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Reliability and objectivity of the new version of the 'susceptibility test for body injuries during a fall' (STBIDF-M) in physiotherapy students

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Abstract

Background and Study Aim Falls are a global public health and economic challenge. Since falls are often unavoidable, it is crucial to focus on preventing injuries caused by the impact with the ground. The aim of this study was to verify the reliability and objectivity of the STBIDF-M.

Material and Methods The sample included 30 male (n = 9) and female (n = 21) physiotherapy students (age 20.97 ± 1.16 years; weight: 66.5 ± 12.06 kg; height: 171 ± 9.62 cm). The STBIDF-M was administered twice, with the second measurement (retest) conducted seven days after the first (test). A method of direct secondary observation, allowing for multiple replays, was used. The assessment involved reviewing video recordings of both stages (test and retest) by three experts experienced in using the STBIDF-M.

Results Each expert observed a tendency to reduce errors during the 'retest' compared to the 'test' stage. This was measured by the arithmetic mean. Statistically significant differences were found in tasks 3, 4, 5, 6, and in the IndexSBIDF-M based on the experts' agreed assessments. Three students (10%) repeated their results from the 'test' stage, showing full correlation. Twenty students (66.67%) demonstrated a tendency to reduce errors. The IndexSBIDF-M 'test-retest' results showed a very high positive correlation ($r = 0.810$, $p < 0.01$). This indicates a statistically significant impact of motor modifications in most students. Specifically, clapping hands during Task 3 and pressing the sponge to the body with the chin during Task 4, simulating a backward fall, helped reduce errors. These reductions were noted during ground impact as the degree of coordination difficulty increased in subsequent tasks.

Conclusions The results of this 'test-retest' procedure demonstrate the flexible, non-standardized possibilities of analyzing and synthesizing data using this basic method. This flexibility is attributed to the innovative motor structure of the STBIDF-M, which goes beyond traditional methodological approaches. Observing the unconscious behaviors and actions of the participants has provided valuable insights into inferential phenomena related to the mental and intellectual aspects of human personality.

Keywords: complementary approach, INNOAGON, simulated fall backwards, unintentional fall

Introduction

Falls are a global health and economic concern. They affect people of all ages. The epidemiology of falls, excluding groups at increased risk, is influenced by climatic conditions and the structure of the ground, including infrastructure. The lowest rates of years lived with a disability and years lost to premature death due to falls are reported in Africa, while the highest rates are found in Scandinavian and other European countries [1]. Most prevention recommendations focus on reducing the risk of falls, particularly among older adults. However, the effectiveness of such interventions impacts only ...% of participants [2].

Since a fall is inevitable, it is fundamental to prevent injury from the impact caused by a fall. The most effective method is to master safe falling skills (techniques) [3]. With an ageing population, it makes little sense to universally teach safe falling to people over 60. Therefore, attention has been drawn to the unique research results and expert recommendations of the 'Polish School of Safe Falling' [4] regarding the phenomenon of susceptibility to body injuries during a fall (SFI) [5]. A key contribution is the development of tools to diagnose the SFI phenomenon, along with secondary intervention programs tailored to individual profiles. The large inter-individual variation and complexity of the SFI phenomenon has been revealed by unique tools (non-apparatus tests) from the new applied science of 'innovative agonology' – INNOAGON [6, 7].

Conclusions from the analysis of the results of many previous studies using the susceptibility test for body injuries during a fall (STBIDF) [8] show that the creator of this first tool was inspired by

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the 'safe falling' theory by Jaskólski and Nowacki in 1972 [9]. This theory was later expanded by Mroczkowski [10]. In 2011, the first results of the STBIDF validation procedure were published [11], and data on its reliability ('test-retest' score) became available in 2022 [12]. In 2023, a comprehensive publication on the prognostic merits of the STBIDF was released [13]. The authors of this publication, while observing a large sample of physiotherapy and physical education students, discovered that the majority had previously experienced traumatic injuries as a result of a fall. The analysis and synthesis of the results from this group revealed the high predictive power of the STBIDF and introduced a new methodological perspective for using this category of tools to explore the SFI phenomenon.

The STBIDF [14, 15, 16, 17] showed that a single evaluation of the lower limbs (referred to as 'legs' in the documentation) is insufficient [18, 19, 20, 21]. A modification of the STBIDF-M (susceptibility test for body injuries during a fall – modified) includes a three-fold evaluation of the legs on a three-point scale indicating error or absence (0, 1, 2). This modification is the result of expanding the test version from three to six tasks [22, 23, 24, 25]. Each body part is evaluated at least three times. The validation procedure for this modification has been limited to an assessment of validity [5, 26, 27].

Thus, previous studies have contributed valuable insights into the evaluation of susceptibility to injuries during falls and the development of tools like the STBIDF and its modified version, STBIDF-M. However, the analysis of the studies highlights limitations in their validation, particularly regarding reliability and objectivity. Moreover, the variability in individual responses to falls and the complexity of injury susceptibility necessitates the search for new, more effective solutions.

The aim of the study was to verify the reliability and objectivity of the STBIDF-M.

