

Optimal body balance disturbance tolerance skills as a methodological basis for selection of firefighters to solve difficult rescue tasks

Władysław Jagiełło¹, Zbigniew Wójcicki², Bartłomiej J Barczyński¹, Artur Litwiniuk³, Roman Maciej Kalina⁴

¹ Faculty of Physical Education, Gdansk University of Physical Education and Sport, Gdansk, Poland

² Zespół Publicznych Placówek Oświatowych, Brok, Poland

³ Jozef Pilsudski University of Physical Education, Warsaw, Faculty of Physical Education and Sport, Biala Podlaska, Poland

⁴ Faculty of Tourism and Recreation, Gdansk University of Physical Education and Sport, Poland

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Abstract

The aim of this study is the methodology of optimal choice of firefighters to solve difficult rescue tasks. 27 firefighters were analyzed: aged from 22–50 years of age, and with 2–27 years of work experience. Body balance disturbance tolerance skills (BBDTs) measured by the 'Rotational Test' (RT) and time of transition (back and forth) on a 4 meter beam located 3 meters above the ground, was the criterion for simulation of a rescue task (SRT). RT and SRT were carried out first in a sports tracksuit and then in protective clothing. A total of 4 results of the RT and SRT is the substantive base of the 4 rankings. The correlation of the RT and SRT results with 3 criteria for estimating BBDTS and 2 categories ranged from 0.478 ($p < 0.01$) – 0.884 ($p < 0.01$) and the results of SRT 0.911 ($p < 0.01$). The basic ranking very highly correlated indicators of SRT (0.860 and 0.844), while the 6 indicators of RT only 2 (0.396 and 0.381; $p < 0.05$). There was no correlation between the results of the RT and SRT, but there was an important partial correlation of these variables, but only then was the effect stabilized. The Rotational Test is a simple and easy to use tool for measuring body balance disturbance tolerance skills. However, the BBDTS typology is an accurate criteria for forecasting on this basis, including the results of accurate motor simulations, and the periodic ability of firefighters to solve the most difficult rescue tasks.

Key words

Ranking of firefighters, Rotational Test, simulation of rescue task

INTRODUCTION

Research on the ability to maintain body balance is dominated by two concepts: measurement of either the dynamic balance, or the static balance. Recommended tests are low correlated with each other or there is a lack of such correlation [1]. Moreover, apart from a few special circumstances – military, funeral, religious ceremony or sport, martial arts, etc., when the person is forced to expose almost exclusively a so-called static balance (i.e. a soldier standing at attention in front of the mausoleum), or almost exclusively a dynamic balance (i.e. a skier), the essence of a very wide range of motor activity is an integrated use of both of these controls of the body posture and stability. Fall avoidance is discussed as one of the most important tasks of postural control [2], but an equally important task of this control system is to ensure the achievement of the objectives of motor actions: locomotion, manipulation, or carried out simultaneously or alternately with postural activities, as in the case of basketball players, construction workers, etc. [3].

The synthetically understood function of stability and the postural control system are identified with body balance disturbance tolerance skills (BBDTs), which is defined as 'the

ability to maintain the vertical posture in the circumstances of a fall hazard' [3]. The results of recent studies confirm the truth of the hypothesis that the highest and higher BBDTS is owned by the people who during professional or other physical activity (sport for all, martial arts, etc.) very often carry out motor activities stimulating compensation mechanisms of intense disturbances of body balance. People who for several years have performed on horseback, at gymnastics, and sport dance are characterizing by the highest level of adaptation – either the ability to perform all motor tasks without any error (type A), or the ability to perform most of motor tasks without error (type B). Highly stimulates BBDTS combat sports and martial arts training, as well as the 10 months military training for paratroopers [3]. The negative direct impact on BBDTS is multi-days survival training [4], especially sleep deprivation [5].

The optimal BBDTS is a prerequisite for the effective performance of a number of occupations with high social significance – professional soldier, police officer, firefighter, lifeguard, etc. Specialists in almost all of these professions operate in circumstances of fall risk that are defined by three criteria: CFR 1 – includes the imbalance caused by an external force acting on the person who has no influence on it; CFR 2 – a force disrupting the balance of a person is a motor activity performed on a relatively stable surface; CFR 3 – includes the cumulative effects of any external force(s) and internal factors concerning the person performing an action [3].

Address for correspondence: Roman Maciej Kalina, Faculty of Physiotherapy, Department of Health Promotion & Research Methodology, Academy of Physical Education, Mikołowska 72A, 40-065 Katowice, Poland
e-mail: kom.kalina@op.pl

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One of the most difficult rescue tasks is the need to transport as soon as possible the person (often unconscious) to a safe place, where the only possible way of escape is a narrow surface with a length of several meters, located at a considerable height above the stable ground. Visualization of such a task, which in this study is simulated in a simplified manner, is shown in Figure 1.

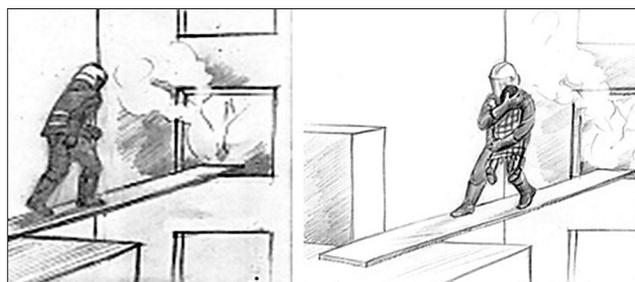


Figure 1. Visualization of rescue tasks simulated in a simplified manner in the tests

In such a situation, the fall rescuer cannot only compromise the ability to achieve the rescue, but even cause the loss of life of both people. The fall rescuer in such situation can destroy not only the ability to achieve the purpose of the rescue action, but also cause even the loss of life of both people.

The aim of the presented study is the methodology of optimal choice of firefighters to solve difficult rescue tasks.

