REVIEW ARTICLE

Body balance disturbation tolerance skills in combat sports and other forms of hand-to-hand combat – narrative review

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C Statistical Analysis
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Abstract

Background and Study Aim: The one of the most important elements of effectiveness in combat sports is body balance disturbation tolerance skills (BBDTS). When competing in many combat sports, throwing the opponent off balance is the basic criterion for demonstrating an advantage or even victory before the end of the regular fight time. Meanwhile, the dominant paradigm is to measure two distinct phenomena (dynamic balance and static balance) within this coordination capacity. The 'Rotational Test' ('RT') recommended for measuring the BBDTS phenomenon (in the 'non-apparatus' and 'quasi-apparatus' versions) is a compilation of dynamic and static components of the complex phenomenon of human body balance. A high level of BBDTS outside sports is an important factor in increasing human motor safety in many hazardous situations. The purpose of this review is knowledge about the BBDTS level of athletes practicing various combat sports and other forms of hand-to-hand combat.

Material and Methods: The search for publications was performed in the largest scientific publication databases: Web of Science, Google Scholar. The query included the following terms: 'body balance', 'combat sport', 'hand-to-hand combat', 'martial arts', using the 'and' operator. The results were divided according to: criterion for 'non-apparatus' and 'quasi-apparatus; version of 'RT'. In both versions of 'RT', the main evaluation criterion is the result in points indicating the number of errors made. 'RT' consists of six tasks (consecutive jumps with body rotation of 360° alternately to the right and to the left). The overall result (motoric aspect) is the sum of the six tasks and includes 0 to 18 stipulated points. Criteria of an individual level of BBDTS are as follows: very high (0-1), high (2-3), average (4-9), low (10-12), very low (13-15), insufficient (16-18). The 'quasi-apparatus' version takes into account execution time 'RT' (this is an additional qualitative criterion).

Results: The number of publications regarding non-apparatus and quasi apparatus versions of 'RT' which the authors analysed is similar. Based on the criterion of errors made (sum of 'RT' points), judo and kick boxing athletes make the least mistakes. An additional qualitative criterion, i.e. the time of 'RT' execution, turned out to be useful information differentiating the compared people in circumstances when the 'RT' results expressed in points after a period of specific homogeneous stimuli (learning new motor activities, identical exercise time, etc.) were identical. The quality of the BBDTS phenomenon is strongly determined by the type of combat sports or martial arts practiced.

Conclusions: There is empirically justified evidence that the BBDTS phenomenon is strongly stimulated by the practice of combat sports in particular, the essence of which is the intense unbalancing of the opponent during tournament and training fights. Therefore, this category of combat sports and some forms of hand-to-hand combat based on such motoric patterns deserve to be recommended together with other aspects of broadly

understood motor safety in relation to strengthening health and survival. Frequent falling meets the criteria for the prevention of bodily injury during unintentional falls in other motor activities. Throwing the aggressor off balance and effectively restraining his body in a horizontal posture is a more reliable means of self-defence than a strike that carries the risk of exceeding these limits. These examples do not raise any doubts about judo, wrestling, aikido, etc. with the possibility of positively strengthening all dimensions of health and survival, not only for a short period of sports career.

Keywords: complementary approach • INNOAGON • motor safety • 'Rotational Test'

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INTRODUCTION

The phenomenon of **body balance disturbation tolerance skills** (BBDTS) is defined as 'the ability to maintain the vertical posture in circumstances of the fall hazard' [1, p. 60]. Even though the definition is simple and unambiguous, some authors who have used 'Rotational Test' (the only tool that measures BBDTS) have reported that it was dynamic balance that was measured. Although, 'RT' is the only tool that measures BBDTS according to the third criterion of understanding this phenomenon by the authors who validated RT [1] – more in section 'Material and Methods'.

