

The susceptibility to body injuries during a fall and abilities related to motor coordination of children aged 10 to 12

Authors' Contribution:

- ☑ **A** Study Design
- ☑ **B** Data Collection
- ☑ **C** Statistical Analysis
- ☑ **D** Manuscript Preparation
- ☑ **E** Funds Collection

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Abstract

Background & Study Aim:

One of the relevant indicators of human motor safety, regardless of age, is the susceptibility to injuries during a fall and level of abilities related to motor coordination. The overall aim of this paper is to obtain knowledge about these features of children aged from 10 to 12 and to answer the question whether training in sports clubs is a factor which stimulates these abilities related to motor coordination and on the other hand reduces susceptibility to injuries during a fall more than physical activity limited to compulsory physical education classes. The specific objective is to determine the relationship between global coordination and body balance disturbance tolerance skills of children aged 10-12.

Material & Methods:

The study involved 88 children aged 10 to 12 (53 boys and 35 girls), whereas 27 boys participated only in compulsory physical education classes and 26 of them additionally took part in trainings conducted by sports clubs. STBIDFT test was applied to measure susceptibility to body injuries during a fall and 'Rotational Test' was used to assess body balance disturbance tolerance skills. Both tests have been developed by Kalina. Global coordination was measured with the use of Starosta coordination test. Information about falls of children studied have been obtained by means of an anonymous questionnaire.

Results:

No statistically significant differences in test results (indicators) have been revealed among the examined children. The results of questionnaire surveys indicate that children in primary school and in sports clubs were not taught the safe falling technique. Boys who train in sports clubs are less susceptible to head injuries during a fall in comparison to boys who participate only in physical education classes. The study showed an average negative correlation ($r = -0.612$ boys, girls $r = -0.578$) between the results of body balance disturbance tolerance skills and global coordination obtained both by boys and girls. Respondents who were able to achieve large range of sum of rotation angles to the left and to the right in the global co-ordination test made at the same time less errors during 'Rotational Test'.

Conclusions:

High susceptibility to injuries during a fall of children and lack of significant differences between studied groups proves small effectiveness of a traditional model of physical education in teaching the motor safety. Motor patterns of sports activity recommended by sports clubs do not substantially improve this situation. Global coordination tests and tests of body balance disturbance tolerance skills turned out to be significantly correlated tools to assess abilities related to motor coordination of girls and boys aged 11-12. Therefore, in certain circumstances they may be used interchangeably.

Key words:

global co-ordination • motor safety • Rotational Test • rotational movements • safe fall

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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 [23]

INTRODUCTION

According to the definition provided by WHO [1], the authors of this paper understand fall as an event as a result of which a person unintentionally found her/himself on the ground, floor or other surface on the lower level. Usually, such event is a consequence of loss of balance due to certain external force (slippery surface, collision, etc.). A fall may also result from events related to health (dizziness, fainting, etc.) but sometimes they occur due to the excessive amount of alcohol or other intoxicants. For over 40 years, this phenomenon has been monitored mainly in relation to the sick and elderly as well as to children and adolescents aged 5 to 14 years [e.g. 2-7]. Most recent studies confirm that the scale of this phenomenon is growing, in particular as a consequence of longer age of human population and the increasing number of reports already pertains to all age groups and representatives of various professions. There are certain recommendations of how to prevent falls by modifying motor behaviour and circumstances in which a person lives [8-12]. For example, one of the most recent meta-analysis reveals that exercise and physical training improve physical function in older adults with visual impairments but their effect on falls is unclear [13].

Kalina along with a team of researchers and educators (physiotherapists, martial arts experts) points out low effectiveness of these methods and promotes the universal teaching of safe falling technique of persons at every age [14-17], patients after limb amputations [18], the visually impaired [19] and patients with mental impairments [20] as an alternative prevention. “*The susceptibility test to the body injuries during the fall*” STBIDF [21] developed by Kalina remains an important cognitive and application achievement. It was validated on 68 young females [22]. Kalina has also developed non-apparatus safe falls preparations test (N-ASFPT) as the next stage of improvement and the modification of the author’s injury prevention system based on the teaching safe falls and avoiding collisions [23].

