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Innovative method of diagnosing the susceptibility to the body injuries during the fall of children from 2 to 6 years

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
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Abstract

Background & Study Aim: Fall is inherent in people's physical activity. It occurs through entire human ontogenesis and is unavoidable (the risk of fall is reduced only in people who stay in bed for longer periods of time or their whole life). Falls occur most frequently in childhood, especially during the first years of life (adopting an upright posture and beginning of locomotion). However, if the environment meets certain conditions (essentially soft surface), children who don't suffer from any neurological dysfunctions will fall safely. Children's motor response to fall changes with increasing age. It includes shock absorption with hands and large parts of the trunk (both done simultaneously or one after another) during a collision with the ground. The cognitive aim of the study is knowledge about errors in controlling distal parts of the body in children (from 2 to 6 years old) during forced fall (laboratory conditions), whereas application aim is the recommendation of an innovative method to diagnose such phenomenon.

Material & Methods: Study group consisted of 191 children at the age of: 2 years (n = 34); 3 – (n = 32); 4 – (n = 47); 5 – (n = 39); 6 – (n = 39) years old. Each of them was diagnosed independently by a physiotherapist (woman) during a special session on a soft surface. The child started the session by rolling the rehabilitation ball during walking or trotting backwards (first fun form of falling – FFFa). The physiotherapist (at any time she decided) knocked the ball aside to make the child fall (task 1/FFFa: force acting below the child's center of gravity). After at least three falls physiotherapist introduced the next play – the child was instructed to pull a judo belt held by a physiotherapist and try to drag him to a predetermined place (task 2/ FFFb: force acting around the child's center of gravity, when the physiotherapist unexpectedly released the grip). After at least three falls, last play was introduced. A physiotherapist was holding a toy above the child's head. The child was reaching for it (with one or both hands) while walking backwards until it got to a pile of mattresses; the child tripped and fell (task 3/ FFFc: force applied simultaneously over and below the child's center of gravity). Every session has no time restriction.

The physiotherapist recorded a number of falls during each task taking criteria concerning quality (correct/incorrect) control of distal parts of the body (hands, head) during a collision with the ground into consideration. SFIdegree index (susceptibility to the body injuries during the fall) is a proportion of the number of falls with at least one error related to control of distal parts of the body (numerator) to the number of falls during a diagnostic session (denominator). The diagnosis was qualified for the analysis if was based on at least 9 falls (three for each task/FFF) and this criterion was met for all children.

Results: The shortest session lasted 10 minutes (the child was not interested in continuing play), and the longest was 40 minutes (but some children demonstrated dissatisfaction because the play ended). All children fell 2616 times in total. The 38.23% of 2-year-old children make no errors in controlling distal parts of the body (there was only one such child in each of the other age populations). Among 6-year-old children 79.49% make some errors placing them at high to extreme risk of injury upon impact with the ground. The lowest value of the SFIdegree index was in the population of 2-year-old children (7.65%). In general, the older children population (3-, 4-, 5-, 6-year-old), the higher value of the SFIdegree index (21.52%; 40.97%; 65.14%; 72.10% respectively). Differences between proportions are statistically significant: p<0.001 (between 5 – and 6-year-old children: p<0.05; non-directional versus test).

Conclusions: The simplicity but at the same time very high efficiency of the FFF method in diagnosing the SFI phenomenon starting from two-year-old children is an opportunity (as a key element of complementary research) to verify a hypothesis of breakthrough importance for the diagnosis of many health risks: the discovery of an organic cause of the extreme degree of SFI already among toddlerhood and preschool children is at the same time the establishment of a highly probable common source of many neuro-degenerative diseases and disabilities.

Keywords: fun forms of martial arts • ontogenesis • safe fall theory

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Fall – is unintentional, a sudden change from vertical to horizontal posture [26]. Falling often leads to injury; that is why it is qualified in the International Classification of Disease (ICD). Codes include falls on the same or upper level, as well as others, unspecified falls. Falls results with a collision with walls, furniture, ground or other objects or obstacles [26, 27].