The following two version of 'Rotational Test' ('RT') are used: non-apparatus and quasi-apparatus [1, 2]. The difference is that timing of the test is also measured in the second case. Evaluation of errors (or their absence) while landing after performing each of the six jumps upwards with a 360° rotation, alternating, starting right, then left, etc., is a shared criterion (primary criterion – motor effect). The criterion for correctness is to land in such a way that both feet make contact with the established line (0 evaluation points). No contact of one foot with the line is a first degree error (I° and 1 evaluation point); no contact of two feet with the line is a second degree error (II° and 2 evaluation points); whereas a fall or supporting oneself with hand/hands or any other body part than the feet while landing is a third degree error (III° and 3 evaluation points) [1]. For more information about evaluation criteria, see section 'Materials and Methods'.

The authors revealed during the validation procedure that some of the leaders, i.e. those with very high and high BBDTS, are practising combat sports and other forms of hand-to-hand fighting (combat) [1]. The term 'martial arts' is not used here for two reasons. First of all, the authors identify with those authors of scientific papers dedicated to the phenomena of hand-to-hand fighting who clearly state that the attractive term 'martial arts' with the word 'mixed' added is an effective way to camouflage neo-gladiatorship [3-15]. Second of all, *aiki-do (aikido)* is equated with martial arts in a vast number of scientific publications. However, the roots of *aikido* have nothing to do with martial training; it is defence arts [16, 17] with deeply humanistic qualities and unique applications in preventive health, therapy and rehabilitation [18-20].

The quasi-apparatus version of 'RT' has proven to be a very useful research tool in a cognitive and applied sense. Especially when the initial and final results (or intermediate results if the experiment includes multiple measurements) of the subjects are identical, or slightly different in terms of motor effect measured with points. In this case, the timing of 'RT' is a good predictor of the effectiveness of the modifying factor (single or repeated cyclic exercise, sleep deprivation, therapeutic or preventive procedure applied, reduced visibility, etc.). The

Non-apparatus test – that motoric test (exercise endurance test) of the required reliability (accurate and reliable), which use does not require even the simplest instruments [74].

Quasi-apparatus test – can be conducted with simple instruments (a stopwatch, a ruler, a measuring tape, etc.) [74].

Innovative agonology – is an applied science dedicated to promotion, prevention and therapy related to all dimensions of health and regarding the optimization of activities that increase the ability to survive from micro to macro scales [39, p. 274].

INNOAGON – acronym 'innovative agonology' [9].

Motor safety – is consciousness of the person undertaking to solve a motor task or consciousness the subject who has the right to encourage and even enforce from this person that would perform the motor activity, who is able to do it without the risk of the loss of life, injuries or other adverse health effects [75].

Methodology of complementary research (second assumption) – 'the language of methodology of complementary research (which is equally applicable to INNOAGON) should be very precise. The object of

advantage of the non-apparatus version is that it can be used to directly control the effect of environmental factors on BBDTS on an ongoing manner. It is related to ensuring motor and exercise safety for those neglected in terms of physical activity (e.g. during rehabilitation courses, when physical efforts are repeated even several times a day) and athletes, soldiers, etc., using extreme training loads. It was Andrzej Tomczak who authored or co-authored most of the results of tests conducted in such circumstances using the non-apparatus 'RT' [21-25]. Tomczak also provided empirical evidence that 'Rotational Test' was the most sensitive diagnostic tool among the coordination tests be used during his last unique experiment [25].

The purpose of this review is knowledge about the BBDTS level of athletes practicing various combat sports and **other forms of hand-to-hand combat.**

MATERIAL AND METHODS

Presumptions and assumptions

A perceptive critic will reasonably conclude that, according to definition of BBDTS and distinguished circumstances of being at risk of fall in particular, this phenomenon can be measured also using other known and applied tests. The author of the test, RM Kalina [26], and the co-authors of the earliest published preliminary validation basically assume that there is a relationship between BBDTS and the consequences of falling in human motor activity. A convincing rationale for this reasoning is the statement of the authors of that validation: *A natural tendency of people who do not know how to fall safely is to automatically try to keep balance after any kind of imbalance, which is by no means a desirable action in every situation* [26, p. 185]. They go on to give examples of the consequences of falling in many sports and competitions. However, their basic assumptions carefully refer to a particular importance of a certain category of sports activity from the perspective of stimulating BBDTS: *It is difficult to clearly indicate in athletes en bloc which of the balance regulation mechanisms are developed to a greater and lesser extent (...); the more balance-distorting elements characterise a given type of sporting struggle, the greater number of these mechanisms are to be improved* [26, p. 185].