Material and Methods

Participants

The sample included 30 male (n = 9) and female (n = 21) physiotherapy students (age: 20.97 ± 1.16 years; weight: 66.5 ± 12.06 kg; height: 171 ± 9.62 cm). The participants were selected from a pool of 41 students enrolled in their first-degree studies during the fifth semester. The inclusion criteria were an adequate health state and voluntary participation. Exclusion criteria included a lack of consent to participate, pregnancy, and any dysfunctions that would prevent taking the test. All participants were thoroughly informed about the aim of the study prior to their participation.

Study Design

Assessment of the susceptibility to body injuries during a fall

The STBIDF-M was administered [5]. Each student was recorded while performing the test, with the camcorder capturing the required motor activities in the sagittal plane. Participants waiting for their turn were kept in a separate room, with no contact allowed between those who had completed the test and those yet to perform it.

The structure of the STBIDF-M consisted of six motor tasks performed on tatami mats. The assessment focused on protecting body parts most vulnerable to injury during a fall (head, hands, hips, legs). Any incorrect collision during the fastest possible transition from a vertical (standing) to a horizontal (lying on the back) position was recorded as either a first-grade ("1") or second-grade ("2") error, with no errors marked as "0." The total score served as a general indicator of susceptibility to body injuries during a fall (i.e., the Index$_{SBIDF-M}$). The scores were classified as very low (0), low (1–11), average (12–18), high (19–23), very high (24–27), and extreme (28–30). For individual body parts, the scores were:

- Legs, hips, head: very low (0), low (1), average (2–3), high (4), very high (5), and extreme (6).
- Hands: very low (0), low (1–2), average (4–6), high (7–8), very high (9–10), and extreme (11–12).

Assessment of the reliability of the STBIDF using a test-retest approach

The test was conducted twice. The second measurement (retest) took place seven days after the initial test. Each participant performed both the test and retest individually. Both sessions were carried out at the same time of day, in the same room, and using identical procedures.

Assessment of the objectivity of the STBIDF using the Delphi method (expert panel)

The method of direct secondary observation with the possibility of multiple replays was applied. The assessment procedure involved reviewing video recordings of both stages of the study (test and retest) by three experts experienced in using the STBIDF-M. Initially, the experts independently evaluated the recordings without sharing their assessments. In cases of scoring discrepancies, the experts reviewed the recordings together (multiple times if necessary) and discussed their opinions before reaching a consensus on the final result.

Statistical analysis

Differences between the test and retest scores were analyzed using the Wilcoxon signed-rank test and T-Test for two dependent means, with the alpha level set at <0.05. Spearman's rank correlation coefficient (r) was employed to assess the relationships between variables. Arithmetic means ($\bar{x}$), standard deviations (SD or ±), minimum (Min), maximum (Max) scores, degrees of freedom (df), skewness (g1), and kurtosis (g2) were calculated, along with z-distribution (z) and probability (p).

To further explore the distribution of differences between the 'test' and 'retest' stages, ranking positions (RP) were assigned based on performance indicators. In cases of equal values, the higher RP was allocated to the participant with the higher 'test' stage score. When multiple participants had identical results, additional identifiers, such as lower-case letters after the RP, were introduced to distinguish them. This classification allowed for dividing participants into different fractions based on their performance trends: error-reducing, stable, or error-augmenting.

Results

The results showed that each of the experts observed a trend of reducing errors during the 'retest' stage in relation to the score of each task from the 'test' stage, as measured by the arithmetic mean (Table 1). This trend is supported by statistically significant differences in the scores of tasks 3, 4, 5, 6, and the $Index_{SBIDF-M}$ based on the experts' consensus scores (Table 2). Additionally, statistically significant correlations of the agreed scores for the nondirectional test were found only from Task 3 onwards. However, the level of generality of the 'test-retest' scores presented in Tables 2 and 3 does not account for individual differences.

Tables 3-5 present the evaluation of the STBIDF-M task scores for physiotherapy students during the 'test-retest' procedure, divided into three distinct groups. The classification divides students into three groups: Table 3 shows the stable fraction, Table 4 presents the error-reducing fraction, and Table 5 highlights the error-augmenting fraction.

The data in Table 3 demonstrate that three students (10%) repeated the score from the 'test' stage, indicating a full score correlation. The data in Table 4 demonstrate that twenty students (66.67%) revealed a tendency to reduce errors. The IndexSBIDF-M 'test-retest' scores correlate very highly and positively ($r = 0.810$, $p<0.01$). This provides statistically significant evidence of motor modifications reducing errors during ground impact in Task 2 of the simulated backward fall. The finding is particularly important, as the positive effect occurs despite the increasing coordination difficulty of Task 2 and each subsequent task. The data in Table 5 demonstrate that seven students (23.33%) revealed a tendency to magnify errors. However, the positive correlation of repeated observations with 'test' scores ($r = 0.661$) is not statistically significant, although it is borderline for directional test significance at df 5.

A statistically significant reduction in head-on

Table 1. Estimation of overall task scores (total points) of STBIDF-M ('test-retest') assessment by three independent experts (A, B, C).

