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Susceptibility to fall injury in students of Physical Education practising handball

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Abstract

Background & Study Aim: Many developed countries are seeing an increase in their elderly and disabled populations who are at higher risk from fall injury. Injuries caused by falling are also an issue in all kinds of more intense physical activity, such as sports or work, at all ages. This paper's goal is the susceptibility to fall injury in students of Physical Education, who practising handball and students those not practising any specific sport discipline.

Material & Methods: The study involved 50 first-year students of Physical Education, three-year programme, at the University of Zielona Góra, aged 19-23 years, divided into two groups: A (n = 27) students who had not practiced any discipline in a sports club before; B (n = 23) students practising handball in a first-division club. In order to identify wrong moving habits which may result in fall injury the 'Susceptibility Test of Body Injury During Falls' (STBIDF) was used. The test consisted of three motor tasks performed on a tatami mat. It assessed the way body parts, such as legs, hips, hands, head, were protected, since they are most at risk of injury from falling. Incorrect collisions – signalled by the quickest possible change of body position, from vertical to horizontal (lying on the back), were documented as errors of the '1st grade' or the '2nd grade', with no errors marked as '0 grade'. The total of points as a general indicator of 'Susceptibility to Body Injury During Falls' (SBIDF) was: low (0), average (1-3), high (4-8), very high (9-14). Statistical analysis of the findings was made using t-Student test for independent samples.

Results: The mean SBIDF result in Group A was 4.851 and in Group B 1.913, which is a statistically significant difference. Highly significant differences were also found between the two groups in each task with regard to head-movement mistakes and the total of points from all tasks at $p<0.01$. In the case of hands-movement mistake significant differences were found between the two groups at $p<0.05$ in task 1 and the total of points from all tasks.

Conclusions: By practising a sports discipline one can develop certain movement habits used when falling. Proper head-holding habits used while falling were acquired by handball players. The habit of holding the head properly was best seen in tasks 2 and 3, since the moves involved in them were the most complex. Throughout the whole of STBIDF the handball players made significantly fewer mistakes with regard to proper hands-movement habit than did the students not practising any discipline. The findings confirm the observations by other researchers that modern Physical Education in Polish schools does not involve the teaching of proper movement habits necessary for safe falling.

Key words: fall prevention programme • innovative agonology • non-apparatus test • safe fall

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INTRODUCTION

Handball – *noun* **1.** (*in football*) a rule infringement committed when a player other than a goalkeeper inside his or her penalty area uses a hand to control the ball **2.** a game for two or four people in which players hit a small hard ball against a wall with their hands **3.** the small hard ball used in the game of handball [38].

Player – *noun* someone taking part in a sport or game [38].

PE – *abbreviation* physical education [38].

Preventive – *adjective* used for describing an action taken to stop something happening, especially to stop a disease or infection from spreading [38].

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 [39].

The World Health Organisation has drawn attention to the fact that falls are the second most common cause of death from unintentional injuries among minors across the world [1, 2]. There are falls prevention programmes which focus on improving fitness or creating such working conditions which prevent the worker from losing balance – a frequent cause of falls [3-8]. However, when specific forces act on a person unexpectedly a fall is unavoidable. According to researchers, an injury need not be an inadvertent result of a fall [9-11]. Biomechanical analyses show that using a proper fall technique the degree of injury can be reduced when the body hits the ground [12, 13].

In Poland, despite the wealth of publications showing the possibilities and effectiveness of safe falls programmes for various age groups [14-17], they are not implemented in schools at compulsory PE classes. The school curricula focus on the students' knowledge of the causes of falls and the resulting injuries, but no emphasis is put on the acquisition of practical skills increasing the students' safety, such as practising safe falls [18].

There are scientific publications which describe safe falls training in some countries. For instance, in Japan, three martial arts, judo, kendo, and sumo, have been included in schools' PE curricula, thus bringing safe falls training into the gym [19, 20]. The research conducted by the Institute for Health Metrics and Evaluation at the University of Washington [21, 22] found that over the period of 1990-2010 Japan saw a sharp fall in the number of people aged 4-59 dying or becoming disabled as a result of falls. Such a tendency was observed only in Japan, unlike in many other countries.

Spain has also taken action in this respect and is currently introducing into schools' curricula the 'Safe Fall' programme which is meant to alleviate the negative effects of falling backwards. The assessment of the correctness of the movements during falling was made using INFOSECA scale for the systematic observation of backward fall [23].