Central limit theorem (**CLT**) – the theorem is a key concept in probability theory because it implies that probabilistic and statistical methods that work for normal distributions can be applicable to many problems involving other types of distributions [28].

Proportion – in statistics, it is a number (fraction, percentage) expressing what part of the elements of a certain set meet a specific condition. Other equivalently used terms are fraction, structure index.

General population – a set (aggregate) of any elements (people, objects, events) related to each other logically

INTRODUCTION

The unintentional fall is the first but unconscious motor experience of any human being who is able to adopt a vertical posture. In ontogenetic development, this basic postural activity of the *homo erectus* population appears at the end of the first year of life – at nine months the infant stands holding onto furniture [1].

Coincidentally, in 2003, Olivia's parents spontaneously immortalized her first fall (hence, among other things, the very poor quality of the recording from which the photo sequence of this event was taken – Photo 1). The girl independently adopted a vertical stance using a stool as support. As the tiled kitchen floor provided enough slip, the father moved the stool gently to cause Olivia to take her first steps. However, the unevenness of the floor tiles caused this movement to be disrupted and the girl unintentionally fell to her side. To the astonishment of her parents, Olivia performed a 'professional' collision with the hard ground (in judo terminology *yoko ukemi*, which means 'falling sideways'): chin drawn to the torso; anticipatory shock-absorbing impact with the arm (at an angle of about 45° to the torso) before the torso collided with the ground; bouncing the arm off the ground (whereas, in the meantime, many people taught the *yoko ukemi* technique stiffen the arm in such circumstances and pin it to the ground, causing the energy of the collision to be transferred to the body instead of being dissipated). The reader is encouraged to watch the two videos at *ArchBudo Academy* ('Safe Falls Academy' and 'Forced Fall To The Side') and to read the work of Michnik et al. [2]. An explanatory hypothesis that is impossible to verify is legitimate: it is likely that the person who developed the first way to fall safely to the side (most likely Chinese or Japanese) witnessed a similar event or several similar events.

A few years later, also by coincidence, the fall of eight-month-old Ana was recorded. The first author of this work witnessed her favorite game – she was reaching with her hand for a crystal vase located near the couch adjacent to the wall. Her father, a professional photographer, was asked to create a 'safe fall laboratory' for Ana and attempted to record the aftermath of this play – Photo 2 (the previously published sequence of these events contains fewer images [3, 4]).

Photo 1. Four phases of loss of balance and falling to the side of less than one-year-old Olivia while taking her first steps on her own, supported by a stool (source: private archive of RM Kalina).

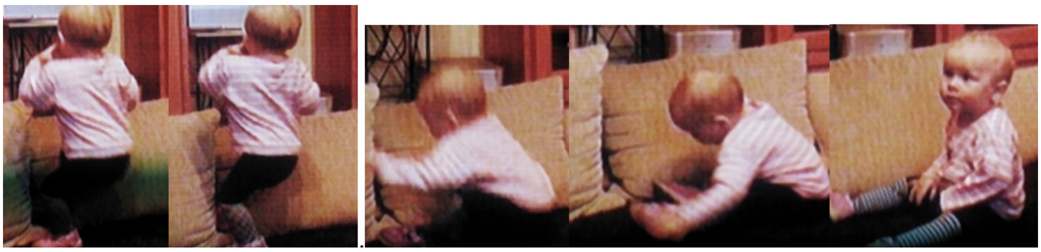


Photo 2. Phases of eight-month-old Ana's fall backward from the moment she lost her balance while reaching for an object placed above her head to the collision with the ground (source: Ana's father Paweł Kalina).

Both situations described above led the first author to develop the initial concept of a fun form of falling (FFF) cycle with the child, which could allow the repeated observation, forced by defined circumstances (mainly external), of two sequential events – a loss of equilibrium resulting in a backward fall on soft ground. Backwards, therefore, to ensure safety based on the principals of safe fall theory [5] (large impact area; increased braking time and distance during ground impact when rolling onto the back; unconscious use by the child of the cushioning functions of the lower limbs). The basic assumption (derived precisely from the criterion of the child's motor safety) was that the force causing the child to be thrown off balance and to fall backwards was gradual: from acting below his or her center of gravity (FFFa); within the center of gravity (FFFb); above (FFFc). At least three falls at each of the contractual levels, on the one hand, entitled the child to continue with the next play (as long as the child was interested in it or did not resist the physiotherapist's new suggestion) – on the other hand, formed the basis of the calculation. SFI index (susceptibility to the body injuries during the fall) from a minimum total of 9 observations. Still in the course of the pilot study, Natalia [6] modified the FFF at level 'c' (see 'Material & Methods' for details).

