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Relation between knowledge about assessment criteria of susceptibility test of body injuries during a fall and body control during the test

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
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Andrzej Mroczkowski[1ABCDE], Dariusz Mosler[2CD], Ewa Paulina Gemziak[3B]

[1] Department of Sport and Health Promotion, University of Zielona Góra, Zielona Góra, Poland
[2] Institute Physical Education, Tourism and Physiotherapy, Jan Dlugosz University, Czestochowa, Poland
[3] Faculty of Physical Education and Health Preservation, State University of Applied Sciences in Konin, Konin, Poland

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Abstract

Background & Study Aim: Fall is one of leading cause of unintentional injuries and may lead to temporary or permanent disability. Susceptibility test of body injuries during a fall (STBIDF) was designed to assess subconscious way of body control during a dynamic change of the vertical posture towards lying on your back. Recent studies did not reveal, whether being familiar with assessment criteria is changing the way of body control during this test. The aim of the study is knowledge if familiarity with assessment criteria of this non-apparatus test influence its results.

Material & Methods: The study was conducted on a group of 37 female participants, who was physiotherapy students in State University of Applied Sciences in Konin in 2016. Age of participants ranged from 20 to 23 years. STBIDF was applied twice with an interval of 2 weeks. The first test (T1) was conducted accordingly to its methodology. Before second test (T2), participants acquire knowledge about assessment criteria.

Results: Results differs significantly between T1 and T2 for the sum of points, as well as for errors in control over hands and head. The highest repeatability of motor habits was shown for control over hands in task II (89%), while the lowest for control over head in task III (59%).The highest persistence of committed errors was shown for control over head in task II (79%), while the lowest for control over hips task I and III (17%).

Conclusions: It was proven that knowledge about assessment criteria influence results of STBIDF. Nevertheless, participants did not correct all of their errors, especially persistence of errors in control over head is proof of the diagnostic value of this test in detecting such bad motor habits, which early detection and correcting may prevent possible injuries.

Keywords: injury prevention • non-apparatus test • safe fall • sensorimotor striatum

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Author's address: Andrzej Mroczkowski, Department of Sport and Health Promotion, Zielona Góra University, Wyspiańskiego 58 Str., 65-178 Zielona Góra, Poland; e-mail: a.mroczkowski@wlnz.uz.zgora.pl

Injury mechanism – *noun* the way in which a casualty sustained his or her injury, e.g. in a fall or collision, which may help with diagnosis and treatment decisions unit [37].

Sensorium – *noun* **1.** the sensory components of the brain and nervous system that deal with the receiving and interpreting of external stimuli **2.** all the sensory functions in the body, considered as a single unit [37].

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 [34].

Quasi-apparatus test – can be conducted with simple instruments (a stopwatch, a ruler, a measuring tape, etc.) [34].

Global science space – conventionally, the global science space is associated with the ability to provide the latest scientific knowledge through prestigious electronic scientific journals [29].

INTRODUCTION

The increased amount of created fall prevention programs, as well as increased interest among scientist and governments, highlights how falls are seen as dangerous phenomena [1]. Among many developed countries, there is an increase in a number of elderly and people with different kinds of disabilities, which is one of the factors that put them in a group of a higher risk of injuries due to a fall [2]. Injuries due to a fall also occur during increased physical activity like work or sport, among all age groups [3].

Fall prevention programs focus on improving gait quality and overall physical fitness of elderly, which could reduce the number of falls, but it cannot eliminate it completely [4]. Other programs focus on safety, as eliminating dangerous factors from the environment, replace surfaces with better materials or wearing special equipment or uniforms [5, 6]. None of those programs can eliminate every possibility of injuries caused by fall. Therefore, the idea of safe falling techniques was developed, based on techniques used in martial arts, mostly from judo [7]. The idea of teaching safe falling is basing on principle, that every person, who can move are prone to injury due to a fall, to some degree. In the same time, every person can improve their safety by reducing the possibility of injury due to a fall in proper body control and proper motor habits during a fall.