Kalina has devised a non-apparatus test 'Susceptibility Test of Body Injury During Falls' (STBIDF) for identifying wrong movements which can cause fall injury and finding out about a person's susceptibility to injury [10, 11]. The test is constructed so as to identify body parts most prone to injury in the backward fall. Mroczkowski has designed a rotating training simulator [24], an apparatus for examining movement habits of a person falling backwards. It causes the fall through the action of inertial force [24, 25].

Some publications discuss the effect of practising sports on susceptibility to fall injury, for instance, in children [6]. In handball, falling backwards occurs quite often (Figure 1). The author expected different results of the susceptibility to injury during a fall by students of Physical Education those not practising any specific discipline, comparing those practising handball

This paper's goal is the susceptibility to fall injury in students of Physical Education, who practising handball and students those not practising any specific sport discipline.

MATERIAL AND METHODS

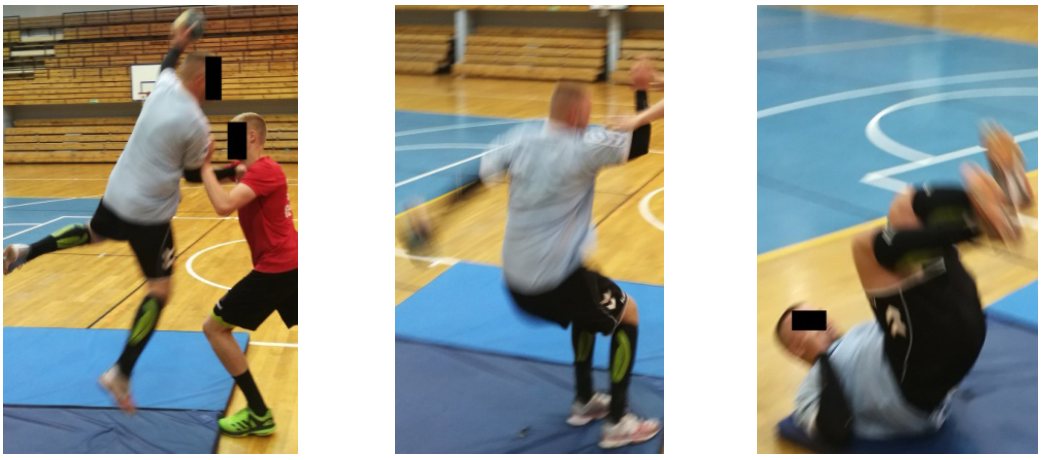
Participants

The study involved 50 first-year students of physical education, three-year programme, at the University of Zielona Góra, aged 19-23, divided into two groups: Group A made up of 27 students who had not practiced any discipline in a sports club before. They said they had only developed their physical skills at gym classes at school. Group B was made up of 23 students practising handball in a first-division club. The study was conducted over the period of 2015 to 2017.

Assessment criteria

In order to identify wrong movement habits which can cause fall injury, the 'Susceptibility Test of Body Injury During Falls' (STBIDF) was used [10, 11]. It is carried out on mattresses and is made up of three tasks. A set of criteria is used to assess the correctness and mistakes in the execution of the tasks. Penalty points are given for every mistake by any of the main four body parts: legs (only involved in Task 3), hips, hands, and the head. Error-free execution scores 0 points, first-degree error 1 point, second-degree error 2 points. All the points are put down in a special table.

Task 1 begins with the command "lie down in a safe way as quick as you can" – on this cue the test participant lies down on the ground on his back. The control of the moves of the hips, hands, and the head is assessed. The failure to duck and



A B C

Figure 1. An example of the backward fall done by a handball player (phases A, B, C).

bend the knees at the right angle, resulting in hitting the ground with the pelvis, is a mistake earning the participant one point. A point is also given for supporting oneself with one hand, and two points for supporting oneself with both hands. The chin should be pressed against the chest not letting the head come into contact with the ground before the end of the exercise – one point is given for failure to do so. Maximum penal score for this task is 4.

In Task 2, the test participant is to hold a sponge between the chest and chin throughout the task. Letting the sponge off or using a hand to hold it in place costs one point for constituting a 'head mistake'. The participant is ordered to clap hands and lie down on the ground as quickly as possible. Stopping clapping is also punished with one point. The points for supporting oneself are the same as in Task 1 – as are criteria for the movement of hips and the maximum penal score.