One of the relevant indicators of human motor safety [24, 25], regardless of age, is the susceptibility to injuries during a fall and level of abilities related to motor coordination. Appropriate physical exercises may help reducing of the risk of balance loss and fall as well as injuries to the body when a collision with the ground or vertical obstacle occurs. A period when a child attains its first peak of motors skills (approx. 12 years) is an optimal adaptation period.

The overall aim of this paper is to obtain knowledge about these features of children aged from 10 to 12 and to answer the question whether training in sports clubs is a factor which stimulates these abilities related to motor coordination and on the other hand reduces susceptibility to injuries during a fall more than physical activity limited to compulsory physical education classes. The specific objective is to determine the relationship between global coordination and body balance disturbance tolerance skills of children aged 10-12.

MATERIAL AND METHODS

Participants

The study involved 88 children aged 10 to 12 (53 boys constituted group “A” and 35 girls who belonged to group “D”). All children participated in four physical education classes per week (45 minutes each), whereas 27 boys participated only in compulsory physical education classes (group “C”) and 26 of them additionally took part in trainings conducted by sports clubs (group “C”): 16 football, 3 hockey, 2 handball, 2 karate, 1 capoeira, 1 dance, 1 judo. The study was performed in September 2014. Local bioethics committee has given consent to the study.

Protocol

1. STBIDFT test was applied to measure susceptibility to body injuries during a fall. The test consists of three motor tasks performed on tatami mats. The structure of STBIDF is: three motoric tasks performed on a tatami mats. A manner of the body parts protection (legs, hips, hands, head) was being assessed, the most exposed to damage during the fall. Any incorrect collision – simulated by the fastest possible change of the posture from vertical to horizontal (lying on the back), were documenting by the errors of the first- (“1”) or the second grade (“2”), and no errors “0”. Total points is a general indicator of the susceptibility to body injuries during the fall (SBIDF): low (0), average (1-3), high (4-8), very high (9-14). Relatively for particular body parts (SBPIDF): low (0), average (1), high (2-6) [21, 22].

2. We used the ‘Rotational Test’ (RT) in non-apparatus version to assess the body balance disturbance tolerance skills. RT consists of 6 tasks, starting with the jump with a 360° rotation to the right (each set of ‘jump-landing-posture correction’ should last about two seconds). The movie is available at the website of the journal Archives of Budo (www.archbudo.com) in the left menu (section: ArchBudo Academy) under link Rotational Test <http://archbudo.com/page/>

Table 1. A general indicator of the susceptibility to body injuries during a fall (SBIDF) of examined children.

Group	Participants	SBIDF [points]				
		mean	SD	min	max	difference
"A"	All boys (n = 53)	8.28	2.28	1	14	0.41
"D"	All girls (n = 35)	8.69	2.86	4	13	
"B"	Boys participating only in physical education classes (n = 27)	8.48	3.17	1	14	0.40
"C"	Boys who additionally attend sports trainings (n = 26)	8.08	2.46	3	11	

Table 2. The susceptibility to injuries of body parts during a fall (SBPIDF) of examined children (the proportion of children who committed errors in %).

Group	Participants	Errors of body parts [%]			
		legs	hips	hands	head
"A"	All boys (n = 53)	36	92	96	83
"D"	All girls (n = 35)	49	94	89	83
"B"	Boys participating only in physical education classes (n = 27)	33	93	96	85
"C"	Boys who additionally attend sports trainings (n = 26)	38	92	96	81

display/id/18/title/rotational-test. *Evaluation criteria:* the overall result is the sum of the six tasks (consecutive jumps with body rotation) and includes 0 to 18 stipulated points; "0" indicates a very high ability to tolerate imbalances, while "18" means the exact opposite of that assessment; criteria of an individual level of BBDS assessment determined by the RT are as follows: very high (0-1), high (2-3), average (4-9), low (10-12), very low (13-15), insufficient (16-18) [26].

3. The measurement of global motor co-ordination was carried out using two task and W Starosta's co-ordination meter – sum of maximum jumps with rotation to right and to the left [27, 28].