Maśliński et al. [27] have reviewed publications reporting the BBDTS of Polish judo athletes in 1974-2016 using various methods and tests (including 'RT'). In this review, in accordance with our assumptions, we focus only on papers whose authors measured BBDTS using a non-apparatus or quasi-apparatus 'RT'.

Search and selection of publications

Publication searches were performed in the largest scientific publication databases: Web of Science, Google Scholar in the second half of 2023, with results being updated to the date the article was submitted for publication. The following keywords were used in the search: 'body balance', 'combat sports', 'martial arts', 'hand-to-hand combat', 'hand-to-hand fighting' using the 'and' and 'or' operator. Dissertations (PhD dissertations, MA theses) and monographs in Polish were also studied.

A distinction was made according to the performance criterion based separately on non-apparatus 'RT' and quasi-apparatus 'RT' of people who were training any combat sport or any other type of hand-to-hand combat (fighting).

The review includes 3 publications in indexed journals, 1 PhD dissertation and 1 MA thesis based on the results of non-apparatus 'RT' and 3 publications in indexed journals based on the results of quasi apparatus 'RT' and 1 PhD dissertation. Furthermore, there are references to the results of practitioners of combat sports and other hand-to-hand fights, which are not monitored in homogeneous groups; in our view, these empirical data are of cognitive value given the purpose of this review.

The review (apart from the control groups) includes the results of 494 people practicing: aikido (n = 22); boxing (n = 37); judo (n = 243); kick boxing (n = 30); self-defence (n = 23); wrestling (n = 48); safe fall (n = 91).

RESULTS

The results of a three-month initial judo training already confirm a positive effect of this physical activity on the formation of BBDTS in children aged 6-12 [28].

Also, two-semester training of gymnastic dance with elements of self-defence in 21-year-old women [29] and observations of six-month effects

innovative agonology research is the phenomenon of struggle in a broad sense, dedicated precisely (to put it somewhat more figuratively) to the defence of development and survival of humans and nature in a non-degenerate form against destructive factors. Moreover, the range of application of INNOAGON products is possible in a great many, even distant, scientific disciplines and implementation into areas of practice (medicine, education, defence, etc.). Precisely because of such broadly understood application possibilities, precise language is one of the basic conditions for successfully practicing the just emerging complementary research methodology. Language must be precise and concise (reduced to essential words) also due to the increasing importance of artificial intelligence in science and many other social activities' [76, p. 81].

Neo-gladiator – a person who trains mix martial arts (MMA) and similar forms of hand-to-hand fighting that do not meet the definition of sport according to the Olympic Charter [7].

of judo training that supports psychophysical education of pilot cadets [30] confirm this effect.

However, the greatest adaptive effects are achieved by those who have been practicing combat sports and other types of hand-to-hand combat for many years [1]. These results are documented using the non-apparatus version of 'RT' (Table 1).

More detailed information on the BBDTS was provided by results of the quasi-apparatus version of 'RT' (Table 2). They confirm the positive effect of a long-term training of combat sports on BBDTS, and significant evidence is provided by the effects of safe fall courses which also contain elements of fun forms of combat and increase this coordination ability [31-34].

Table 1. Promotional works and publications using the 'RT' non-apparatus version.