In Task 3, the test participant stands on a platform 15 centimetres above the ground. Next to it, behind the participant, is a mattress. The command is "leap backwards and lie down as soon as you can after landing". As in the previous task, the participant holds a sponge under the chin and claps his hands. The assessment criteria are the same as in Task 2 – but, additionally, the participant's control of his legs is taken into account. Landing on one leg is seen as a mistake, so one point is given for it, while two points – when the participant lands on straight legs or when the interval between the landing and the beginning to lie down exceeds one second. Maximum penal score for this task is 6.

In each task, the maximum number of points for 'legs mistakes' is 2 points, for 'hips and head mistakes' 3 points, and for 'hands mistakes' 6 points. The total of penalty points for all tasks is 14 and the total a test participant gets in dicates his 'susceptibility to body injury during falls' (SBIDF) as: low (0), average (1-3), high (4-8), very high (9-14) [10, 11].

Statistic analysis

The arithmetic mean and standard deviation (±) were calculated. The findings were analysed using t-Student test for independent variables.

RESULTS

The mean SBIDF result in Group A was 4.851 and in Group B 1.913, which shows that Group A students were at high risk of fall injury and Group B students – at medium risk. The difference between those results is statistically significant at $p<0.01$ (Table 1). Highly significant differences were also found between the two groups in each task with regard to head-movement mistakes and the total of points from all tasks at $p<0.01$ for the mean values of STBIDF results. In the case of hands-movement mistakes significant differences were found between the two groups at $p<0.05$ in Task 1 and the total of points from all tasks. The mean numbers of mistakes of hips and legs movement were lower in the handball players, yet the differences were not statistically significant.

Table 1. General results of t-Student test for independent variables for Group A (not practiced sport) and Group B (practising handball) from each task and the total of points for STBIDF.

Body part	Average & SD (±)		Difference between A-B	t	p
	Group				
	A (n = 27)	B (n = 23)			
		Task 1			
hips	0.185 ±0.396	0.087 ±0.288	0.098	0.987	0.328
hands	0.963 ±1.018	0.348 ±0.714	0.615*	2.431	0.019
head	0.741 ±0.447	0.348 ±0.487	0.393**	2.974	0.005
		Task 2			
hips	0.222 ±0.424	0.130 ±0.344	0.092	0.831	0.410
hands	0.185 ±0.483	0.174 ±0.491	0.011	0.082	0.935
head	0.741 ±0.447	0.174 ±0.388	0.567**	4.750	0.000
		Task 3			
hips	0.333 ±0.480	0.130 ±0.344	0.203	1.688	0.098
hands	0.185 ±0.396	0.130 ±0.344	0.055	0.517	0.607
head	0.407 ±0.694	0.304 ±0.703	0.103	0.520	0.605
legs	0.889 ±0.320	0.087 ±0.288	0.802**	9.238	0.000
		All tasks			
hips	0.333 ±0.480	0.130 ±0.344	0.203	1.688	0.098
hands	0.198 ±0.401	0.116 ±0.323	0.082	1.358	0.177
head	0.519 ±0.823	0.275 ±0.639	0.243*	1.994	0.048
legs	0.790 ±0.410	0.203 ±0.405	0.587**	8.794	0.000
Sum of points	4.852 ±2.852	1.913 ±2.172	2.939**	4.041	0.000

*p<0.05 **p<0.01

DISCUSSION

The results show that by practising a sports discipline one can develop certain movement habits used when falling. Such habits were acquired by the handball players. They exhibited significantly lower susceptibility to fall injuries than did their counterparts not practising any sports. The mean values of the sum of mistakes made by the students in STBIDF differed statistically between the two groups. It is arguable whether the "moves made in STBIDF can be seen as to constitute a fall according to the WHO's definition of 'fall', since the test begins with the command 'lie down on the ground safely as fast as you can'. The WHO defines 'fall' as a result of a situation which makes one land accidentally on the ground, floor, or any other lower-level surface [1, 2].

Yet, research has shown that STBIDF does detect to some degree movement habits in people performing fast-paced exercises, since a considerable number of the students thus tested cannot correct the mistakes they make even though they are made familiar with the assessment criteria [27]. This is especially the case with the 'head mistake' which kept recurring in the faster and more complex Tasks 2 and 3. The diagnostic value of STBIDF for detection of vulnerability to fall injury of the head is thus confirmed.