To diagnose improper motor habits, which may lead to injury during a fall, susceptibility test of body injuries during a fall (STBIDF) were designed [8]. Its construction allows determining, which body parts are most prone to injury during backward fall. During for example slip, which is common situation that leads to backward fall, people often do not lower their bodies by bending knees and fall on straight or partially bend legs which may cause injuries in the area of pelvis [9, 10]. During such phenomena, people may try to protect themselves by supporting with straight hands, which often led to injuries of hands, wrists or forearms [11]. Another crucial part of the body is head [12]. The motor habit of bending head and sticking chin to a trunk prevents from hitting it on the ground. Weak muscle or improper habits leads to severe head injuries or even deaths. While falling from height and landing on the legs also may be dangerous [13]. To some height, it is possible to land safely, but landing on straight legs may end up with broken bones. All presented parts alongside with the threats are assessed during STBIDF. During three tasks, motor habits are diagnosed, and the results indicate where a person is committing errors and the way of it correction during the teaching of safe fall techniques.

Motor habits are involuntary, a subconscious way of performing the different motor task. This phenomenon is subconscious [14]. The way people perform their action is related to many environmental and behavioural factors. Person's physiology, undergone motor activity in the past, learned skills, the area of living etc. is affecting human motor behaviour. Motor habits are deeply rooted in the sensorimotor striatum, as obtained patterns of sensory-motor habits in the human brain. They are hard to change or eliminate [15].

Most tested people using STBIDF present bad habits while performing different tasks, on different severity. There were some studies, where participants were tested before and after intervention composed of learning safe fall techniques. Precursory in this kind of intervention was presented in validation article for this test, where alongside with motor learning, there was a cognitive explanation of testing criteria and theory behind safe fall techniques [8]. However, there was no intervention, which checks, how cognitive factors like knowing the criteria for testing, affects its performance by participants.

Therefore, the aim of this study is knowledge, whether or to what degree, knowing assessment criteria of STBIDF affects results, therefore.

MATERIAL AND METHODS

Participants

The study was conducted in State University of Applied Sciences in Konin in 2016. There were 37 female participants, who attend physiotherapy studies. Their age ranged from 20 to 23 years.

Assessment criteria

Susceptibility test of body injuries during a fall (STBID) is performed on the mattress. It is composed of three different tasks. During each task, control and errors during performing each task are assessed, accordingly to assumed criteria. When a person commits an error during each

task for a different body part, points are granted. During all test, control of four body parts is assessed. The first one in the chart is control over legs (occurrence only while performing task III), then hips, hand and head. For lack of mistake there are no points, for first-degree error one point is given, and two points for second-degree error. All points are written down on the special chart (Table 1).

The first task is starting with a command "lie down safety as fast as you can", then on a mark, a person is expected to lie down on a back. During this task, body control over hips, hand and head are assessed. If a person does not the lower body and bend knees to an angle of 90 degrees in the assessment of knee flexion, and hits mattress with the pelvis, one point is given as an error. If participant supports himself on the mattress while lying down with one hand, one point is given, and two points when he uses both hands. Head should tuck to a chin and do not touch mattress until the end of the task. Otherwise, one point is given. In this maximum task number of points (errors) is 4.

In the second task, a person is asked to hold sponge on chest using chin during the whole task. Losing sponge or holding it with hands is considered as error over head control. Meanwhile, on a command, a person is supposed to start clapping with hands. After that, again there is a command to lie down with the same formula. When a person stops clapping or supports with one hand, one point is given. Supporting with both hand while lying down is considered as a second-degree error (2 points). Hips criteria remain the same. A maximum number of errors (points) is 4.

During the third task, a person starts standing on a platform, which is 15 cm height. On the back, there is the mattress. A person is asked to jump down backwards on the mattress and lie down immediately after landing, alongside with clapping and holding the sponge in the same manner as in the second task. All assessment criteria from the second task remain the same. Assessment of leg control is added. Peron is given one point while landing on one leg only. Two points are given when person land on straight legs or if the interval between landing and starting to lower body is longer than one second. A maximum number of points for errors is 6.

To sum up, the participant can get 14 points for errors from all tasks. Susceptibility to body injuries during a fall (SBIDF) is divided into four levels " low (0 points); average (1-3 points); high (4-8 points), very high (9-14 points). During all task, a maximum number of error over control of legs is 2 points, 3 points for hips and head and 6 points for hands. Results were documented in the special form [8].