No	Year & Author(s)	Combat sport/form of hand-to-hand-combat (material)	Aim (hypothesis)	Study design	Results, conclusion, recommendations
1	**2004** Krakowski [28] MA thesis	observations of 37 boys and 21 girls (58 in total) aged 6-12, who have participated in three-month preliminary judo training in a big Polish city.	main hypothesis: gender and age are not factors differentiating the BBDTS level of primary school students starting judo training; a three-month introductory judo training for primary school students improves their BBDTS; students who initially revealed a lower level of BBDTS are more likely to quit judo classes than students with a higher level of this feature.	16 boys and 6 girls have resigned already in first weeks of the training; the analysis of the results of children who completed the course is included in the work dedicated to the RT validation procedure; in this review we fill in the relevant details.	average RT score of 6 boys who gave up training 11.06 points (2 to 18) and 6 girls 9.25 points (6 to 14); in the group of 21 boys who completed the training, no one performed RT correctly for the first time, and among the 13 girls only one (8%); after initial training, total errors during RT were reduced by 3 boys (14%) and 1 girl (8%); before the training, 38% of the boys made more than half of the errors in the qualitative sense during RT (from 10 to 16 points, including 8 boys who fell 17 times), after three months of training, 24% (from 9 to 11 points, including 5 boys who fell 5 times); among girls, before 8% (one, 10 points) and none of them fell, after the training the result did not change in a quantitative sense; however, girls reduced the average raw 'RT' score by 1.8 points (from 5.8 to 4.0), boys by 1.82 points (from 7.3 to 5.48). Saturating the initial judo training process of school-age children with balance-disrupting agents is an effective stimulus for stimulating BBDTS, as evidenced by empirical data. Students who initially revealed a lower level of BBDTS are more likely to quit training. Judo teacher(s) should be blamed for this didactic mistake i.e. inability to arouse interest at the training. Mental effects of failing to practice judo may have much deeper implications than missed opportunity (documented by 'RT' results) of obtaining motor effects significant for safety.
2	**2005** Syska [29] PhD dissertation	modern gymnastic and dance forms with elements of self-defence: EG (experimental group 23 female students): age 21.17 years; CG (control group 97 female students): age 20.65 years.	main hypothesis: systematic nine-month physical education of young women based on modern forms of gymnastic and dancing with music and combined with self-defence exercises provides stimuli to develop general physical performance, basic motor skills and above-average self-defence skills by most women, and also contributes to the reduction of feeling anxiety and aggressiveness.	9 months (2001-2002) pedagogical experiment: EG the special programme of modern gymnastic and dance forms with elements of self-defence which includes physical exercise, relaxation exercises, verbal actions (2 times a week for 9 months, each time for 60 minutes), 66 training sessions and 30 PE each 90 minutes; CG only 90 minutes PE per week.	RT (points, M, SD, min÷max): EG female students before experiment (7 ±4.21 (0÷14), after experiment (5.41 ±3.47 (0÷13); CG female students before experiment (7.68 ±3.22 (0÷15), after experiment (7.37 ±3.24 (0÷14). Only in the group of female students ($n = 6$) who won all test fights in a vertical position (TFVP): a high positive correlation ($r = 0.583$, $p>0.05$) of RT points with static balance (Flamingo test – number of reps); S-Index with fear and aggressiveness ($r = -0.856$, $p<0.05$) means that young female participants who are able to win all testing fights in a vertical posture (F-Index = 1) exhibit a low degree of fear and aggressiveness.