The cognitive aim of the study is knowledge about errors in controlling distal parts of the body in children (from 2 to 6 years old) during forced fall (laboratory conditions), whereas application aim is the recommendation of an innovative method to diagnose such phenomenon.

MATERIAL AND METHODS

Participants

Study group consisted of 191 children at the age of: 2 years (n = 34); 3 – (n = 32); 4 – (n = 47); 5 – (n = 39); 6 – (n = 39) years old. Each of them was diagnosed independently by a physiotherapist (woman) during a special session on a soft surface.

The observations were carried out by three physiotherapists independently in three regions of southern Poland. Children were recruited from friends or clients currently using various physiotherapy services, as well as from pre-schools

(having common attributes or traits) but non-identical from the point of view of the studied feature. The general population includes all the items being studied, for which general conclusions are formulated. In the case when the elements of the general community are subjected to survey (examination) due to one feature, then this group is called one-dimensional (single feature). The collectivity is called multidimensional (multi-feature) if many features are considered in the study.

Cognitive – *adjective* relating to the process of acquiring knowledge by the use of reasoning, intuition, or perception [29].

Motor skills – *plural noun* the ability of a person to make movements to achieve a goal, with stages including processing the information in the brain, transmitting neural signals and coordinating the relevant muscles to achieve the desired effect [29].

Sensory memory (SM) – is considered to be outside of cognitive control and is instead an automatic response. The information represented in SM is the 'raw data' which provides a snapshot of a person's overall sensory experience [30].

Division of the combat sports under forms of the direct confrontation – workings of weapons; hits (strokes); throws and grips of immobilization of opponent's body [17].

Counterproductive – from praxeological perspective certain action can be productive – non-productive – counterproductive – neutral. The action is **counterproductive** when a doer achieved goal opposite than intended [31, p. 220].

Body balance disturbation tolerance skills – the ability to maintain the vertical posture in circumstances of the fall hazard.

in Krakow, the capital of Małopolska, (Lesser Poland). Beforehand, the child's parents or legal guardians were made aware of the purpose of the research being conducted and, after giving their consent (and verbally stating that the child was in good health), attended the session as observers. There was not a single case of parents (guardians) intervening with a request to stop the session.

The study was conducted within the research project URWWF/S/04: "Motor, methodological and mental effects of educating students in safe falling of blinds and/ or after limbs amputations" (Resolution No. 03/02/2011 Bioethics Committee at the University of Rzeszow, Poland).

Study design

The child started the session by rolling the rehabilitation ball (diameter 65 cm) during walking or trotting backwards. The physiotherapist (at any time she decided) knocked the ball aside to make the child fall (task 1: force acting below the child's center of gravity) – Photo 3.

After at least three falls physiotherapist introduced the next play – the child was instructed to pull a judo belt held by a physiotherapist and try to drag him to a predetermined place (task 2: force acting around the child's center of gravity, when the physiotherapist unexpectedly released the grip) – Photo 4.

After at least three falls last play was introduced. A physiotherapist was holding a toy above the child's head. The child was reaching for it (with one or both hands) during walking backwards until got to a pile of mattresses; the child tripped and fell (task 3: force applied simultaneously over and below the child's center of gravity) – Photo 5. This modification was introduced by Natalia [6] during

Photo 3. Visualization of the first game (FFFa).

Photo 4. Visualization of the second game (FFFb).

Photo 5. Visualization of the third game (FFFc).

a pilot study of children aged 2 to 6 years (n = 59), as simply reaching for a toy held high above the child's head by a physiotherapist was not sufficient conditions to cause the child to fall backwards.