4. Based on an anonymous questionnaire, we have established the proportion of children who experienced a fall, declare fear of falling or its lack and the proportion of those who participated in the safe falling course.

Statistical analyses

We calculated arithmetic means, standard deviations (SD), range (minimum and maximum values) and range of the analysed empirical variables. In order to determine the significance of the differences between the two means, at test for independent samples was used. We defined the significance of the difference

between two proportions independent.

RESULTS

All children who took part in the study declared that they have experienced unintentional fall. Fear of falling is felt by 49% of girls and 19% of boys, an equivalent to 31% of children studied. Five boys (9%) and 2 girls (6%), i.e. 8% in total, participated in the safe falling course.

No statistically significant difference was revealed between all boys (n = 53) and all girls (n = 35) in terms of an indicator of the susceptibility a body injuries during a fall (SBIDF). The score amounted to: 8.28 points and 8.69 points, respectively. Similarly, there are no differences between boys participating only in physical education classes (8.48) and those who additionally attend sports trainings (8.08 points) (Table 1).

The highest rate of susceptibility to injury during a fall happening to boys pertains to hands (96%) and hips (92%) and girls pertains to hips (94%) and hands (89%) and the lowest one applies to legs. The greatest differences between the groups are related to errors in legs (13%) and hands (7%) control. As far as boys who train only during physical education classes and boys who participate in sports training are concerned,

Table 3. The results of ‘Rotational Test’ (RT) of assessed children.

Group	Participants	RT [points]				
		mean	SD	min	max	difference
“A”	All boys (n = 53)	10.00	2.80	0	16	1.46*
“D”	All girls (n = 35)	8.54	3.32	2	14	
“B”	Boys participating only in physical education classes (n = 27)	10.11	1.91	6	14	0.23
“C”	Boys who additionally attend sports trainings (n = 26)	9.88	3.54	0	16	

*p<0.05

Table 4. The results of ‘Rotational Test’ (RT) of assessed children (selected jump with a 360° rotation to the right and to the left).

Group	Errors generated during jumps to the:	Three jumps with a 360° rotation [points]					
		mean	SD	min	max	difference	
“A” all boys (n = 53)	right	5.06	1.49	0	8	0.12	right
	left	4.94	1.71	0	9		1.00**
“D” all girls (n = 35)	right	4.06	1.88	0	7	0.43	left
	left	4.49	1.95	1	10		0.45

**p<0.01

the largest difference pertain to error in legs (5%) and head (4%) control. The differences are not statistically significant (Table 2).

Girls have greater body balance disturbance tolerance skills (RT result = 8.54 points) than boys (RT result = 10) and the difference is statistically significant (p<0.05). Boys are not differentiated in terms of sports activity (athletes scope = 9.88 points, others = 10.11 points) (Table 3). Similar relationships are taking into account the sum of the three jumps with a 360° rotation to the right and the left during the ‘Rotational Test’. However, the difference statistically significant only for the sum of three jumps of 360° rotation to the right (p<0.01) (Table 4).

The results of global motor co-ordination test do not significantly differentiate boys and girls. The largest difference (11.7°) occurs between maximal rotation towards the right performed by girls (338.17°) and by boys (326.47°). Boys who participate in sports trainings perform this test more effectively (Table 5).

There is average negative correlation (r = -0.612 boys, girls r = -0.578) between the results of ‘Rotational Test’ and global motor co-ordination test

– a statistically significant correlation both p<0.01 (Figures 1, 2). Higher values of correlation coefficient occur if we compare rotational movements (between the results of ‘Rotational Test’ and global motor co-ordination test) in the same direction (Tables 6, 7). The higher is the correlation (p<0.01) between the three jumps with a 360° rotation to the right and to the left during RT among boys (r = 0.530) and girls (r = 0.507). Relatively between maximum jumps with rotation to right and to the left during global motor co-ordination test: (r = 0.251, p<0.05) and girls (r = 0.386, p<0.05).

DISCUSSION

it seems that neither teachers of physical education nor coaches do not consider teaching children of safe falling techniques to be important. The majority of studied boys declared that they train football. Thus, they must fall many times, especially during the game and perhaps this is the reason why they made less mistakes related to head control during STBIDF test. This is obvious that children who participate team games spontaneously learn how to relatively safely collide with the ground.