Estimation	STBIDF-M result (points) – possible results of odd Tasks (shaded grey from 0 to 4 points) & even Tasks (without shade 0 to 6)												$Index_{SBIDF-M}$ (points)	
	1		2		3		4		5		6			
	test	retest	test	retest	test	retest	test	retest	test	retest	test	retest	test	retest
Expert A														
x̄	2.43	2.27	2.67	2.53	1.93	1.77	2.37	1.80	2.00	1.73	2.57	2.13	13.97	12.23
SD	0.97	1.23	0.99	1.14	1.11	1.10	1.00	1.19	0.87	0.83	0.97	0.97	4.29	5.59
Min	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Max	4	4	4	4	4	3	4	4	3	3	4	4	20	18
Expert B														
x̄	2.43	2.2	2.7	2.47	1.97	1.8	2.4	1.87	2	1.73	2.6	2.2	14.1	12.27
SD	0.94	1.16	0.95	1.14	0.93	1.10	1.04	1.28	0.83	0.78	0.89	1.06	4.04	5.64
Min	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Max	4	3	4	4	3	3	4	4	3	3	4	4	20	20
Expert C														
x̄	2.43	2.2	2.8	2.47	1.93	1.83	2.43	1.9	2.07	1.77	2.63	2.2	14.3	12.37
SD	0.94	1.16	1.10	1.14	0.98	1.12	1.07	1.30	0.83	0.77	1.03	1.06	4.29	5.70
Min	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Max	4	3	5	4	3	3	4	4	3	3	5	4	20	20

Table 2. Estimation of overall task scores (total points) of STBIDF-M ('test-retest') after all experts corrections.

Estimation	STBIDF-M result (points) – possible results of odd Tasks (shaded grey from 0 to 4 points) & even Tasks (without shade 0 to 6)												Index$_{SBIDF-M}$ (points)	
	1		2		3		4		5		6			
	test	retest	test	retest	test	retest	test	retest	test	retest	test	retest	test	retest
x̄	2.43	2.23	2.8	2.47	1.93	1.77	2.4	1.87	2.03	1.73	2.63	2.2	14.23	12.27
SD	0.94	1.19	1.10	1.14	0.98	1.07	1.04	1.28	0.85	0.78	1.03	1.06	4.22	5.67
Min	1	0	1	0	0	0	0	0	0	0	0	0	4	0
Max	4	4	5	4	3	3	4	4	3	3	5	4	20	20
g1	−0.74	−0.87	−0.08	−0.74	−0.57	−0.40	−0.31	−0.05	−0.43	0.07	−0.18	−0.06	−0.54	−0.56
g2	−1.02	−0.69	−0.12	−0.27	−0.61	−1.04	−0.40	−0.97	−0.59	−0.53	0.74	−0.83	−0.67	−0.81
Spearman rank correlation	0.085		**0.319*^**		**0.526****		**0.519****		**0.651*****		**0.571*****		**0.494****	
Wilcoxon Signed-Rank Test	Z = 0.566 p = 0.568		Z = 1.432 p = 0.152		Z = −0.847 *p* = 0.395		Z = 2.295 *p* = **0.021***		Z = 2.118 *p* = **0.034***		Z = 2.106 *p* = **0.035***		*Z* = 1.982 *p* = **0.047***	

*p<0.05; **p<0.01; ***p<0.001; ^one-sided test

Table 3. Estimation of the scores (total points) of the STBIDF-M tasks of three physiotherapy students who repeated errors (identical IndexSBIDF-M) during the 'test-retest' procedure - 'stable' fraction (S).

Code/RP	Tasks of the 'test' stage							Tasks of the 'retest' stage						
	1	2	3	4	5	6	Index$_{SBIDF-M}$	1	2	3	4	5	6	Index$_{SBIDF-M}$
S1a	3	3	3	3	3	3	**18**	3	3	3	3	3	3	**18**
S1b	3	3	3	3	3	3	**18**	3	3	3	3	3	3	**18**
S2	1	1	1	1	2	2	**8**	1	1	1	1	2	2	**8**
x̄	2.33	2.33	2.33	2.33	2.67	2.67	14.67	2.33	2.33	2.33	2.33	2.67	2.67	14.67
SD	1.15	1.15	1.15	1.15	0.58	0.58	5.77	1.15	1.15	1.15	1.15	0.58	0.58	5.77
Min	1	1	1	1	2	2	8	1	1	1	1	2	2	8
Max	3	3	3	3	3	3	18	3	3	3	3	3	3	18

Table 4. Estimation of the scores (total points) of the STBIDF-M tasks of the twenty physiotherapy students who reduced errors during the 'retest' stage – the 'error-reducing' fraction (R).