MATERIAL AND METHODS

Evaluation of body balance disturbance tolerance skills.

The 'Rotational Test' (RT) in the non-apparatus version was used. RT consists of six tasks, starting with the jump with a 360° rotation to the right (each set of 'jump-landing-posture correction' should last about two seconds). The movie is available at the website of the journal Archives of Budo (www.archbudo.com) in the left menu (section: ArchBudo Academy) under link Rotational Test (<http://www.archbudo.com/text.php?ids=351>).

Evaluation criteria. The overall result is the sum of the six tasks (consecutive jumps with body rotation) and includes 0–18 stipulated points; '0' indicates a very high ability to tolerate imbalances, while '18' means the exact opposite of that assessment. The criteria for an individual level of BBDTS assessment determined by the RT are as follows: very high 0–1, high 2–3, average 4–9, low 10–12, very low 13–15, insufficient 16–18. The typology includes two groups (I – has the ability to maintain vertical posture during all physical activities; II – lack of such ability), and each group has five specific of categories: I – A, B, C, D, E; II – E, F, G, H, K, Z [3].

Simulation of rescue task. Passage (there and back) on the balance beam (a plank with a width of about 20 centimeters and length of 4 meters) fixed to a platforms located on two scaffoldings, 3 meters above the concrete ground. This is a simplified simulation of one of the most difficult situations, when the firefighter risks his own life in saving another person (Fig. 1).

Procedure: the firefighter stands with one leg at the beginning of the balance beam and the second leg on the

platform beside the beam; on the command 'start', the firefighter moves as soon as possible to the opposite edge of the balance beam; one foot touches the platform, rotates 180°, and returns to the starting point. During this particular test, on the concrete ground on both sides of the balance beam, the firefighters were lined up in a manner that would secure each other in a real rescue operation.

Evaluation method: the balance beam passage time was measured by a stopwatch with 0.01 second accuracy – from the 'start' command to bringing (after going back and forth) both feet on the platform behind the balance beam.

Evaluation criteria: about higher effectiveness (comparing 'everyone against everyone') provides a shorter time for performing the task.

Self-assessment of effectiveness during rescue actions (SAE).

The firefighters made a self-assessment on a six-point scale, where '1' represented the equivalent of the phrase 'I do not take risks', and '6' – 'I always «get away unharmed»' from the action. Individual research cards and the whole of the procedure guaranteed self-assessment confidentiality and protection of other private data.

Indicators body building. The somatic potential of the firefighters was described by three indicators: height, weight and BMI.

Ranking of firefighters.

At the basis of the empirical system is an assumption that the firefighter, regardless of the circumstances, should save people whose lives are threatened. Thus, the firefighters undertook the 'Rotational Test' (RT1 and RT2) as a simulation of a rescue task (SRT1 and SRT2), performed at first in everyday clothing (sports tracksuit), followed by the so-called protective clothing weighing around 12 kg (ankle boots with thick-soles, firefighter clothes, helmet, belt, flashlight).

In order to achieve an optimal method of firefighters' selection, the results of RT and SRT were the empirical basis for four rankings: BRF (basic ranking firefighters) is the result of the arithmetic mean of ranking position RT1, RT2 (xRT) and SRT1, SRT2 ($xSRT$). This ranking is mainly based on quantitative criteria. The RF-L (ranking adjusted to the level of BBDTS) is the result of the arithmetic mean of ranking position LEV1 and LEV2 ($xLEV$) and $xSRT$. This ranking is based primarily on the quantitative criteria (each BBDTS level is mapped by points contained within a given period). The RF-TA (ranking rectified by type BBDTS) is determined based on the results of the ranking position TYP1 and TYP2 ($xTyp$) and $xSRT$ – based on the quantitative and qualitative criteria. The RF-TE ranking is determined on the basis of the ranking position type (TYP) of the referenced BBDTS to the extremely unfavourable result of the RT of the examined person, and $xSRT$ (the qualitative criterion is emphasized which, by assumption, should balance the quantitative criteria and optimize the result).

Statistical analysis. The estimation of empirical variables (arithmetic mean, sample standard deviation, etc.), measure of skewness ($g1$) and measure of kurtosis ($g2$). Hypothesis testing (significance test – independent correlation coefficients). Correlation coefficient between pairs of specified variables and partial correlation.

Participants and organization of studies. 27 professional firefighters from the Fire and Rescue Unit of a city in Poland, who operate within the framework of the national system. Significant variation applied to all empirical variables: age from 22–50, professional experience from 2–27 years, body height 164–188 cm, weight 65–105 kg (Tab. 1).

Table 1. Indicators of body build, age, professional experience and self-assessment of firefighters (n = 27) participating in the experiment

Empirical variable/test (and symbol)	Statistical indicator						
	\bar{x}	SD	x_{min}	x_{max}	g_1	g_2	
Height [cm] // BH	178.81	6.2	164	188	-0.74	-0.02	
Weight [kg] // BW	82.63	11.35	65	105	0.37	-0.47	
BMI // BMI	25.85	3.55	20.5	37.7	1.32	3.52	
Age [years] // AGE	33.41	7.59	22	50	0.58	-0.08	
Work experience [years] // WE	10.17	6.92	2	27	0.76	0.16	
Self-assessment [points in scale 1–6] // SAE	5.19	0.79	4	6	-0.35	-1.26	
'Rotational Test' [points]	in sports tracksuit // RT1	3.96	2.23	0	9	0.46	0.03
	in protective clothing // RT2	5.07	2.30	0	10	-0.08	-0.01
Simulation of rescue task [s]	in sports tracksuit // SRT1	5.58	1.49	3.4	9.7	0.93	1.46
	in protective clothing // SRT2	5.39	1.23	3.72	8.8	1.08	2.45

Different: RT1 – RT2 *1.11 points* ($p < 0.10$); SRT1 – SRT2 *0.19 s* ($p < 0.10$)

The test cycle was repeated for three days (by ten persons each of the three sections separately), in the morning in similar weather conditions. One firefighter did not take the test because of an earlier injury; one was delegated to duties outside the garrison; one refused to perform the simulation of the rescue task in protective clothing. Thus, the results of 27 subjects.