Table 5. The results of global motor co-ordination test of assessed children.

Group	Maximal jumps with rotation to:	Maximal jumps with rotation [°]					Sum of maximum jumps with rotation to right and to the left [°]				
		mean	SD	min	max	difference	mean	SD	min	max	difference
"A" all boys (n = 53)	right	326.47	36.92	245	405	1.55	651.40	57.54	530	804	13.91
	left	324.92	35.84	255	400						
"D" all girls (n = 35)	right	338.17	33.53	270	402	2.99	665.31	56.10	570	782	
	left	327.14	33.87	270	381						
"B" boys (n = 27)	right	319.26	34.78	245	380	0.85	639.37	54.07	530	734	24.51
	left	320.11	33.90	281	389						
"C" boys athletes (n = 26)	right	333.96	38.23	270	405	4.04	663.88	59.39	572	804	
	left	329.92	37.75	255	400						

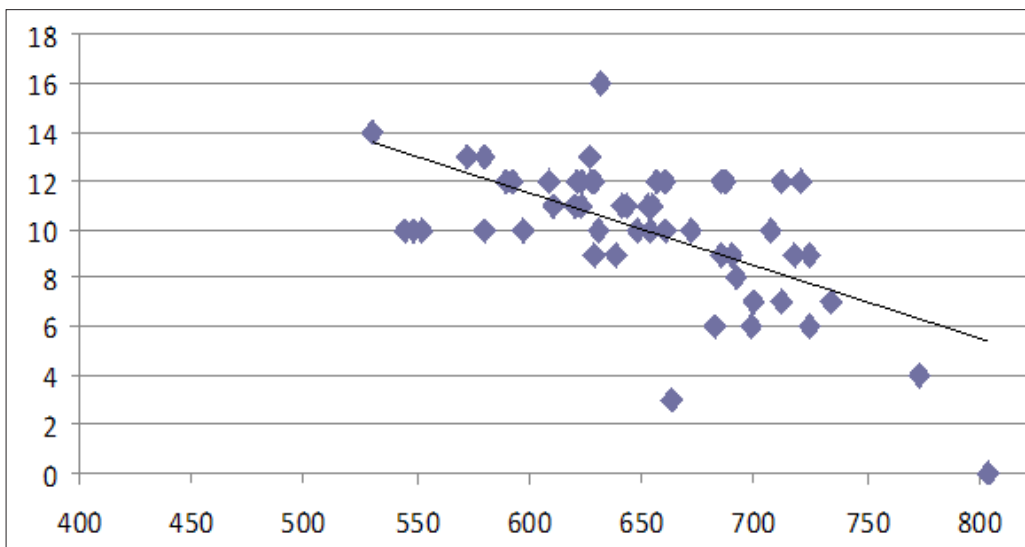


Figure 1. The correlation ($r = -0.612$) between the results of 'Rotational Test' (Y) and global motor co-ordination test (X) of assessed boys ($n = 53$). The regression equation: $Y = 29.399X - 0.0297807$

Table 6. The correlation between the results of 'Rotational Test' and global motor co-ordination test of assessed girls ($n = 53$)

		'Rotational Test': three jumps with a 360° rotation to the: [sum of points]	
		right	left
Global motor co-ordination test	right	-0.461**	-0.313*
	left	-0.311*	-0.602**

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

Physical education programme since recently implemented in Polish schools [29] contains teaching content related to safe physical activity of students. However, the attention is paid to the student's knowledge about causes of accidents and injuries

during physical education classes. According to Mroczkowski [25], the effect of practical skills in increasing human motor safety, including safe falling exercises, is underestimated. The results of studies presented here justify the above statement. The