No	Year & Author(s)	Combat sport/form of hand-to-hand-combat (material)	Aim (hypothesis)	Study design	Results, conclusion, recommendations
3	**2013** Kalina et al. [1]	age and training in years: aikido male (n = 22) age 27.9 (15-48) training 2-15; boxers 27 male and 3 female, age 20.57 (16-33) training 3-17; freestyle wrestler male (n = 23) age 20.8 (16-24) training 3-17; Greco-Romano wrestler male (n = 24) age 21.5 (16-32) training 1-14; judo female (n = 9) age 19.48 (16-23) training 3-12; judo male (n =16), age 21.5 (18-25) training 10-15; kick boxers 28 male and 2 female, age 23.60 (17-47) training 1-20.	appropriateness and reliability of 'Rotational Test' ('RT') as BBDTS measurement tool.	The research was carried out as part of promotional (MA theses) at the Academy of Physical Education in Warsaw (Poland) in the years 2002, 2003.	RT (points, M, SD, min÷max): judo female 2 ±2.36 (0÷7); kick boxers 2.5 ±2.42 (0÷11); judo male 2.69 ±2.36 (0÷7); freestyle wrestler 2.9 ±2.00 (0÷8); boxers 3.23 ±2.71 (0÷11); Greco-Romano wrestler 3.3 ±3.00 (0÷11); aikido 4.45 ±2.32 (0÷8). 'High adaptive effects are also typical for people training combat sports and martial arts (especially judo, wrestling) During training sessions these athletes perform numerous rotational movements with high dynamics in a relatively limited space.' [1, p. 67].
4	**2017** Maśliński et al. [27]	results of 'RT' (points) non-apparatus version different of the groups of Polish judo athletes (2002-2004) – the review also includes the results of Krakowski's work [28]; judo male (n =116), female (n = 30).	the purpose of this review is knowledge about the original evaluation methods, and results of the BBDTS exhibited by Polish judo athletes from 1976 to 2016.	review of three MA theses at the Academy of Physical Education in Warsaw (Poland) in the years 2002-2004.	The authors postulate research on the intercorrelation of 'RT' with Flamingo Balance Test and Marching Test at various stages of selection for sports and associating the evaluation of the BBDTS phenomenon with sports results.
5	**2021** Wochyński [30]	the research covered male cadets, mostly aged 19 who are students at the Air Force Military Academy in Dęblin (Poland). Group A (n = 14) was made up of students practising judo in a sports section, whereas group B (n = 14) was made up of pilot cadets who follow the program of pilot training.	knowledge about projected changes in the level of physical fitness and changes in the components of the body composition under the influence of a special training process in judo practitioners in relation to the control group.	the students underwent fitness tests before (examination I) and after (examination II) a six-month training period: Aviation Synthetic Efficiency Test (ASET); 1,000 m run, 100 m run, pull-ups on the bar and a 'RT'; all the students had their heart rate (HR), blood pressure (BPS, BPD) measured prior to and after completing the ASET.	In group A in examination II, there was a statistically significant increase in the ASET performance ($p<0.0001$) in relation to examination I. In group B, in examination II, there was a statistically significant increase in the ASET performance ($p<0.01$), in the 1,000 m run ($p<0.01$) and pull-ups on the bar ($p<0.02$) in examination II in relation to examination I. In group B, the HR, BPS, BPD findings were significantly higher before and after completing the ASET than in group A. A six-month training period for the judo practitioners significantly improved the performance in the ASET, in the 1,000 m run and in the 'Rotational Test'. Thus, judo is an important element in supporting the fitness of future military pilots, however, judo training is a more useful method of physical and mental preparation for survival.

Table 2. Promotional works and publications using the 'RT' quasi-apparatus version.