Study composition

Participants undertook STBIDF twice in an interval of two weeks. The first test was conducted accordingly to the original instruction of test (T1), where participants are not aware of assessment criteria of the test [8]. Before the second trial, all assessment criteria were presented (on the day of the research). After that, second test (T2) were conducted.

RESULTS

Mean overall result of SBIDF in the first task was 4.189, while in the second test it was reduced to 2.811. In every case, the mean value of results shown by participants was lower in the second test. While statistical significance between result was shown in the first, ask for hands and head, separately in another task only results of head errors was significant in all cases. For sum of results, the difference between hand and head error was significant, as well as for sum of points. Mean for the sum of head errors were higher than for hand errors (2.351 reduced to 1.703 for the head in comparison to 1.324 reduced to 0.757) (Table 1).

For all tasks together, errors in control over hips were reduced by 5 participants (13.5%), while 3 of them (8%) committed more errors during the second test. Fifteen out of 37 participants (40.5%) reduced the number of errors in control over hands in the second test. Five participants (13,5%) committed more errors or the same number of errors. Out of 37 participants, 15 reduced their errors in control over head (40.5%). Alongside, 16 out of 37 participants committed the same amount or more errors (43.2%). In case 9 out of 37 participants (24,3%), the result of SBIDF remain the same or was higher in the second test.

Participant showed strong repeatability of results

Table 1. Results of t-Student for dependent samples between first (T1) and second test (T2) of each task and total results (sum of points) of SBIDF women surveyed (n = 37).

Body part	Mean the standard deviation		Difference	t-Student for dependent samples	
	Test 1	Test 2		t	p-value
Task I					
hips	0.162 ±0.374	0.054 ±0.393	0.108	1.672	0.103
hands	0.838 ±0.986	0.351 ±1.017	**0.486**	**2.909**	**0.006**
head	0.730 ±0.450	0.486 ±0.597	**0.243**	**2.480**	**0.018**
Task II					
hips	0.189±0.397	0.081 ±0.393	0.108	1.672	0.103
hands	0.135 ±0.419	0.162 ±0.440	0.027	0.374	0.711
head	0.757 ±0.435	0.541 ±0.417	**0.216**	**3.151**	**0.003**
Task III					
hips	0.162 ±0.374	0.081 ±0.433	0.081	1.138	0.262
hands	0.351 ±0.676	0.243 ±0.658	0.108	1.000	0.324
head	0.865 ±0.347	0.676 ±0.518	**0.189**	**2.220**	**0.033**
legs	0.270 ±0.450	0.135 ±0.481	0.135	1.709	0.096
All tasks					
hips	0.514 ±1.070	0.216 ±1.051	0.297	1.721	0.094
hands	1.324 ±1.492	0.757 ±1.425	0.568	2.423	0.021
head	2.351 ±1.033	0.703 ±1.136	0.649	3.474	0.001
legs	0.270 ±0.450	0.135 ±0.481	**0.135**	**1.709**	**0.096**
Sum of points	4.189 ±2.559	2.811 ±2.385	**1.378**	**3.516**	**0.001**

for legs and hips errors (or lack of it). The best repeatability were shown during the assessment of hand errors in task II, which value rises to 89%. The poorest results of repeatability were shown in task 1 (lowest value for the head errors), and the highest was shown in task II. For sum of tasks, the poorest repeatability was shown for hand errors, and equally the highest values were for legs and hips errors (73%) (Table 2).

Among all participants, the less persistent error where shown for hips (13% in overall result), while the most persistent error was for head errors, up to 72% in task III and 58% in overall results (Table 3).

DISCUSSION

Despite the overall reduction in a mean indicator of SBIDF for a group of participants, not all of them a reduced number of errors, in different areas. In some cases, the result was even higher than in the first task. Lack of statistical difference

Table 2. Repeatability (%) of results obtained by the participant (n = 37) for each task and sum of all task in STBIDF.

Body part	Tasks STBIDF			All tasks
	I	II	III	
legs	-	-	73	73
hips	73	86	81	73
kands	65	89	81	51
head	59	78	73	57

Table 3. Proportion (%) of participants (n = 37), who do not correct their errors during the second test (committed the same amount or more errors).