Code/ RP	Tasks of the 'test' stage							Tasks of the 'retest' stage							Difference (−)
	1	2	3	4	5	6	Index$_{SBIDF-M}$	1	2	3	4	5	6	Index$_{SBIDF-M}$	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
R1	2	3	3	3	3	2	**16**	1	1	1	0	1	1	**5**	11
R2a	3	5	2	3	2	4	**19**	1	3	1	1	1	2	**9**	10
R2b	3	4	2	3	2	2	**16**	1	1	1	1	1	1	**6**	10
R3	2	2	2	2	1	1	**10**	0	0	0	0	1	1	**2**	8
R4	3	1	1	1	2	2	**10**	1	1	0	0	1	1	**4**	6
R5a	1	5	2	4	1	5	**18**	3	2	3	2	2	1	**13**	5

Table 4. Continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R5b	3	4	3	4	2	2	**18**	3	4	1	2	1	2	**13**	5
R5c	3	4	2	3	2	3	**17**	3	1	2	3	1	2	**12**	5
R5d	3	2	0	2	1	3	**11**	0	2	0	1	1	2	**6**	5
R5e	3	3	0	1	1	2	**10**	0	3	0	0	1	1	**5**	5
R6a	3	3	3	4	3	3	**19**	3	3	3	2	2	2	**15**	4
R6b	1	1	1	1	0	0	**4**	0	0	0	0	0	0	**0**	4
R7	3	3	3	3	3	3	**18**	3	3	2	2	2	3	**15**	3
R8a	3	3	3	4	3	4	**20**	3	3	3	3	3	3	**18**	2
R8b	3	3	1	2	1	2	**12**	2	2	2	2	1	1	**10**	2
R9a	4	3	3	3	3	3	**19**	3	3	3	3	3	3	**18**	1
R9b	3	3	3	3	3	3	**18**	3	3	3	3	2	3	**17**	1
R9c	3	3	3	2	2	2	**15**	3	3	2	2	2	2	**14**	1
R9d	3	3	2	2	2	3	**15**	3	3	2	2	2	2	**14**	1
R9e	3	2	2	0	1	1	**9**	2	2	2	0	1	1	**8**	1
x̄	2.75	3	2.05	2.5	1.9	2.5	14.7	1.9	2.15	1.55	1.45	1.45	1.7	10.2	4.5
SD	0.72	1.08	1.00	1.15	0.91	1.15	4.41	1.25	1.14	1.15	1.15	0.76	0.86	5.46	3.20
Min	1	1	0	0	0	0	4	0	0	0	0	0	0	0	1
Max	4	5	3	4	3	5	20	3	4	3	3	3	3	18	11
g1	−1.49	0.00	−0.81	−0.46	−0.25	0.00	−0.85	−0.51	−0.56	−0.14	−0.10	0.59	0.12	−0.23	0.72
g2	2.47	0.23	−0.24	−0.40	−0.85	0.60	−0.08	−1.50	−0.68	−1.38	−1.43	0.15	−0.73	−1.10	−0.38

Table 5. Estimation of the scores (total points) of the STBIDF-M tasks of the seven physiotherapy students who magnified errors during the ‘retest’ stage - the ‘error magnifying’ fraction (M).

Code/ RP	Tasks of the ‘test’ stage							Tasks of the ‘retest’ stage							Difference (+)
	1	2	3	4	5	6	$\text{Index}_{\text{SBIDF-M}}$	1	2	3	4	5	6	$\text{Index}_{\text{SBIDF-M}}$	
M1	1	3	2	2	2	3	**13**	3	4	3	4	2	4	**20**	7
M2a	1	1	1	3	3	3	**12**	3	3	1	4	3	4	**18**	6
M2b	1	3	0	2	1	2	**9**	3	3	2	2	2	3	**15**	6
M2c	1	1	1	1	2	3	**9**	3	3	3	1	2	3	**15**	6
M3	3	3	2	2	2	2	**14**	3	4	2	3	2	3	**17**	3
M4	3	4	2	3	2	4	**18**	4	4	2	4	2	4	**20**	2
M5	1	2	2	2	3	4	**14**	3	3	2	2	2	3	**15**	1
x̄	1.57	2.43	1.43	2.14	2.14	3	12.71	3.14	3.43	2.14	2.86	2.14	3.43	17.14	4.43
SD	0.98	1.13	0.79	0.69	0.69	0.82	3.15	0.38	0.53	0.69	1.21	0.38	0.53	2.27	2.37
Min	1	1	0	1	1	2	9	3	3	1	1	2	3	15	1
Max	3	4	2	3	3	4	18	4	4	3	4	3	4	20	7

collision errors during a simulated fall was observed by all experts. This provides important empirical evidence. The sponge motor modification is shown to be a highly effective methodological innovation (Table 6).

Discussion

The aim of this study was to verify the reliability and objectivity of the modified susceptibility test for body injuries during a fall (STBIDF-M). The results demonstrated a statistically significant reduction in

Table 6. Mean score and SD corresponding to the susceptibility of the predetermined parts of the body to injuries in physiotherapy students (n = 30).

