Is it not true that co-ordination and flexibility, for example, are also critical for a soldier when moving in the battle field? Jošt and Agrež (1994) state that it can be established from the set of motor tasks what members of the Slovenian Armed Forces are required to master (several hours' marching, short and medium-long sprints with changes in direction, climbing with free and mixed hangs, crawling and climbing, throwing, lifting and carrying, pulling and pushing) and that the motor skills are very heterogeneous, including nearly all natural types of movement. These motor skills primarily require well-developed energy potential as displayed in motor abilities of the endurance type and which manifest themselves in different types of strength and speed. On the other hand, some movements and motor tasks such as overcoming artificial and natural barriers as well as handling different objects and technical devices mainly require a high level of co-ordination and flexibility.

The obtained classifications and characteristics of the clusters show that, with subjects with lesser physical readiness, the physical fitness evaluations cannot be directly compared to the statistical groups because of the combining of the tests of strength and endurance. The only exception is physically fit subjects who achieve good results in all three tests, which is also discernible from the characteristics of the clusters of 'performing excellently' group and the comparison of the latter with the evaluation 'highly fit'. The results put into question the selected test battery and physical fitness evaluation criteria and thus also the validity of the points system.

Standardisation of results is a challenging task and so is the verification of its validity. According to Astrand and Rodahl (1986), in some cases it is very difficult to standardise muscle strength measurement for several reasons (e.g. to measure maximum muscle force different types of resistance exercises can be used on training devices – bench press, curl, squat) and the same applies to push-ups. Regardless of the above, the PU as a test of strength is applied by the Slovenian Armed Forces and some others. One could question the adequacy of individual tests in the selected test battery. We can improve our understanding of the execution of tests from the practical point of view. Using the observation method during the process of testing physical fitness, we established that the bulk of incorrect and harmful-to-health executions of exercises were seen in the PU test. Therefore, this test can in the long run be considered as jeopardising the health condition of members of the army. The incorrect and harmful-to-health performance of the PU test is mainly due to the low level of fitness in terms of arm strength (and the entire body) and the incorrectly learnt execution. For these reasons, it is probably the most difficult test of all three to measure objectively and, therefore, the grader subjectively assesses whether the exercise is performed correctly.

The study results showed the physical readiness of the subjects in terms of strength and endurance. According to the physical fitness evaluation, most members of the army were 'fit', followed by 'highly fit' and 'unfit', which means that the majority demonstrated good physical readiness. In terms of the physical fitness evaluation, the descriptive statistics corroborate the above. In all three tests some subjects achieved the maximum number of

points (100) and were, on average, close to the criterion of high fitness (80 points). The ability to achieve high levels of physical readiness or fitness in terms of both strength and endurance is substantiated by the characteristics of the clusters of 'performing excellently' group and the overlapping of this group with the evaluation 'highly fit'. This high level of physical fitness can be attributed to regular and systematic training and high motivation. A low level of physical fitness in terms of strength and endurance is substantiated by the characteristics of the final cluster centres of the classification in the 'underperforming in terms of strength' group. In the 'underperforming in terms of endurance' group the distinctively below-average values in the 3200MR confirm the poor level of endurance. Most subjects underperformed in terms of strength (38), accounting for less than half of the total, whereas together with the 'underperforming in terms of endurance' group (10) their share exceeded one-half.

In terms of age, physical fitness declines with years regardless of the fact that age is already considered in the process of converting points into scores. This raises the question of the evaluation criteria even if, according to Pokorn (1998), the pace of the age-related downturn in physical abilities depends on the physical activity of each individual, as regular physical activity can cause a stagnation of abilities between the ages of 25 and 50. In our case this could mean that members of the army are insufficiently physically active and fail to maintain the vital capacities of their body. Another explanation is that the types of statistical groups indicate poorer results and poorer physical readiness since the existing evaluation and ensuing finding that the physical fitness evaluation depends mainly on the evaluation criteria. Clearly, the decline in physical fitness with age is substantiated by the distribution into types of statistical groups by age as well as physical fitness evaluation.

As regards the achievement of the results in the tests, it should not be overlooked that members of the army are informed beforehand of the criteria and this can influence their decision on the score they wish to achieve. It is possible that someone might decide to fulfil only the minimum fitness criterion, even if they are capable of achieving more. Owing to this inclination of each individual (their motive), the fulfilled criteria and achieved points do not necessarily paint a realistic picture of their physical readiness. Moreover, our sample was relatively small, particularly in the youngest and oldest age groups. Based on the above, one can hardly speak of good or poor physical fitness and, in fact, this was not what the study aimed at. It is true that the comparison of the existing physical fitness evaluation with the results reveals incongruence, which is why the evaluation criteria should be investigated further (Tkavc, 2004b).

Conclusion

The study results reveal a need for: (1) a balanced test battery; (2) a test battery that establishes physical readiness (fitness) more comprehensively, according to the motor ability structure; (3) an evaluation structure that yields realistic information on physical fitness and individual motor abilities and thus underpins proper planning of the training process and other procedures relevant to sport exercise in the army. Our study applied one of the multivariate methods. The results revealed the problems associated with a synthetic physical fitness evaluation and thus the need for the further and profound study of this subject. Formulating a battery of motor tests, criteria and physical fitness evaluations is a challenging and responsible task and it therefore needs to be constantly verified in practice, investigated and confirmed by scientific work methods. The study and periodical verification of an existing test battery applied in practice can thus serve as one of the forms of its evaluation. The process must also consider the changes brought about by global and local development trends.

Perhaps, it sometimes seems like the easiest way, is to use something which other armies employ and has already been 'tested'. Consideration must also be made of geographical, socio-demographic and other characteristics of and differences between various cultures. A study is a way to establish or verify the state of affairs using a selected sample. The findings can be shared with others and thus help paint a clearer picture and enable a critical understanding of the state of affairs. This can also trigger new questions. If new findings raise a series of new questions, further research is inevitable. In this way research becomes a sensible continuum.

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