Every session has no time restriction.

Method of documenting observational data and indicators

Session time

Counted to the nearest 1 minute from the start of the FFFa until the child was no longer interested in continuing the exercise.

Criteria for the evaluation of body errors during ground impact

A fall during which the child props himself up with one or both hands on impact with the ground or, in the case of rolling onto his back (side), touches the ground with his head, is wrong.

SFIdegree (index of susceptibility to the body injuries during the fall related to the whole session) is calculated from the formula:

$$\frac{SFI(FFFa)+SFI(FFFb)+SFI(FFFc)}{total\ falls\ during\ the\ session}$$

or, in shorter form: $\frac{CE}{\text{Nfalls}}$,

where: cumulative error (CE) is precisely the sum of the numerator of the previous formula, and Nfalls is the sum of its denominator.

We base the SFIdegree standards for children aged 2 to 6 years on the assumptions of the method [7], although these assumptions are fundamentally different. STBIDF-M has references to the cognitive and behavioral spheres. The FFF-based method is a combination of emotion and spontaneous motor response to a stimulus causing loss of balance and falling. This has little to do with the way in which the common motor effect – the collision of the body with the ground due to loss of balance – is documented. The essence of observing this phenomenon (collision) is to determine whether, in addition to contact with the ground of large areas of the body (meeting the basic safe fall principium [5]), there is also contact with distal parts of body segments (feet, hips, hands, head), which in many circumstances of a fall on hard, uneven ground are the cause of bone fractures, mutilations, etc., or even death: *Falls are the second leading cause of unintentional injury deaths worldwide* [8], see also [9, 10]. Although greater diagnostic possibilities are offered by the STBIDF-M [7], a prerequisite for the use of this tool is an understanding of the essence of each of the six test tasks (to perform them as instructed by the examiner). A condition that cannot be fulfilled especially by the youngest preschool children. On the other hand, the advantage of the FFF – based method (necessarily on soft ground) is a very high degree of motor safety.

However, from the perspective of diagnostic performance, it is irrelevant whether the CR is the sum of the results of errors accumulated either only in the lower limbs, or only in the hips, or only in the upper limbs, or only in the head, or is a compilation of all or at least two of these distal parts (property STBIDF-M). In the case of FFF, errors are accumulated either only in the upper limbs, only in the head, or both of these body parts combined.

Criteria for presentation and some scope for interpretation of results

Presumptions and assumptions

Already the results of the pilot study (based on a sufficiently large sample of >50) provided evidence that, in the population of children aged 2 to 6 years, there are those who do not make errors during an experimentally forced backward fall and those who make an error every time. However, the central limit theorem condition was not met – the distribution of results was found to be bimodal [6]. The factor strongly modifying the results turned out to be the age of the children a variable discrete SFIdegree. Thus, it is to be expected that a more than threefold increase from the population sample in this study proper (n = 191) would confirm these relationships.

Since the variable discrete is to be confirmed, some deviation from the means of determining the exact boundaries of the class intervals recommended by eminent statisticians [11] is legitimate. The smallest score is '0' (at the same time the most desirable for health criteria) and the largest score is '1' (its health opposite), so a class interval of 0.1 turns out to be debatable for two reasons. First, we have not encountered such an example in the statistical literature. Secondly, from the perspective of the expected diagnostic reliability of the FFF method in the areas of health and education, setting an exact class interval limit for this variable discrete (SFIdegree), according to the recommended statistical methodology, would prove counterproductive (see glossary) in extreme cases. Accepting this statistical paradigm, with an assumed value of 0.1, would mean that the exact limits of the class interval would be 0.05 and 0.15. In the case of the specificity of the SFI phenomenon, these limits would be precisely inaccurate.

Class intervals

Thus, we take as the basis for the class interval decision the lowest SFI score >0 (conventionally ≤0.001) and the highest score 0.99. Arbitrarily, we take a class interval of 0.0998 and, as a result, 10 class intervals that meet the condition of encompassing the majority of the measurement data in relation to the entire sample from the population of children aged 2 to 6 years. However, due to the diagnostic value of the extreme results, we take the results '0' and '1' as the boundaries of the set (continuum) and conventionally treat them as extreme class intervals. Thus, we base the monitoring of test results on 12 class intervals (Table 1).