Stage	Body parts in STBIDF-M tasks (points)																				
	Task 1			**Task 2**				**Task 3**			**Task 4**				**Task 5**			**Task 6**			
	hips	**arms**	**head**	**legs**	**hips**	**arms**	**head**	**hips**	**arms**	**head**	**legs**	**hips**	**arms**	**head**	**hips**	**arms**	**head**	**legs**	**hips**	**arms**	**head**
Expert A																					
Test	**0.07** ±0.25	**1.43** ±0.9	**0.93** ±0.25	**0.17** ±0.38	**0.03** ±0.18	**1.57** ±0.82	**0.9** ±0.31	**0.03** ±0.18	**1.3** ±0.88	**0.6** ±0.5	**0.3** ±0.47	**0.03** ±0.18	**1.4** ±0.86	**0.63** ±0.49	**0.03** ±0.18	**1.33** ±0.61	**0.63** ±0.49	**0.3** ±0.53	**0.07** ±0.25	**1.47** ±0.57	**0.73** ±0.45
Retest	**0.13** ±0.35	**1.33** ±0.92	**0.8** ±0.41	**0.23** ±0.43	**0.03** ±0.18	**1.43** ±0.86	**0.83** ±0.38	**0.07** ±0.25	**1.13** ±0.94	**0.57** ±0.5	**0.23** ±0.43	**0.03** ±0.18	**1.07** ±0.94	**0.47** ±0.51	**0.07** ±0.25	**1.27** ±0.69	**0.4** ±0.5	**0.3** ±0.47	**0.03** ±0.18	**1.3** ±0.65	**0.5** ±0.51
Difference	0.07	0.1	0.13	0.07	0	0.13	0.07	0.03	0.17	0.03	0.07	0	**0.33***	0.17	0.03	0.07	**0.23***	0	0.03	0.17	**0.23***
Expert B																					
Test	**0.03** ±0.18	**1.47** ±0.9	**0.93** ±0.25	**0.2** ±0.41	**0.03** ±0.18	**1.57** ±0.82	**0.9** ±0.31	**0.03** ±0.18	**1.3** ±0.88	**0.63** ±0.56	**0.3** ±0.47	**0.03** ±0.18	**1.4** ±0.86	**0.67** ±0.48	**0.03** ±0.18	**1.33** ±0.55	**0.63** ±0.49	**0.3** ±0.53	**0.03** ±0.18	**1.5** ±0.57	**0.77** ±0.43
Retest	**0.07** ±0.25	**1.33** ±0.92	**0.8** ±0.41	**0.2** ±0.41	**0.03** ±0.18	**1.4** ±0.86	**0.83** ±0.38	**0.07** ±0.25	**1.17** ±0.95	**0.57** ±0.5	**0.23** ±0.43	**0.03** ±0.18	**1.1** ±0.96	**0.5** ±0.51	**0.07** ±0.25	**1.23** ±0.68	**0.43** ±0.5	**0.3** ±0.47	**0.03** ±0.18	**1.33** ±0.66	**0.53** ±0.51
Difference	0.03	0.13	0.13	0	0	0.17	0.07	0.03	0.13	0.07	0.07	0	0.3	0.17	0.03	0.1	**0.2***	0	0	0.17	**0.23***
Expert C																					
Test	**0.03** ±0.18	**1.47** ±0.9	**0.93** ±0.25	**0.27** ±0.58	**0.03** ±0.18	**1.57** ±0.82	**0.93** ±0.25	**0.03** ±1.18	**1.3** ±0.88	**0.6** ±0.5	**0.33** ±0.55	**0.03** ±0.18	**1.4** ±0.86	**0.67** ±0.48	**0.03** ±0.18	**1.37** ±0.56	**0.67** ±0.48	**0.37** ±0.61	**0.03** ±0.18	**1.5** ±0.57	**0.73** ±0.45
Retest	**0.07** ±0.25	**1.33** ±0.92	**0.8** ±0.41	**0.2** ±0.41	**0.03** ±0.18	**1.4** ±0.86	**0.83** ±0.38	**0.07** ±0.25	**1.17** ±0.95	**0.6** ±0.5	**0.27** ±0.45	**0.03** ±0.18	**1.1** ±0.96	**0.5** ±0.51	**0.07** ±0.25	**1.27** ±0.64	**0.43** ±0.5	**0.3** ±0.47	**0.03** ±0.18	**1.33** ±0.66	**0.53** ±0.51
Difference	0.03	0.13	0.13	0.07	0	0.17	0.1	0.03	0.13	0	0.07	0	0.3	0.17	0.03	0.1	**0.23***	0.07	0	0.17	**0.2***

*p<0.05

errors during the retest stage, particularly in tasks involving head-on collisions. This indicates the effectiveness of the sponge motor modification as a methodological improvement in reducing injury risk during simulated falls.

Both the STBIDF-M [5] and its original version, the three-task STBIDF [11], are unique tools for measuring a phenomenon that has only recently begun to be explored [8]. In the classic study of reliability using the 'test-retest' method for non-motor psychological and pedagogical tests, it is generally expected that the original results will be confirmed after several days of repeated testing under identical experimental conditions. Whether or not these expectations are met is documented by the correlation coefficient (r) value. However, these tests, which measure the SFI phenomenon, incorporate motor modifications of increasing difficulty.

At the methodological core of these modifications are three partly enthymematic assumptions. First, pressing the sponge with the chin to the chest and clapping the hands should reduce errors during hand-head collisions. In Task 2 of the STBIDF, the instructions state: "From the vertical posture, press the sponge with the chin to the chest, on the command READY start clapping hands, and on the command GO lie on your back again" [11]. Secondly, increasing the coordination difficulty of each successive task can be counterproductive for some individuals. For example, in Task 3 of the STBIDF (the final task), participants perform the same actions as in Task 2 but with the added challenge of a backward jump from a 20 cm elevation. Thirdly, some individuals exhibit stable motor responses during ground collisions resulting from falls. The continuum of responses ranges from an absence of errors during these motor simulations to the maximum accumulation of both quantitative and qualitative errors.