No	Year & Author(s)	Combat sport/form of hand-to-hand-combat (material)	Aim (hypothesis)	Study design	Results, conclusion, recommendations
1	**2017** Gąsienica Walczak [31] PhD dissertation	there were 177 PT students: 68 female and 22 male during pilot studies (1st stage); during the second stage of research: 30 women, 14 men.	hypothesis complementary motor education in the field of safe falls and collision avoidance (i.e. also including exercises supporting these skills) has a stimulating effect on both the development of this category of motor competences and the increase in BBDTS, muscle strength and flexibility.	motor effects were based on results of: the test of safe falls (TSF) and modified test of safe falls (TSF-M4); the susceptibility test of the body injuries during the fall (STBIDF); 'RT') – quasi-apparatus version; 3 trials of strength and flexibility (the International Test of Physical Fitness (ITPF); methodical effects were based on knowledge tests from: kinesiology; theories and methods of health training; theories and methods of safe fall; mental effects were based on diagnostic survey: the meaning of teaching safe fall (MOTSF); self-evaluation of motor and methodical competences (SMMC).	during pilot studies (1st stage), the average score of female students decreased from 7.01 points before the course to 4.66 points after the training ($p<0.0001$), while among male students from 7.73 points to 5.55 points ($p<0.0094$) respectively; BBDTS, measured by 'RT' execution time: female 13.99 s to 12.03 s ($p<0.0001$); male 13.08 s to 11.94 s ($p<0.0186$); during the second stage of research: 6.53 points (before the courses) to 5.17 points ($p = 0.0271$) after the training female students and male students decreased from 6.93 points to 3.86 points ($p = 0.0106$); RTs in circumstances where the eyes were covered or the hands were restrained with an orthopaedic belt were more difficult tasks for the students: deterioration of the results measured in points (female 8.83 and 6.93; male 9.21 and 7.71), and the time of ,RT' (female 18.41 and 13.91 s; male 18.44 and 14.93 s).
2	**2019** Gąsienica Walczak et al. [32]	a woman (age 21, body height 168 cm, body mass 118 kg, BMI 41.81), a third year physiotherapy student.	the second cognitive purpose: the effect of safe falling training in person with third degree obesity.	she participating in specialist courses on the theory and methodology of safe falling in academic years 2009/2010.	the score 'RT' 7 points before and after safe fall courses is the evidence of an average level of body balance disturbance tolerance; reduction of test performance duration from 16.41 to 11.81 seconds (by 28.01%) confirms a favourable adaptive effect. Adaptive effects are important arguments for implementation of health related training for overweight and obese persons, based on safe falling workouts. There is no need to organize special safe falling and collision avoidance courses for overweight and obese persons; a competent application of the pedagogic rule of individualization during training sessions is sufficient.
3	**2022** Litwiniuk et al. [33]	PE students: 11 practitioners combat sports (CS) and 1 neo-gladiator (NG); PE students practicing other sports or daily, varied physical activity (control group – CG): n = 12.	knowledge about the relationship between BBDTS and the motor effects of an intensive, multi-day basic alpine skiing course and with the body composition indices of combat – and non-combats sport athletes; twenty-four physical education students were examined: 12 training combat sports (including 1 neo-gladiator); 12 (control group) practicing other sports or daily, varied physical activity.	the basic skiing course lasted 10 days: 6 teaching hours (45 minutes each) a day; motor effects (skiing techniques) were assessed by 3 experts on a scale from 2 to 5 (with an accuracy of 0.5) and the criterion was the arithmetic mean of all scores.	CS students athletes revealed a higher level of BBDTS (as documented by motor indexes and RT execution time) both before and after the basic alpine skiing course.
4	**2023** Litwiniuk et al. [34]	reference group – RG, PE students practitioners combat sports: 3 boxing, 2 karate kyokushin, 1 wrestling empirical group – EG, 25 PT students.	knowledge about BBDTS in the dynamically changing circumstances of human activity under laboratory conditions.	PE students (reference group) performing 'RT' two times. Trial I before and trial II after alpine skiing course (10 days, 6 teaching hours (45 minutes each) a day); the high-dynamic-change experiment was based on performing 'RT' three times repeated at 1 minute intervals: trial I (under standard conditions), trial II (in darkened goggles); trial III (upper limbs restrained with an orthopaedic belt).	RT (points, M, SD, min÷max) (time in seconds: M, SD, min÷max) RG before skiing course (0), after RT seconds 11.68 ±0.62, 10.7÷12.3, after 11.85 ±0.76, 10.6÷12.7; EG, RT points trial I, 5.32 ±3.28, 0÷11, trial II 8 ±2.62 3÷12, trial III 5.92 ±2.38, 2÷11; RT seconds trial I 14.15 ±1.19, 11.51÷16.75, trial II 19.99 ±5.26, 12.94÷33.72, trial III 16.19 ±3.31, 12.75÷27.24; There are individuals who are able to compensate for negative effects at a similar level, despite dynamically changing circumstances stressing components of the neurophysiological system responsible for BBDTS. Thus, the results of such and similar empirical arrangements can form the basis for the selection of persons for especially difficult rescue or intervention tasks. Thus, providing personal security for those who would not be able to cope with such tasks precisely because of low BBDTS. The results may also be useful in sports, prevention and therapy.