The ordinal variable for presentation of the individual results was the ranking of the BRF. It is also the identity codes of the firefighter. The following lower case letters of the alphabet ('a', 'b') indicate a ranking item assigned to two people (therefore, ranking includes 22 positions).

The study was approved by the Bioethics Committee at the University of Rzeszow, Poland (Resolution No. 05/12/2010).

RESULTS

Different circumstances (sports tracksuit/protective clothing) did not significantly influence the change of the 'Rotational Test' results and simulation rescue task (Tab. 2).

However, the body balance disturbance tolerance skills of firefighters deteriorates when action is necessary in protective clothing (results are similar to the normal distribution). This is evidenced not only by a higher, on average, by 1.11 points RT results, but also the migration indicators level of BBDTS, indicating the enhancement of errors mainly in the quantitative meaning. Migration indicator types of BBDTS (whose essence is the total mapping of quantitative and qualitative errors) is also an indication that protective clothing inhibits the efficiency of action, but also follows the assimilation results to normal distribution. The opposite trend concerns the results of the simulation of a rescue task. The firefighters completed SRT2 a somewhat faster, but with a slight reduction in results variability (lower SD and range).

Statistically significant are the correlations with each other of all three indicators of BBDTS in the three systems of relationships: in the same circumstances (RT1, LEV1, TYP1), which are high correlations (0.761–0.876), respectively, for the variables (RT2, LEV2, TYP2). There were also high correlations (0.789–0.895) when pairs of identical variables were correlated (RT1, RT2), etc. However, the r values were already lower (0.508–0.601). Very strong correlation (0.911) linked the results of the simulation of a rescue task in two circumstances determined by the different clothes. Both SRT indicators strongly correlated with the ranking of the firefighters; however, only on average and only with two (LEV1, TYP1) among the six calculated indicators of body balance disturbance tolerance skills (Tab. 2).

The firefighters with a lower body mass, lower BMI index, and were younger, and those who more accurately made self-assessment of effectiveness during rescue actions, more effectively performed the SRT1 task (Tab. 3). The younger firefighters were classified in a higher ranking position. BRF with ranking negatively and average correlated is still just the SAE indicator. The SAE indicator was also correlated negatively, and with a similar power with the effectiveness of the SRT2 task performance. The accuracy of self-assessment of effectiveness during the simulated rescue action confirmed the results of RT (with one exception) and SRT – the lower

Table 2. Correlation matrix of main indicators of empirical variables (measuring BBDTS and effectiveness during rescue actions) and basic ranking of 27 firefighters

Variables (and symbol)	Correlation coefficient							
1 in sporty tracksuit								
2 in protective clothing								
Ranking of firefighters // BRF								
'Rotational Test' [points] // RT1		.304						
Level of BBDTS // LEV1		.381*	.847**					
Typology of BBDTS // TYP1		.396*	.884**	.739**				
'Rotational Test' [points] // RT2		.209	.631**	.592**	.618**			
Level of BBDTS // LEV2		.210	.531**	.508**	.529**	.895**		
Typology of BBDTS // TYP2		.265	.478*	.520**	.523**	.814**	.789**	
Simulation of rescue task // SRT1		.860**	-.031	.061	-.162	-.120	-.099	.049
Simulation of rescue task // SRT2		.844**	-.008	.088	.087	-.038	-.046	.911**
Variable symbol		BRF	RT1	LEV1	TYP1	RT2	LEV2	TYP2
								SRT1

* $p < 0.05$; ** $p < 0.01$

the effectiveness, the lower the SAE indicator. However, there was a statistically significant difference only for the extreme ratings (6 and 4), and the simulated results in protective clothing.

Table 3. Correlation of the basic ranking of 27 firefighters and main indicators of empirical variables (measuring BBDTS and effectiveness during rescue actions) with indicators of their body build, age, professional experience and self-assessment

Variable (and symbol) 1 in sporty tracksuit 2 in protective clothing	Body height BH	Body weight BW	BMI	Age AGE	Work experience WE	Self-assessment SAE
Ranking of firefighters // BRF	.187	.369	.263	.446*	.300	-.496**
'Rotational Test' [points] // RT1	-.143	-.125	-.081	.294	.242	-.084
Level of BBDTS // LEV1	-.093	-.225	-.214	.348	.223	.010
Typology of BBDTS // TYP1	-.113	.103	.140	.317	.222	-.036
'Rotational Test' [points] // RT2	.014	-.077	-.102	-.048	-.073	-.093
Level of BBDTS // LEV2	.117	-.028	-.105	-.101	-.097	-.012
Typology of BBDTS // TYP2	.050	.016	-.020	-.073	-.084	.004
Simulation of rescue task // SRT1	.090	.433*	.386*	.392*	.373	-.427*
Simulation of rescue task // SRT2	.181	.325	.220	.274	.220	-.579*

* p<0.05; ** p<0.01

The BRF ranking, which is based on quantitative criteria (Fig. 2) and the most rigorous RT-TE ranking (Fig. 3) divided the firefighters into 22 positions, the others into 19 and 21 positions. Only four ('1a', '1b', '2', and '4') were classified in all the rankings in the same position. The promotion of five positions of relative BRF rankings obtained by firefighter '10b', and four firefighter items of four other firefighter - '12a', '13', '17', and '21' (Fig. 2). However, the indicators of all the rankings correlated strongly to one another (Fig. 3).