Therefore, it makes sense to categorize participants into three groups: 'stable' (those who either consistently make errors or correctly protect distal body parts despite the increasing difficulty of the conditions under which a fall is inevitable); 'reducers' (those who show a reduction in errors related to distal body parts colliding with the ground during a fall under laboratory conditions, either completely or to a limited extent); and 'augmenters' (those who demonstrate an increase in such errors during a simulated backward fall). The results of studies to date have shown that individuals classified as 'stable' in the extremely positive sense ($Index_{SBIDF-M}$ = 0 points each time) are rare [13]. This pertains only to diagnostic testing, not to the intervention programme stage. A different case is that of a student who was diagnosed with an IndexSBIDF of 14 points before the one-year experiment and, after the experiment, showed a reduction of all errors [28]. This is an isolated example of an extremely positive case among the 'reducers'.

We were inspired to make this division by the results of the study by Gąsienica Walczak and A. Kalina [13]. The authors found that among 213 physiotherapy and physical education students, 160 (75.12%) had suffered injuries as a result of a fall. In this group, 14 students (8.75%) with a history of traumatic falls made a series of errors involving four observed body parts during the three STBIDF tasks. Since the test consists of three tasks and four body parts are observed, the number 12 is typically associated with the quantitative evidence of a set of errors for those unfamiliar with the details. However, the evaluation of errors involving the legs, although observed in each of the three tasks, is only documented by the results of Task 3 in the STBIDF [8,11]. Therefore, the number 10 may or may not serve as empirical evidence of a complete set of errors. "Maybe" because errors involving the hands, observed in each of the three tasks, can be documented with two points (6 in total), and errors with the legs, one at a time, result in 2 points, leaving only 2 points missing for a total of 10. Since errors involving the hips and head are evaluated three times using the "zero-one" scoring system, this combination of scores indicates that the person did not make an error on four occasions.

Only a score of 14 points ($Index_{SBIDF}$) serves as evidence of complete errors in both a quantitative and qualitative sense. The quantitative assessment of this score indicates "complete repeatability of errors", while the qualitative assessment suggests "resistance to motor modification and impaired cognitive functions". This qualitative assessment was also assigned by the researchers to six students who scored 13 points on the $Index_{SBIDF}$. However, these students differ from the others in their quantitative assessment, which revealed a "higher weight of first-degree errors (61.54%)". Two students with an $Index_{SBIDF}$ score of 12 points quantitatively demonstrated a "moderate dominance of first-degree errors (80%)", while qualitatively showing "very low cognitive-behavioral potential". For three students with an $Index_{SBIDF}$ score of 11 points, the quantitative assessment indicated a "dominance of first-degree errors (90%)", and the qualitative assessment reflected their "cognitive-behavioral limitations" [13].

The results of the study by Gąsienica Walczak and A. Kalina [13] were not derived from a 'test-retest' procedure, so it is impossible to hypothesize about the repetition of these characteristics (profiles) within a short time interval. On the other hand, the published results of the STBIDF 'test-retest' procedure, based on the observations of 35 students, do not provide information about the proportions of individuals according to the proposed breakdown [12]. However, it is known that in that validation procedure, two experts observed a maximum IndexSBIDF score of 14 points during the 'test' stage. There is no data available to determine whether this was an isolated result or if it applied to other individuals as well. During the 'retest' stage, two experts again reported a maximum score of 14 points, but the final consensus was 12 points. This adjustment still does not clarify whether the maximum score (or any score of 14 points) from the 'test' stage is related to the 12-point score from the 'retest' stage.

Here, we highlight the omission of the number of observations related to extreme outcomes in the available estimations. Litwiniuk [29] and Litwiniuk et al. [30,31] provided examples illustrating the importance of this information when selecting individuals for various intervention groups (such as rescue teams, police, military, etc.). These groups often consist of individuals with different ages, genders, and specific competencies across various fields, but with a desired similarity in motor potential.

Valuable, though general, knowledge about the effect of motor modifications in successive STBIDF tasks on the cognitive-behavioral domain of the subjects was provided by the correlation coefficients of tasks repeated 7 days apart. These correlation values are higher than those found in our study: task one r = 0.816, task two r = 0.772, task three r = 0.572, and $Index_{SBIDF}$ r = 0.865 [12].

The decreasing r-values are a consequence of the motor modifications and, combined with the lower arithmetic means of the sum of errors for each task and the overall STBIDF score during the 'retest', suggest a trend toward error reduction. It is not surprising that the error-reduction process proved to be relatively slow, as 'self-education' using the STBIDF involves only two motor modifications during three simulated backflips under laboratory conditions – each time the test is applied [12]. Our validation results provide evidence that augmenting the motor modifications with three additional tasks, compared to the original STBIDF structure, has a statistically significant error-reducing effect starting from Task 5 in the STBIDF-M. Statistically significant differences in the mean scores of Task 5 and Task 6 were unanimously confirmed by all experts.