DISCUSSION

There is a small number of empirical studies in which the authors have applied 'RT' to the study of individuals training in combat sports or other forms of hand-to-hand combat, especially to improve health, expand defensive motor competence, and broaden knowledge to be used in sports selection.

For example, the postulate by Maśliński et al. [27] to determine an intercorrelation between the Flamingo Balance Test, Marching Test and 'Rotational Test' and the selection stage, with subsequent adaptive effects of training and sports achievements. This poses an interesting cognitive and application challenge.

Such knowledge would also be useful from the perspective of promoting personal health and safety. The reader is also deprived of such knowledge by the authors of studies who have applied 'RT' with people practicing combat sports or specific hand-to-hand combat exercises but who did not provide individual profiles. For example, Mroczkowski and Sikorski [35] associated the 'RT' results with 'global motor coordination test' in very important studies of children aged 10-12. There were 2 karate, 1 capoeira and 1 judo practitioners in the group of boys who additionally attend sports trainings (n = 26). The presented results were dominated by 16 football, 3 hockey, 2 handball players.

The cognitive potential of the raw 'RT' results analysed in relation to developed typology of ability to tolerate balance disturbances [1]. Litwiniuk et al. [33] showed that negative migration of these BBDTS indicators was observed only in students who did not train combat sports (75%) under the influence of cumulative, intensive physical exertion of physical education students (the alpine skiing course).

Meanwhile, 25% practitioners of hand-to-hand combat (two practitioners of WTF taekwondo and one neogladiator) exhibited a higher level of BBDTS (as confirmed by motor indices and RT performance time) both before and after the elementary alpine skiing course.

Scientific literature does not basically analyse BBDTS being modified by current physical exercise and based on the typology highlighted above. However, the adaptation effects resulting from long-term training are well documented [1]. Therefore, attention is drawn to the unique studies of Maciej Krakowski [28], also because judo training (initial course) was given up by young adepts of this combat sport in the first weeks (the oldest ones are 12 years old). It is not only the scale of the phenomenon in question: 43% of boys and 38% of girls gave up, but above all its qualitative dimension.

Among the boys, a 12-year-old boy gave up, having committed a 3rd grade error (i.e. either falling or supporting himself with his hands, as he was unable to maintain vertical posture by performing alternating jumps with a 360% turn – the raw 'RT' score was 18 points. The coach should refer this boy and some other children to have neurological tests performed.

This score, 18 points, means 'type Z: lack of ability to maintain vertical posture', according to the BBDTS typology. But the following also resigned: a seven-year-old with a score of 17 points, an eight-year-old with 16 points, an eight-year-old with 15 points, a six – and eleven-year-old with 13 points and others with lower raw 'RT' scores. In this typology, scores of 16 or 17 points mean 'type L: ability to maintain vertical posture during at least one ZR, but lack of ability to perform without an error', whereas scores of 12-15 points mean 'type K: lack of ability to maintain vertical posture during half of ZR', with ZR being 'from among 6 jumps with a 360° rotation'. Among the girls, one nine-year-old with a score of 14 points (subtype BBDTS G22: two errors of third degree and 1-4 errors of second degree, one nine-year-old with 10 points (subtype BBDTS F1: one error of third degree and 2-5 errors of first and second degree) have also resigned. None of the others who gave up committed a 3rd grade error.