Decomposition of raw FFF-evaluated SFI results into STBIDF-M standards

In the case of STBIDF-M, the limit of the error continuum is the sum of 30 points and this means 100% of possible errors (or a value of '1' as an alternative notation of the error proportion), and when using FFF, it has to be empirically determined each time – each fall with an error is also subject to one of these score notations (100% or 1). The reader will easily verify that the raw SFI results setting the limits of the SFIdegree norms for STBIDF-M (Table 4 in [7, p. 381] are either identical (very low degree) or slightly different from those for the FFF-based method (Table 2).

For SFI, when the minimum evaluation criterion (three falls) is met, four levels of score proportions are possible: 0 (very low); 0.33 (low); 0.66 (high); 1 (extreme). The SFI calculated from at least nine required falls during the entire session, already closes in ten possibilities: 0; 0.11; 0.22; 0.33; 0.44; 0.55; 0.66; 0.77; 0.88; 1. Thus, each of these possible scores will be consistent with the correlated SFIdegree evaluation criterion (Table 2).

Table 1. Specific class ranges of raw SFI phenomenon scores measured by the fun form of falling (FFF) method.

Class interval	Proportion indicator	
	fraction	%
1	0	0
2	0.001÷0.0998	0.01÷9.98
3	0.0999÷0.1997	9.99÷19.97
4	0.1998÷0.2996	19.98÷29.96
5	0.2997÷0.3995	29.97÷39.95
6	0.3996÷0.4994	39.96÷49.94
7	0.4995÷0.5993	49.95÷59.93
8	0.5994÷0.6992	59.94÷69.92
9	0.6993÷0.7991	69.93÷79.91
10	0.7992÷0.8990	79.92÷89.90
11	0.8991÷0.9999	89.91÷99.99
12	1	100

Table 2. Simulations of indicators meeting SFI risk level standards determined by child observation during three types of FFF.

SFIdegree (name)	Proportion indicator	
	fraction	%
very low	0	0
low	0.001 to 0.3799	0.1 to 37.99
average	0.38 to 0.6399	38 to 63.99
high	0.64 to 0.7999	64 to 79.99
very high	0.80 to 0.9399	80 to 93.99
extreme	0.94 to 1	94 to 100

The SFI low level adapted to the FFF-based evaluation fills the raw scores of 2, 3, 4 class intervals and 95.95% 5 class-. Average level: 4.05% 5 class-, and also 6, 7 class – and 91.51% 8 class-. The other levels, respectively: high 8.49% 8 class-, 9 class – and 0.07% 10 class-; very high 93.92% 10 class – and 93.99% 11 class-; extreme 6.01% 11 class – and 12 class.

When analyzing the results of homogeneous groups of children (of identical chronological age), the limits of the sets of individual FFF and the entire session can be assigned a purely theoretical probability that they fall between '0' (no CE) and '1' (errors during each fall). It is this criterion of set homogeneity that may be a factor significantly modifying the variance of the SFI phenomenon results.

The author of the original version of the published 'the susceptibility test of the body injuries during the fall' (STBIDF), interpreted a score of '0' SFIpoints (with a range of 0 to 14 points) as a low SFIdegree [3, 4, 10]. The authors of the modification of the STBIDF-M [7] admittedly attributed a very low level to this score, but not the valence of absolute certainty that a fall would not result in a negative health outcome. On the contrary, the authors clearly emphasize both that this is some organic property of the person and, in the case of older children and adults, also the effect of established habits (assuming that the person has not been previously educated about safe falls) and (regardless of the flawless SFI score) the inevitability even of loss of life under certain circumstances of a fall. The argumentation is logical: '(…) the flawless performance of any of the tests for diagnosing SFI (STBIDF or STBIDF-M and those yet to be developed) doesn't mean that there are people who are not at risk of losing their lives, let alone their health, as a result of falling and colliding with the ground or a vertical obstacle. Such consequences are determined in each case by specific circumstances and a compilation of concomitant events that is often difficult to foresee. In other words, each person, as a result of a certain category of falls and the combination of events mentioned above, can either die or spend the rest of his or her life in disability' [7, p. 395].