The authors of the STBIDF 'test-retest' procedure [12] did not report the proportions of students classified as 'stable', 'reducing', or 'increasing'. Our analysis of repeated 'test-retest' STBIDF-M scores revealed two students (S1a and S1b) with identical profiles in terms of total scores and their structure ($Index_{SBIDF-M}$ = 18 points), and one student (S2) with an $Index_{SBIDF-M}$ score of 8 points (r = 1). In the group of students 'augmenting errors', we found two identical $Index_{SBIDF-M}$ profiles: a male student (M2b, 21 years old) and a female student (M2c, 20 years old), with scores of 9 points in the 'test' stage and 15 points in the 'retest' stage. While the low positive correlation (r = 0.265) between their profiles in the 'test' stage was not statistically significant, the correlation in the 'retest' stage was significant (r = 0.640, $p<0.05$).

The examples of different outcome calculations cited here demonstrate the multifaceted nature of these phenomena, while also highlighting their significant cognitive potential.

The aim of the 'test-retest' procedure, in the standard sense, is not to establish the proportions of individuals by the error criterion (or lack thereof) mentioned above, nor to correlate the profiles of individuals with identical initial characteristics. However, the results of our validation procedure provide evidence that a meaningful synthesis can be achieved through a complementary approach [7,32]. Thus, the STBIDF-M meets methodological expectations by identifying individuals according to their sensitivity to motor modifications related to personal safety [33,34]. In this regard, it is an innovative tool in the fields of health prevention and survival in the broadest sense. On one hand, SFI profiles based on this methodology can be applied to the design of intervention programmes that follow the pedagogical principle of individualisation. On the other hand, it allows for the prediction of potential injuries resulting from unintentional falls.

Conclusions

The results of this 'test-retest' procedure highlight the unique and non-standardised opportunities for analyzing and synthesizing outcomes using this fundamental method. This was made possible by the innovative motor structure of the STBIDF-M, which extends beyond methodological advancements. Observations of the unconscious behaviors and actions of participants provide valuable insights into cognitive and intellectual phenomena related to human personality. We recommend that the authors of STBIDF and STBIDF-M (as they possess the raw data) conduct a secondary analysis and synthesis of the collected empirical data to further enrich this understanding.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