This study saw a decrease in the number of 'head mistakes' made by the handball players in Tasks 2 and 3, compared with Task 1. In this author's view the explanation is that in Task 1 the students often did not concentrate on the exact execution of the command, since they were to lie down on the floor covered with mattresses, which enhanced their sense of security. The sequence of moves in Task 2 and 3 is more complicated and it involves holding a sponge and clapping and in Task 3 – jumping

off an elevation [10, 11]. It is those exercises which can be performed by the handball players better than by Group A students, since the players have acquired proper movement habits – likely because in the game of handball they hold the ball while falling, which places additional burden on their locomotive system thus making it more difficult for them to fall safely (Figure 1).

With this sporting experience the correct habit of holding the head comes to them naturally in Tasks 2 and 3. The lack of such experience may be responsible for Group A students' failure to make fewer 'head mistakes' in Tasks 2 and 3 (Table 1). Highly significant differences were found between the two groups in each task with regard to head-movement mistakes and the total of points from all tasks at $p<0.01$ for the mean values of SBIDF results. Developing the habit of holding the head in a safe position when falling cannot be overestimated since hitting the ground with the head is much more powerful than it is with other body parts while falling [13, 25]. The importance of holding the head properly during exercise has been recognised by trampoline exercise instructors who have devised an exercise for beginners involving the holding of a sponge under the chin while jumping on the trampoline – much like in STBIDF in Tasks 2 and 3 [28].

The results show that the handball players make significantly fewer mistakes while falling with regard to the correct holding of their hands, compared with their fellow students who did not practise any discipline in a sports club. The differences in the results of Task 1 and the total of points from all tasks, however, were much less significant compared with 'head mistakes' at $p<0.05$. Making 'hands mistakes' considerably contributes to fall injury of upper extremities. It should be noted that the percentage of 'hips and legs mistakes' (Table 1) made by the handball players was not lower than it was in the case of Group A students, with the differences statistically insignificant. The results suggest that the skill of safe falling backward is not only better achieved by practitioners of various martial arts [29, 30], but also by handball players.

There are publications discussing the importance and principles of safe falls in martial arts and combat sports [31, 32]. It is difficult to find publications on handball which discuss the principles of safe falling – although there are ones which deal with injuries sustained by handball players [33-35]. Especially important seems the fall backwards, so often occurring in the play. This author has discussed this issue with handball coaches. They do instruct their players about safe falling backwards, but this is done on individual basis according to particular players' skills. Also, a common commentary was "when he's fallen a couple of times, he will know how to do it properly." It follows from this author's interviews with handball players that they gain experience in falling backwards from their general experience of playing handball. If they make a mistake while falling they try not to repeat it anymore. In this author's opinion putting greater emphasis on the teaching of safe falling to handball players might contribute to a decrease in the number of injuries in this discipline. Safe-falls instruction might accelerate the acquisition of a proper movements habit when falling, normally developed through multiple repetition of movements.

The results of the study, i.e. the results of Group A students, confirm the conclusions of other scientific publications [13, 26] that nowadays physical education in Polish schools fails to teach safe falling through developing 'proper moves' habits in students. The results of using the rotating training simulator for validating it as an apparatus for inducing falls confirm the occurrence of movement habits in falls [25]. Obviously, proper movement habits are acquired through systematic repetition of sequences of moves. It is thus necessary to introduce safe falls training into schools' physical education curricula. A good idea in this respect seems to be spending 10 minutes of a gym class to do safe fall exercises as it has been done in Spain by the adoption of 'Safe Fall' programme [23].

The subject of this paper should be seen as belonging in innovative agonology (that is: *prophylactic and therapeutic agonology* [35]) which is an interdisciplinary science, while the issue of safe falls should be recognised as part of preventive-therapeutic mission [36, 37].

CONCLUSIONS

Handball players exhibit lower susceptibility to fall injury, compared with students of Physical E ducation who do not practice any specific discipline. Practising handball results in the acquisition

of a habit of holding the head in a safe way when falling. Throughout the whole of STBIDF handball players made significantly fewer mistakes in the way they held their hands, compared with their fellow students not practising any specific discipline. Currently, PE in Polish schools fails to include the teaching of proper movement habits for falling safely.

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