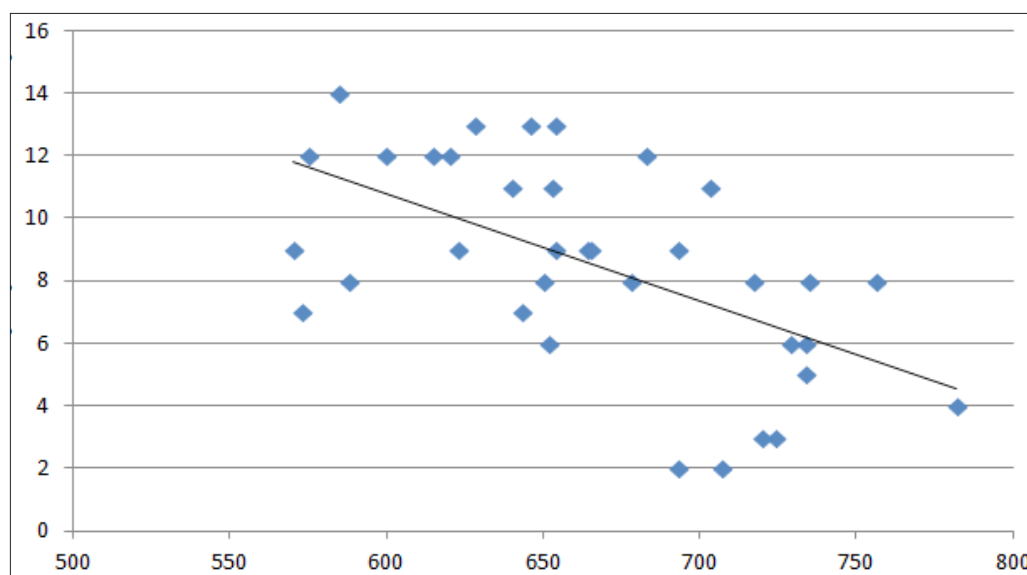


Figure 2. The correlation ($r = -0.578$) between the results of 'Rotational Test' (Y) and global motor co-ordination test (X) of assessed girls ($n = 35$). The regression equation: $Y = 31.2844X - 0.0341817$

Table 7. The correlation between the results of 'Rotational Test' and global motor co-ordination test of assessed girls ($n = 35$)

		'Rotational Test': three jumps with a 360° rotation to the:[sum of points]	
		right	left
Global motor co-ordination test	right	-0.508**	-0.316
	left	-0.251	-0.591**

** $p < 0.01$

fact that every third student declares fear of falling leads to the conclusion that implementation of these exercises is highly recommended.

The application of the STBIDFT test so far provides evidence that if persons regardless of their age learn safe falling techniques [17, 20] or train judo, self-defence [30, 31] will effectively control their body during falls simulated in laboratory conditions.

The results of 'Rotational Test' and the global motor coordination test provide important evidence that boys who participate in sports trainings are not sufficiently stimulated to develop body balance and coordination ability. Thus, educational programme of physical education and the offer of sports activities in free time have little impact on improving motor safety of children and adolescents with the prospect of improvement of life quality in the future.

As far as biomechanics is concerned, safe falls should consist of appropriate circular body position assumed during a contact with the ground. The habit to assume such position of the body during contact with the ground may be developed by frequent exercises of the so-called cradle. Sports which have the best impact on training such habit include martial arts [16, 17, 20, 32] or fun forms of martial arts [15, 33]. This conclusion may be justified by the fact that in the entire group of children studied, there was one boy who trained judo. His personal results of STBIDFT test, 'Rotational Test' and the global motor co-ordination test turned out to be outstanding.

The results of our studies suggest further need for detailed studies to determine the relationship between results of tests examining motor coordination and tests assessing the susceptibility to injuries during a fall in non-apparatus way and with the use of specialist devices. The example of such device is a rotary

training device as it may force falls under the influence of external forces disturbing balance [34, 35]. Such studies will also broaden the knowledge about the causes of body injuries during a fall.

CONCLUSIONS

High susceptibility to injuries during a fall of children and lack of significant differences between studied groups proves small effectiveness of a traditional model of physical education in teaching the motor

safety. Motor patterns of sports activity recommended by sports clubs do not substantially improve this situation. Global coordination tests and tests of body balance disturbance tolerance skills turned out to be significantly correlated tools to assess abilities related to motor coordination of girls and boys aged 11-12. Therefore, in certain circumstances they may be used interchangeably.

COMPETING INTERESTES

Authors declare that have no competing interests.

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