1. The Global Burden of Disease. *Generating Evidence, Guiding Policy*. Washington: Institute For Health Metrics and Evaluation, University of Washington; 2013.
2. Finchley Memorial Day Hospital. *Information on falls. For patients and carers*. London: Produced by the staff at the Falls Clinic FMH; 2005.
3. Dobosz D, Barczyński BJ, Kalina A, Kalina RM. The most effective and economic method of reducing death and disability associated with falls. *Arch Budo,* 2018; 14: 239–246.
4. Iermakov S, Podrigalo L, Podrigalo O, Yermakova T, Jagiełło W. Means and methods of physical activity in the context of prevention and treatment of Alzheimer's disease (analysis of Russian-language scientific resources) and the perspective of implementing the unique achievements of the "Polish School of Safe Falling". *Arch Budo,* 2022; 18: 121–143.
5. Gąsienica-Walczak B, Kalina RM. Validation of the new version of "the susceptibility test to the body injuries during the fall" (STBIDF-M). *Arch Budo,* 2021; 17: 371–400.
6. Kalina R, Kalina A. Three methods of prophylaxis and therapy of innovative agonology, important from the perspective of personal safety. *Arch Budo Sci Martial Arts Extreme Sports,* 2020;16:7–15.
7. Kalina RM, Kruszewski A. INNOAGON is an acronym for 'innovative agonology', but is not synonymous with 'science of martial arts'. *Arch Budo,* 2023; 19: 193–204.
8. Kalina RM. Soft landing. *Medical Tribune,* 2009; 7(13): 28–29 (In Polish).
9. Jaskólski E, Nowacki Z. *Teoria, metodyka i systematyka miękkiego padania. Część I. Teoria miękkiego padania* [Theory, methodology and systematics of soft fall. Part I. The theory of soft fall]. Wrocław: WSWF; 1972: 83-88 (in Polish).
10. Mroczkowski A. Motor safety of a man during a fall. *Arch Budo,* 2015; 11.
11. 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); 203–216.
12. Klimczak J, Oleksy M, Gąsienica-Walczak B. Reliability and objectivity of the susceptibility test of the body injuries during a fall of physiotherapy students. *Physical Education of Students,* 2022; 26(1): 4–10. https://doi.org/10.15561/20755279.2022.0101
13. Gąsienica-Walczak B, Kalina A. Predictive validity of STBIDF (the susceptibility test to the body injuries during the fall) – two methodological aspects. *Arch Budo Sci Martial Art Extreme Sport,* 2023; 19: 219–246.
14. Boguszewski D, Kerbaum K. Judo training as a means of reducing susceptibility to injury during falls. *Polish Journal of Sports Medicine,* 2011; 27(3): 205–212. https://doi.org/10.5604/1232406X.971228
15. Boguszewski D, Zabłocka Adamczyk JG. Podatność na uszkodzenia ciała podczas upadku dzieci niewidomych. *Postępy Rehabilitacji,* 2012; 26(2): 63–70. https://doi.org/10.2478/rehab-2013-0039 (in Polish).
16. Boguszewski D, Adamczyk JG, Kerbaum K, Antoniak B, Obszyńska-Litwiniec A, Białoszewski D. Susceptibility To Injury During Falls In Women Practising Combat Sports And Martial Arts. *Polish Journal of Sport and Tourism*, 2015;22(1): 15–19. https://doi.org/10.1515/pjst-2015-0009
17. Mosler D. Changes of susceptibility of body injuries during a fall of patients with mental impairment participating for several months in special cognitive-behavioral therapy. In: Kalina RM (ed). *Proceedings of the 1st World Congress on Health and Martial Arts in Interdisciplinary Approach, HMA 2015*, 17–19 September 2015, Czestochowa, Warsaw, Poland. Warsaw: Archives of Budo; 2015. P. 196–8.
18. Mroczkowski A, Sikorski MM. The susceptibility to body injuries during a fall and abilities related to motor coordination of children aged 10 to 12. *Arch Budo Sci Martial Art Extreme Sport,* 2015; 11: 65–71.
19. Boguszewski D. *Zdrowotne aspekty sportów i sztuk walki* [Health aspects of martial arts and sports]. Warsaw: Medical University of Warsaw; 2017 (in Polish).
20. Mroczkowski A, Mosler D, Gemziak EP. Relation between knowledge about assessment criteria of susceptibility test of body injuries during a fall and body control during the test. *Arch Budo Sci Martial Art Extreme Sport,* 2017; 13: 55–61.
21. Bąk R. Relationship the body balance disturbation tolerance skills with susceptibility to the injuries during the fall of young women and men. *Arch Budo Sci Martial Art Extreme Sport,* 2018; 14: 189–196.
22. Boguszewski D, Adamczyk JG, Ochal A, Białoszewski D. Relationships between susceptibility to injury during falls and physical fitness and functional fitness of musculoskeletal system. Pilot study. *Arch Budo Sci Martial Art Extreme Sport,* 2018; 14: 197–204.
23. Kalina RM, Mosler D. Risk of Injuries Caused by Fall of People Differing in Age, Sex, Health and Motor Experience. In: Ahram T (ed.) *Advances in Human Factors in Sports, Injury Prevention and Outdoor Recreation*, Cham: Springer International Publishing; 2018. P. 84–88. https://doi.org/10.1007/978-3-319-60822-8_8
24. Mroczkowski A. Susceptibility to fall injury in students of Physical Education practising handball. *Arch Budo Sci Martial Art Extreme Sport,* 2018; 14: 109–115.
25. Mroczkowski A. Susceptibility to Head Injury during Backward Fall with Side Aligning of the Body. *Appl Sci,* 2020; 10(22): 8239. https://doi.org/10.3390/app10228239
26. Błach W, Dobosz D, Gasienica-Walczak B, Grants J, Litwiniuk A. Falls are the Leading Cause of Injuries among Farmers Limitations of Practicing Judo in Preventing These Incidents. *Appl Sci,* 2021; 11(7324): 1–13. https://doi.org/10.3390/app11167324
27. Blach W, Malliaropoulos N, Rydzik Ł Bikos G.,

Litwiniuk A, Grants J, Ambroży T, Maffulli M. Injuries at World and European judo tournaments in 2010-2012. *Arch Budo*, 2021; 7: 127–133.
28. Gąsienica-Walczak B, Barczyński BJ, Kalina RM. Evidence-based monitoring of the stimuli and effects of prophylaxis and kinesiotherapy based on the exercises of safe falling and avoiding collisions as a condition for optimising the prevention of body injuries in a universal sense – people with eye diseases as an example of an increased risk group. *Arch Budo,* 2018; 13: 79–95.
29. Litwiniuk A. Conditioning and coordination motor abilities of combat sports athletes. *Arch Budo Sci Martial Arts Extreme Sport,* 2023;19: 169–177.
30. Litwiniuk A, Bąk R, Chodała A. Profiles of general physical fitness of young men training in combat sports. *Arch Budo,* 2023; 19: 287–297.
31. Litwiniuk A, Gąsienica Walczak B, Jagiełło W, Kruszewski A. Body balance disturbation tolerance skills combat sports athletes and people with other motor experiences in dynamically changing circumstances in own research – a perspective for predicting personal safety during real-life performance in extreme situations. *Arch Budo,* 2023;19: 41–49.
32. Kalina RM. Methodology of complementary research as the basis for integrating science in fulfilling its social mission in the future. *Arch Budo,* 2023; 19.
33. Litwiniuk A, Grants J, Waldzinski T. Professional competences of personal trainers. *Arch Budo Sci Martial Art Extreme Sport,* 2020; 16: 79–84.
34. Kruszewski A, Litwiniuk A. The importance of the quality of education of personal trainers from the perspective of personal security. *Arch Budo Sci Martial Arts Extreme Sports*, 2021; 17: 197–202.

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