Only one component - *xSRT* - had very highly correlated variables (0.941-0.962), no matter what the methodology used to create the ranking. Only the partial correlation presented such compounds, also with specific indicators BBDTS (*xRT* and *xTYP*) (Fig. 2). The stabilization effect of a firefighter's position in the ranking caused the appearance of a significant correlation between *xSRT* and *xRT* (-0.598, p<0.01), and *xSRT* and *xTYP* (-0.411, p<0.05) and *xSRT* and *TYP* (0.404; p<0.05). Double the negative correlation means that firefighters who performed the SRT tasks faster made more mistakes (both in quantitative and qualitative terms) during RT. The positive correlation between the *TYP* and *xSRT* indicates that the task carried out faster by SRT firefighters who ranked a rigorous typology BBDTS, and were qualified into higher ranking positions. This is empirical proof that the most useful methodology is ranked RF-TE in terms of both cognitive and application methodology.

Standardization of the firefighters' results are due to the type of BBDTS disclosed is proof that this feature is a factor that most diversifies them (Fig. 4). The leaders were also distinguished by those of younger age and more slender build of body.

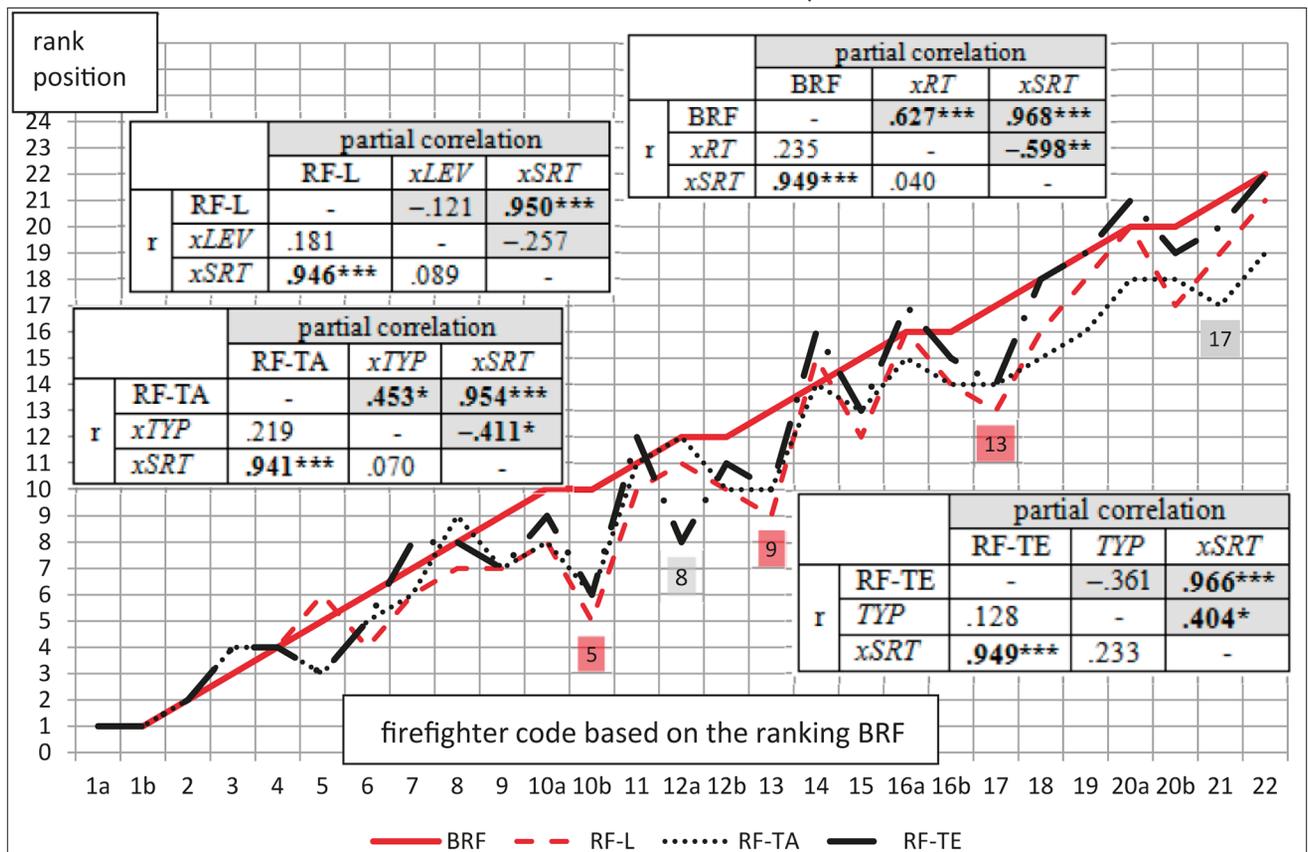


Figure 2. Rankings of 27 firefighters based on 4 different criteria (rank position of the BRF is an ordinal variable and the code identifying the person). Grey fields - partial correlation.