Body part	Tasks STBIDF			All tasks
	I	II	III	
legs	-	-	20	20
hips	17	29	17	13
hands	31	50	44	25
head	56	71	72	58

in comparison of some body parts control may be caused by only two points of assessment, which is hard to detect changes in statistical computing. During this test, authors observe, that some participants lower they body more (higher knee flexion) during the second test, but this improved cannot be shifted onto assessment chart, as there is 0 and 1 condition for hip control errors, making improvement hard to distinguish. Errors of hands control are represented by a higher number of points, which may be a reason why differences were significant. However, for errors of head control, criteria were similar to hips or legs control assessment, and yet it showed the statistical difference of result. It is a proof that sole understanding of assessment criteria may be enough to improve the result of this test, without any safe fall training. On the other hand, there was average and good repeatability of results, despite changed criteria of the test in the second trial. This indicates that motor habits are strong for people who commit errors and at the same time, people who present proper control during the performed task, repeat it in the second test. This indicates satisfying repeatability of a test.

The proportion of errors, where presented by participants errors of body control remains on the same level or were even higher is most exposed during the assessment of head control. Even with a handicap like holding sponge were not enough to eliminate errors completely. During backward falling, head acquires the biggest velocity among all body parts in a moment of collision of the body with a ground [16]. The method based on using a sponge to help control head during performing a motor task like in STBIDF also find usage during training of athletes who perform jumps on a trampoline [17]. Holding sponge is more complex task than simply tucking chin into a chest. Losing sponge even when the participant is aware of mistake is proof of persistence of improper motor habit, and it is big threat of injuries while falling during accidental fall or while performing different sports activities, such as jumps on the trampoline. During such activity, proper neck and head align and tucking chin to a chest is essential to prevent injury while falling backwards, as well as to observe surroundings to land within restricted area properly.

For control of a head, hands and hips, participants were shown the worse repeatability of results and at the same time the best error correction. The second and third task is more complicated. With the proper coordination skills and strength, the applied motor task was supposed to help to lie down without committing any errors. Good repeatability of results proved it, but if a condition of proper coordination and skills are not met, errors cannot be corrected. It was proven by results, when for hands or head control errors, participant shown repeatability of errors from around 50 to 70%.

According to WHO definition, fall is a phenomenon, when person change position from vertical to horizontal unwillingly. Both in case of a surface on the same level and change from higher to lower surface [18]. Sticking to this definition, during the assessment of STBIDF, fall does not occur, as all task are performed voluntarily, after the command to "lie down safety". However, it detects to some degree motor habits during the performance of fast motor tasks, because for a significant amount of participants, errors could not be corrected even after knowledge about assessment criteria. However, primary results indicate a correlation between STBIDF results and results of a test using *rotating training simulator* [19]. This simulator is forcing a fall because of inertia force applied to the participant after sudden stopping of the device, on which participant is standing and moving in a circle (rotating on the simulator) [20].

Results of this study are confirmed by other interventions, where participants reduced their SBIDF indicator, but do not eliminate all errors even after long training [21, 22]. This indicates the persistence of bad motor habits which may lead to injury, and even prolonged interventions with a cognitive explanation of safe fall rules are not enough.

Modern physical education in Polish schools does not include teaching proper motor habits of safe falling for children [16]. It was confirmed by a pilot study of children in age from 10 to 12 years old, which present average SBIDF indicator [23]. As injury prevention during a falls is understand here as correcting bad motor habits and improving physical fitness, martial arts and fun forms of martial arts [24], understand as non-traditional forms of activity [25]. Martial arts, safe fall techniques have an origin, seems to be a correct starting point as well as life-time interventions for improving quality of life [26] and self-protection [27].

A unique mission in this area is fulfilled by prophylactic and therapeutic agonology (innovative agonology) [28], promoted since 2015 in global science space [29, 30]. Innovative agonology combines the heritage of martial arts with the diagnostic capabilities of modern technology [19, 20, 31] and by no means limited to the safe fall [32, 33]. Combining these technological possibilities with non-apparatus [3, 8, 21, 34, 35] and quasi-apparatus test [36] opens up optimistic, broad perspectives of cognition and applications.

CONCLUSIONS

Knowledge about assessment criteria of STBIDF has a significant influence on results of the test. STBIDF can detect motor habits during its performance to some degree because a significant part of participants commits error despite knowing how to perform the test correctly. High persistence of committing the error of controlling head during test indicates its diagnostic value in detecting susceptibility to head injuries during a fall.

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