Statistical analysis

We base the analysis of the results at a high level of generality on basic estimation indicators recommended by, among others, Ferguson and Takane [11]. The estimation of the results is based on the following indicators: frequency (N, n); mean (M); minimum (Min); Maximum (Max); standard deviation (SD or ±); skewness and kurtosis. We calculated the significance of differences in the proportions of SFIdegree indicators between the groups of studied children.

An in-depth analysis of the results will make sense after additional observations are made, which we point out in the discussion of the current results.

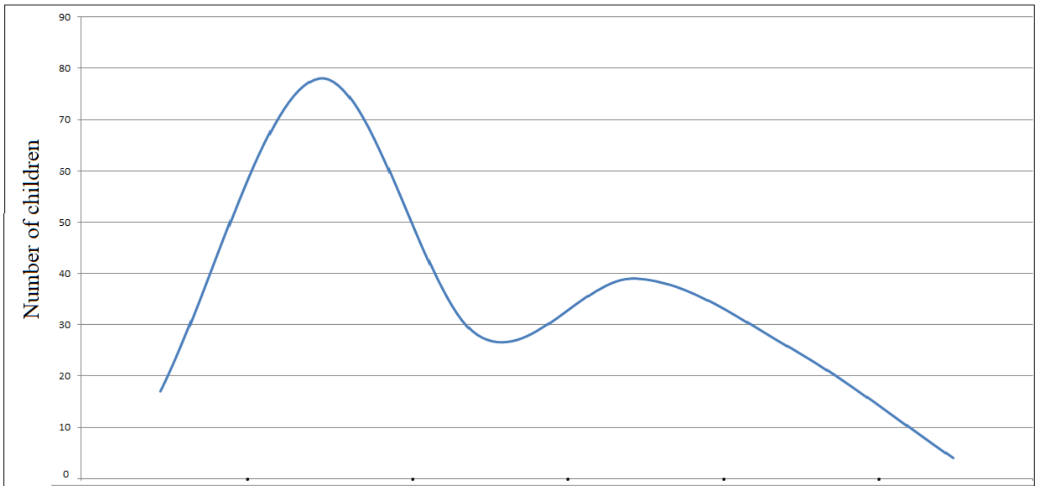
RESULTS

The indicator that most differentiates the groups of children studied is the SFIdegree (from 0.0765 two-year-olds to 0.7210 six-year-olds) with, in a sense, a jumping trend of increasing errors with the chronological age of the children. Differences between proportions are statistically significant: $p<0.001$ (between 5 – and 6-year-old children: $p<0.05$; non-directional versus test). Similar in principle but opposite in trend is the decreasing number of child falls during the diagnostic session: two-year-olds M = 17.29 ±6.50; six-year-olds M = 11.28 ±1.64. By far the smallest variation in extreme results concerns the duration (in minutes) of the diagnostic session: four-year-olds M = 24.40 ±6. 14; six-year-olds M = 21.62 ±4.11. The reduction in the number of falls of five – and six-year-olds relative to the youngest (two – and three-year-olds) with similarity in session duration is not evidence of less interest in FFF by the older children, but rather of their more formed body balance disturbation tolerance skills. The longest diagnostic session lasted 40 minutes (among four-year-olds). And the shortest 10 minutes (among two-year-olds); the highest number of falls performed (n = 32) was found among two-year-olds (Table 3). It was a boy who made errors during 4 falls (SFIdegree = 0.1250), two during FFFc and one each during FFFa and FFFb.

Flawless falls observed under repeated, safe laboratory conditions are the property of 38.2 per cent of two-year-olds. Under such circumstances, the ability to protect the upper limbs and head from collision with the ground each time was revealed by only one child each from three to six years of age (Figure 1). Due to the different sizes of the age groups studied, this result means that, in the population of children between the ages of three and six, this unique ability, which is closely

Table 3. Estimation of the results of the FFF method used in diagnosing the phenomenon of SFI in children aged 2 to 6 years (n = 191).