* p<0.05; ** p<0.01; *** p<0.001

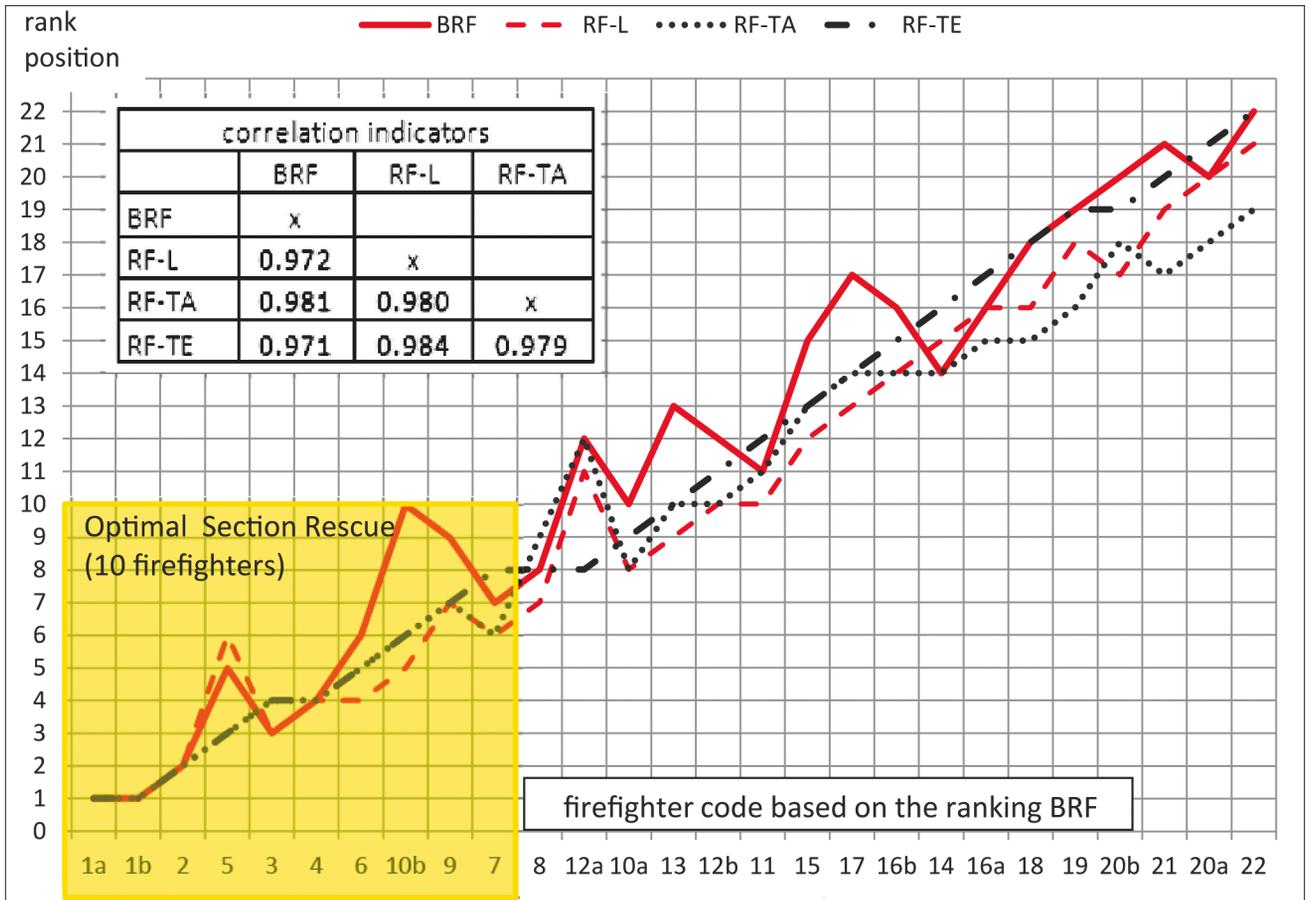


Figure 3. Rankings of 27 firefighters based on 4 different criteria (ordinal variable: position in the ranking of the RF-TE)

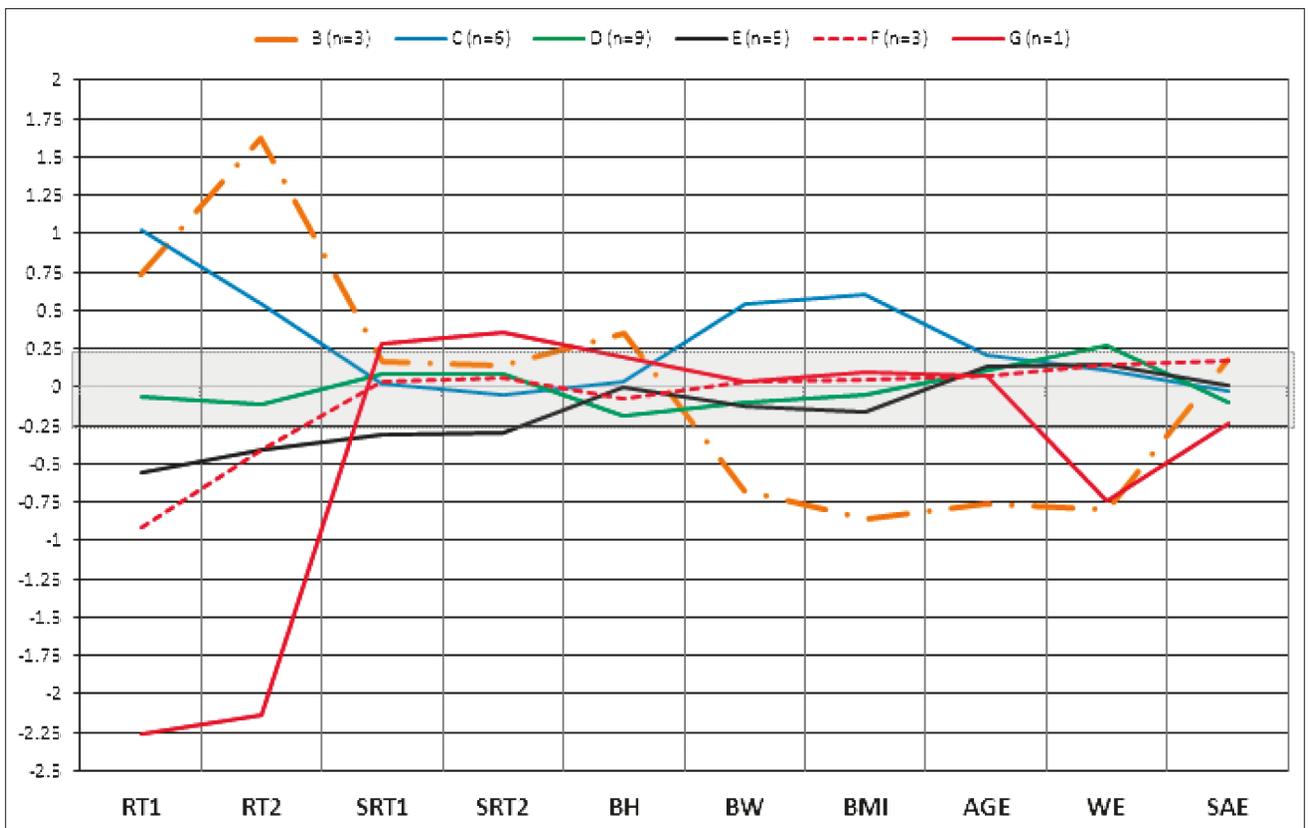


Figure 4. Standardized on the arithmetic mean and standard deviation profiles of firefighters who differ in the type of BBDBTS based on main indicators of empirical variables