Previous studies into the phenomenon of dropouts from combat sports and other forms of hand-to-hand-combat training in the Polish population have not addressed the need to link the results of the initial diagnosis of motor potential (as one of the basic indicators of somatic health) with monitoring of deficits and health risks (the above examples of BBDTS interpretation using the typology [1]) in relationships primarily with the child's parents and legal guardians. This would only be preliminary information both to inspire

the child's parents/care givers and to develop tailored interventions that take into account the child's motor capabilities and expected health and survival-related outcomes. Parents/care givers should understand what health and personal safety benefits a child can have through regular participation in training. If such an outcome is achieved, it would mean that the trainer/instructor is fulfilling their social role.

When asked about the reasons for giving up training, Polish educators in combat sports and hand-to-hand-combat systems most often mention lack of rapid effects arising out of technical and sports difficulties (31.3%), too high training load (26.6%), change of interest (25%), health problems (23.4%), lack of time, regularity and perseverance (21.9%). Lack of authority of the coach/instructor is indicated only by 15.6% of respondents. Lack of authority of the coach/instructor is indicated only by 15.6% of respondents and 14% of them pointed to low qualifications of a coach [36]. When referring to the latter two reasons, none of 64 respondents (aged 21-52) had themselves in mind.

Unlike many recommended motor tests, the 'RT' is a universal INNOAGON [37-39, 9] without breakdown by gender and age of the respondents. Other tools of this new applied science also have identical methodological values [40, 2, 41]; these include: 'basic self-defence skills test' [42]; 'testing fights in a vertical posture' (TFVP) [43-45]; 'the ability to optimally use the limbs muscle strength' [46]; 'the susceptibility test to the body injuries during the fall' (STBIDF) [47, 35, 48, 49] and modified version (STBIDF-M) [50]; 'test of making safe fall' [51-55]; fun forms – some addressed to children [56], others of universal use [57-59]. These unique diagnostic tools have to do with motor safety in particular and personal safety in a broader sense [60, 61]. At the same time, many of these motor tests and simulations are designed to reduce negative phenomena [2] that teachers using traditional education methods cannot cope with. The basic INNOAGON method is a complementary approach (see glossary).

Applications of 'RT' in areas of exploration not directly related to combat sports provide evidence of high predictive validity and ease of application even in field conditions [21, 62, 22-24, 63, 25, 64]. A required ability to perform at least one jump with a near 360° rotation completed by maintaining a vertical posture is the only limitation, which is related to health and age. Therefore, a trial performance of two jumps with 360° rotation (right and left), in a sense, acts as a pre-test, after making sure that there are no health contraindications. This is a specific 'self-defence' that Artur Kruszewski and Bartłomiej Gąsienica-Walczak [65] discovered in the titles of 1,568 publications classified by Web of Science Clarivate into multiple categories. Moreover, the unique motor tests and simulations recommended by INNOAGON can become attractive, safe and reliable means of supporting health spa treatment due to their universal criteria for the evaluation of results [66, 67]. In our opinion, in view of crisis of values and personal security it is precisely health spa treatment that is a good form of strengthening all dimensions of health and survival, also recommended by the first INNOAGON experts, who have repeatedly verified methods of healing exercises of Asian origin [68-73].

CONCLUSIONS

There is empirically justified evidence that the BBDTS phenomenon is strongly stimulated by the practice of combat sports in particular, the essence of which is the intense unbalancing of the opponent during tournament and training fights. Therefore, this category of combat sports and some forms of **hand-to-hand combat** based on such motoric patterns deserve to be recommended together with other aspects of broadly understood motor safety in relation to strengthening health and survival. Frequent falling meets the criteria for the prevention of bodily injury during unintentional falls in other motor activities. Throwing the aggressor off balance and effectively restraining his body in a horizontal posture is a more reliable means of self-defence than a strike that carries the risk of exceeding these limits. These examples do not raise any doubts about judo, wrestling, aikido, etc. with the possibility of positively strengthening all dimensions of health and survival, not only for a short period of sports career.

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