Age	Statistical indicators	SFI profile of children's age group				FFFa			FFFb			FFFc		
		SFIdegree	Nfalls	CE	Time of session (minutes)	SFI(FFFa)	fall (n)	error (n)	SFI(FFFb)	fall (n)	error (n)	SFI(FFFc)	fall (n)	error (n)
2 years (n = 34)	**M**	**0.0765**	**17.29**	**1.32**	**21.94**	**0.0800**	**5.21**	**0.41**	**0.0775**	**6.15**	**0.44**	**0.0877**	**5.94**	**0.47**
	SD	0.10	6.50	1.49	4.89	0.12	2.19	0.56	0.11	2.51	0.61	0.15	2.37	0.66
	min	0	9	0	10	0	3	0	0	3	0	0	3	0
	max	0.3571	32	5	31	0.4000	10	2	0.3333	11	2	0.6667	11	2
	skewness	1.64	0.95	1.15	−0.04	1.31	0.98	0.93	1.18	0.53	1.08	2.39	0.57	1.11
	kurtosis	2.28	−0.44	0.56	−0.21	0.59	0.08	−0.12	0.09	−1.16	0.24	6.25	−0.96	0.15
3 years (n = 32)	**M**	**0.2152**	**15.44**	**2.81**	**22.13**	**0.1816**	**5.03**	**0.78**	**0.2366**	**5.31**	**1.00**	**0.2435**	**5.09**	**1.03**
	SD	0.19	5.21	1.97	5.08	0.24	1.73	0.91	0.25	2.29	0.88	0.27	1.84	0.90
	min	0	9	0	13	0	3	0	0	3	0	0	3	0
	max	0.9000	25	9	40	1	9	3	1	10	3	1	10	3
	skewness	1.85	0.78	1.32	1.31	1.82	0.51	1.30	1.26	0.62	0.61	1.53	0.78	0.51
	kurtosis	4.45	−0.85	2.05	3.88	3.45	−0.65	1.34	1.48	−1.11	−0.18	2.46	0.06	−0.45
4 years (n = 47)	**M**	**0.4097**	**13.34**	**5.19**	**24.40**	**0.3543**	**4.34**	**1.47**	**0.3694**	**4.68**	**1.62**	**0.5285**	**4.36**	**2.11**
	SD	0.21	3.21	2.32	6.14	0.26	1.24	1.02	0.25	1.24	0.95	0.30	1.11	0.94
	min	0	9	0	11	0	3	0	0	3	0	0	3	0
	max	1	22	10	40	1	8	3	1	8	3	1	7	4
	skewness	0.76	1.03	0.16	0.83	0.89	0.89	0.35	0.89	0.50	0.05	0.35	0.71	−0.22
	kurtosis	0.34	0.71	−0.50	0.88	0.50	0.56	−1.02	0.81	−0.01	−0.92	−1.21	0.15	−1.11
5 years (n = 39)	**M**	**0.6514**	**11.97**	**7.54**	**23.10**	**0.5624**	**3.82**	**2.08**	**0.6927**	**4.18**	**2.72**	**0.7496**	**3.97**	**2.74**
	SD	0.22	1.91	2.20	3.26	0.29	0.76	0.96	0.27	1.05	0.89	0.26	1.18	0.75
	min	0	9	0	17	0	3	0	0	3	0	0	3	0
	max	1	17	11	30	1	6	3	1	7	5	1	8	5
	skewness	−0.88	0.44	−1.42	0.33	0.15	0.70	−0.35	−0.41	0.34	−0.35	−0.77	1.37	−1.10
	kurtosis	0.68	−0.50	2.40	−0.16	−1.09	0.38	−1.44	−0.49	−0.48	3.15	0.05	2.09	5.86
6 years (n = 39)	**M**	**0.7210**	**11.28**	**8.00**	**21.62**	**0.6901**	**3.56**	**2.41**	**0.7230**	**4.10**	**2.85**	**0.7927**	**3.67**	**2.74**
	SD	0.19	1.64	2.04	4.11	0.27	0.68	0.88	0.28	1.17	1.20	0.24	0.93	0.59
	min	0	9	0	14	0	3	0	0	3	0	0	3	0
	max	1	15	12	30	1	5	3	1	8	7	1	6	3
	skewness	−1.73	0.77	−1.75	0.19	−0.67	0.81	−1.18	−1.01	1.47	0.69	−1.04	1.15	−3.04
	kurtosis	4.87	−0.46	5.48	−0.75	−0.20	−0.43	0.07	0.68	2.60	4.89	1.40	0.20	11.28