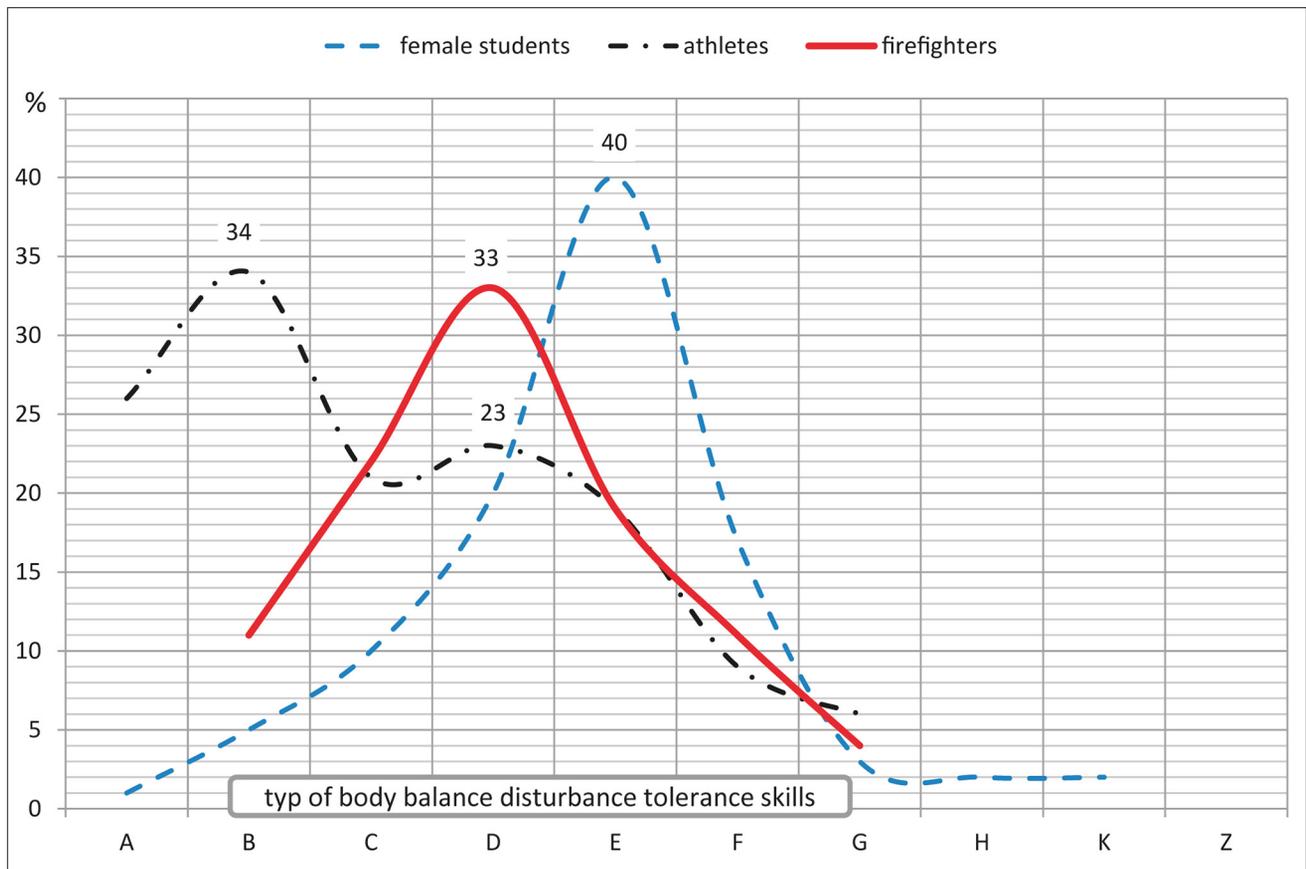


Figure 5. Distribution types of BBDTS firefighters (n = 27) against the female students (n = 100) and athletes (n = 218) [3]

DISCUSSION

The cognitive value of the results of this study concern several aspects. That there was no simple correlation between the results of the 'Rotational Test' and simulation of rescue task confirms the truth of the two considered hypotheses. One is that the system stability and motor control are very complex. The second is that, although the large plasticity of the brain and all the motor control system, the ability of these systems have still not been accurately diagnosed. Moreover, recent research [6] justifies a revision of many theories of the topical paradigm of motor learning and control [7].

The lack of this correlation explains the elementary logic: in point of fact it is about the relationships between the results of two simulations. The 'Rotational Test' is a reliable tool for measuring BBDTS (the validation procedure of test lasted several years [3]). This is simulated in the need to repeat the six-fold rotation of the body about 360° (alternately left and right) in the laboratory term, then ended in each case in favour of a stable vertical posture. The applied simulation tasks exposed the need for rapid transition within several meters along a narrow stretch of equivalents, located a few meters above the ground and, with the appraisal of only one change of direction of 180°. Thus, both simulations measure the two phenomena, for which there is no doubt that the ability to communicate (or its lack) to maintain body balance in situations where there is a lot of pressure on the possibly fastest and finest motor skills to perform several tasks on the negative impact of environmental factors (slippery ground, smoke, height, etc.). These phenomena (abilities) differ in details, which are disclosed in the required laboratory studies

and by sophisticated techniques. An example is the recent discovery of the importance that the sensory errors coded by the cerebellum principally contribute to the fine tuning of motor activity required for motor learning [6].

In real rescue operations, the need to help one rescuer, as shown in Figure 1, may concern even a few persons in a dangerous situation. The results of four successive simulations provide evidence that the expected stability of the rescuer possibilities – under any circumstances – refers to only 15% of the analyzed group of firefighters. Only four firefighters were classified in each of the rankings on the same position (on the first two, and one on the second and fourth).

These simulations proved to be very valuable in terms of the selection process because of the potential exposure of people who cannot be delegated to a certain category of rescue task (in this case, the transition to the balance beam at high altitude). The firefighter who refused SRT2 needed 12.59 seconds for the transition while wearing a sports tracksuit (SRT1) on the balance beam – the total distance was only 8 meters. The leader completed the task in 3.40 seconds (for comparison, the Polish record holder completed in 15.8 seconds a 100 meter fire obstacle course; a world record holder, in 12.95 seconds ran 32.25 meters with a ladder hooked-up for her to climb through the third floor of a dummy building at a height of 10.85 meters [8]). If we add the four firefighters who during the 'Rotational Test' were unable to maintain a vertical posture during all the tasks, that excluded 17% of the firefighters. If everyone – due to the lack of knowledge about the possibilities of rescue – was included in the ten-section on duty, the projected efficiency of the section in similar situations would be only 50%.

The greatest predictive value should be assigned to the RF-TE ranking, in which the methodology was the most rigorous. A key element of this methodology is the evaluation of body balance disturbance tolerance skills, based only on the disclosed type BBDS, which is an extremely unfavourable representation of the 'Rotational Test'. Based on this criterion, the BBDS profile (Fig. 5) places the firefighters among young women who have not performed regular physical activity, and athletes (male and female) representing 16 disciplines [3]. This comparison shows that the area of real improvement in the level of the appropriate selection and appropriately-targeted training concerns 15% of persons. Because of the fact that among the firefighters dominated respondents of type D (i.e., lack of ability to perform half of the motor tasks without error), and on the understanding that the best would be the ability of a firefighter to perform half of motor tasks without any error (type C), then the area of possible improvement (through the appropriate selection and continuous training) should refer to approximately 66% of persons.

The simplest and the most accurate way to increase the likelihood that during a rescue action, a firefighter or a larger group of people will be designated who will be able to maintain a vertical attitude in spite of unfavourable environmental factors (Fig. 2), is to monitor the effects of this type of rescue and motor test results of the corresponding simulation. Tests may be useful as a non-apparatus and quasi-apparatus [9], including diagnosing the susceptibility to injuries during a fall [10]. An important empirical evidence is also the statistically significant correlations of the results of the RT and SRT made in different circumstances. This means that the exercises by firefighter in sports tracksuits provides comfort, as opposed to the discomfort of exercises in protective clothing [11, 12, 13], will allow a greater number of repetitions, etc., bring economic benefits, and under the right conditions to adapt. Therefore, this correlation ensures that the motor function performed in protective clothing will be just as efficient.

Since there is also a wide class of situations in which the sustaining of a vertical posture would be counterproductive, a separate group of tests [14] should help to determine if a firefighter can safely collide with the ground when suddenly losing balance, or when this is done on purpose, e.g. example avoiding collision with falling elements of a burning building.

This way of reasoning is widely justified by empirical evidence from outside the experiment. During 1992–2002, 94 firefighters died in rescue actions in Poland, and although in the years 2007–2010 these losses were reduced to zero (two persons died in 2011), the number of affected people is still high (annually 1,276–1,512). The prevailing causes of accident are sports (485–609), rescue actions (284–515), and events in the guard house (146–225). The most common causes are: carelessness and abnormal behaviour (710–842), difficult, uneven and slippery surfaces (258–336), and sudden medical emergencies (180–219). Among the events directly causing accidents, dominate tripping, slipping, loss of balance and fall, including the depth of a cavity (579–701), physical dynamic load (177–248), while the most common consequences of accidents are fractures and dislocations (545–872) and contusions (155–235) [8]. Based on these statistics, questions arise: would the number of these accidents be reduced if the specific rescue tasks were assigned to other firefighters, if the selection system was based on more accurate tests, and

if the tests were the basis for the periodic verification of professional usefulness?

The sport of fire is very generalized [8, 15, 16, 17] and the social recognition of gain various forms of survival [18] and extreme sports and activity [19]. However, the disparity between the results of athlete firefighters and officers lead to the conclusion that the permanent training of firefighters is not based on sports competitions that are powerfully relevant rescue simulations [8].

Józef Bergier [20], in an overall review of publications on physical activity and health, showed that the authors of many works emphasize the issue of increased motivation to work, and the content of life of people who are physically active. Only then, adequate physical activity reduces the risk of many diseases, especially the diseases of obesity and diabetes. People with low physical activity are at increased risk of an untimely death. Recent research by Kalina [21] and Jagiello [22, 23] shows that young women, students of physiotherapy, tourism and recreation, physical education (training courses related to promotion and prevention of health), rate the lowest their own ability to survive when collectively carrying out self-assessment of the skill sets of the three dimensions of positive health (somatic, physic, social).

The comprehensive approach of the well-documented knowledge leads to the conclusion that in the case of firefighters and other rescue groups and the formation of defence (military, police, etc.), is not only a matter of systematic physical activity, but also on physical activity-oriented sense. Physical performance is impossible to maintain through simple means – walking, running, cycling etc., but also through participation in a variety of permanent multiathlon specialities, in this case, related to a specific motor activity of firefighters. This type of multiathlon and discipline are also another plus – it prepares the participant mentally for real rescue operations. If this reasoning is complemented by awareness that the firefighter often works in very unfavourable environments (exposed to a higher degree than others of leptospirosis [24]), the issue of selection and training of permanent firefighters appears in a clearly interdisciplinary dimension, located, in our view, on the border of at least: environmental medicine, sports science, sports medicine, psychology, sociology, and many specific disciplines, such as motor learning and control, biomechanics, hygiene, occupational medicine, ergonomic, etc. Now we are entering into the difficult but important area of breaking down barriers [25] which still exist within the study, and at the interface of science and many disciplines of practicality.

CONCLUSION

The 'Rotational Test' is a simple and easy to use tool for measuring body balance disturbance tolerance skills. However, the BBDS typology is an accurate criteria for forecasting on this basis, including results of accurate motor simulations, and the periodic ability of firefighters to perform the most difficult rescue tasks.

REFERENCES

1. Drowatzky JN, Zuccato FC. Interrelationships between selected measures of static and dynamic balance. *Research Quarterly*. 1967; 38: 509–510.
2. Coogler CE. Falls and imbalance. *Rehabilitation Management*. 1992; 5/6: 53–79.
3. Kalina RM, Jagiełło W, Barczyński BJ. The method to evaluate the body balance disturbance tolerance skills – validation procedure of the “Rotational Test”. *Arch Budo*. 2013; 9(1): 59–69.
4. Tomczak A. Effects of a 3-day survival training on selected coordination motor skills of special unit soldiers. *Arch Budo*. 2013; 9(3): 167–171.
5. Dąbrowski J, Ziemia A, Tomczak A, Mikulski T. Physical performance of healthy men exposed to long exercise and sleep deprivation. *Med Sport*. 2012; 16 (1): 6–11.
6. Brooks JX, Cullen KE. The Primate Cerebellum Selectively Encodes Unexpected Self-Motion. *Current Biology*. 2013; 23(11): 947–955.
7. Schmidt RA, Wrisberg CA. *Motor Learning and Performance. A Situation-Based Learning Approach*. Fourth Edition. Human Kinetics 2008.
8. Information Bulletin of the State Fire Service (for years: 1999, 2000, 2001, 2002, 2011). Warszawa (in Polish).
9. Kalina RM. Applying non-apparatus and quasi-apparatus tests in a widely understood concept of health promotion – an example of flexibility measurement and assessment. *Arch Budo*. 2012; 8(3): 125–132.
10. Kalina RM, Barczyński BJ, Klukowski K, Langfort J, Gąsienica-Walczak B. The method to evaluate the susceptibility to injuries during the fall – validation procedure of the specific motor test. *Arch Budo*. 2011; 7(4): 201–215.
11. Gavhed D., Holmer I. Thermoregulatory Responses of Firemen to Exercise in the Heat. *European Journal of Applied Physiology*. 1989; 1–2: 115.
12. Barker R, Deaton S, Liston G, Thompson D. A CB Protective Firefighter Turnout Suit. *International Journal of Occupational Safety and Ergonomics* 2010; 16(2): 135–152.
13. Kaiser C, Wyss P, Rossi RM. Analysis of Steam Formation and Migration in Firefighters’ Protective Clothing Using X-Ray Radiography. *International Journal of Occupational Safety and Ergonomics*. 2010; 16(2): 217–229.
14. Kalina RM, Barczyński B, Jagiełło W, Przeździecki B, Kruszewski A, Harasymowicz J, Syska J, Szamotulska K. Teaching of safe falling as most effective element of personal injury prevention in people regardless of gender, age and type of body build – the use of advanced information technologies to monitor the effects of education. *Arch Budo*. 2008; 4: 89–89.
15. Davis P, Dotson CO, Laine SM. Relationship between Simulated Fire Fighting Tasks and Physical Performance Measures. *Med Sci Sport Exercise*. 1982; 1; 65.
16. Ellam LD, Fieldman GB, Garlick J, Goldsmith L, Pateman C. Initial Training as a Stimulus for Optimal Physical Fitness in Firemen. *Ergonomics*. 1994; 5: 933.
17. Sterkowicz S. Results of fire sport contestants compared with the indices and physical development. In: Kalina RM, Klukowski K, Jędrzejak K, Kaczmarek A. Contemporary trends of physical education development in defensive formations. PTNKF, Warszawa 2000: 75–87 (in Polish).
18. Bergier J, Sroka M. *Survival w teorii i praktyce*. PWSZ, Biała Podlaska 2009 (in Polish).
19. Bąk R. Definition of extreme physical activity determined through the Delphi method. *Arch Budo Sci Martial Art Extreme Sport*. 2013; 9: 17–22.
20. Bergier J. Studies and measurements of physical activity of the society. *Ann Agric Environ Med*. 2012; 19(3): 329–331.
21. Kalina RM. The profile of Sense of Positive Health and Survival Abilities indices (subjective assessment) as a diagnostic tool used in health-related training. *Arch Budo*. 2012; 8(3): 179–188.
22. Jagiełło W, Sawczyn S, Jagiełło M. The subjective profile of positive health and survival abilities in women differing as to physical activity. *Arch Budo*. 2012; 8(4): 219–224.
23. Jagiełło W, Sawczyn S, Jagiełło M, Michałowska-Sawczyn M. Positive health profile and survivabilities of female students with different levels of physical activity. *Teoria i Praktyka Fizycznej Kultury* 2013; 5: 15–18.
24. Wasiński B, Dutkiewicz J. Leptospirosis – current risk factors connected with human activity and the environment. *Ann Agric Environ Med*. 2013; 20(2): 239–244.
25. Barczyński BJ, Graczyński M, Kalina RM. Barriers Restricting the Free Dissemination of Scientific Achievements: Own Experiences in Crossing Walls and Bridges. *J Hum Kinet*. 2009; 22(22): 7–14.