Age	very low 0		low (>0÷0.37)		average (0.38÷0.63)		high (0.64÷0.79)		very high (0.80÷93)		extreme (0.94÷1)	
	Variable the degree of risk of SFI											
	n	%	n	%	n	%	n	%	n	%	n	%
2 years (n = 34)	13	**38.2**	21	**61.8**	0	**0**	0	**0**	0	**0**	0	**0**
3 years (n = 32)	1	**3.1**	26	**81.3**	3	**9.4**	1	**3.1**	1	**3.1**	0	**0**
4 years (n = 47)	1	**2.1**	24	**51.2**	15	**31.9**	5	**10.6**	1	**2.1**	1	**2.1**
5 years (n = 39)	1	**2.6**	6	**15.4**	6	**15.4**	14	**35.8**	11	**28.2**	1	**2.6**
6 years (n = 39)	1	**2.6**	1	**2.6**	4	**10.3**	19	**48.7**	12	**30.7**	2	**5.1**
SFIdegree proportions of all examined children (n = 191)												
	17	**8.9**	77	**40.3**	28	**14.7**	39	**20.4**	25	**13.1**	5	**2.6**

Figure 1. Distribution of the SFIdegree index in age groups of children aged 2 to 6 years (n = 191).

linked to personal safety in the perspective of the entire ontogeny, is retained by approximately 2% to 3% of the general population.

Each time, more and more children make mistakes during a fall, starting at the age of four (2.13%), five-year-olds (2.56%), and six-year-olds (5.13%). Two-year-olds' mistakes end up in the fifth-grade range (29.96 to 39.95%) of the risk that a collision with the ground may end in a body, and this is also the threshold – abstracting from the single case of zero SFIdegree in this age group – at which five-year-olds' risk of body injury begins. For the largest proportion of five-year-olds (35.89% of them), the level for such a risk starts from a range of 64% to 79.99%. This risk level also accumulates the largest proportion (41.02%) of six-year-olds (Table 4). These proportions vary in relation to the established class interval (Table 5).

The results of the observations compiled according to the criterion of the degree of risk of SFI have a bimodal distribution (Figure 1). The highest accumulation of results (n = 77) applies children to low SFIdegree – among them, the largest number is three – (n = 26), four – (n = 24) and two-year-olds (n = 21). It is proof that most children in this age have a low risk of bodily injury during a collision with the ground. The second top indicates an accumulation of mainly six-year-olds (n = 16) and five-year-olds (n = 14) – total 39 children from 3 to 6 old – but reports about already high level of risk (SFIdegree).

Both are clearly documented by the skewness of the distribution. Positive values for two-year-olds (1.64) and three-year-olds (1.85) indicate that the grouped results are closer to the lower SFIdegree (0% to % very low and low of two-year-olds, and 84.4% of three-year-olds) while negative values for five-year-olds (−0.88) and six-year-olds (−1.73) indicate that their risk of body injury during ground collisions is close to the highest values (Table 5, Figure 2). These rates for 47 four-year-olds (among them: 53.2% very low and low, 31.9 average, and 14.8% from high to extreme) are evidence that this age is a watershed in terms of revealing children's tendency to lose the innate ability to protect their upper limbs and head from impact with the ground every time (under certain standard circumstances).

Table 4. The number (and proportion) of children in each age group whose raw SFI scores qualify them for the appropriate SFI levels.

SFI degree (raw SFI scores)			Groups of children's										Total (n = 191)	
name	proportion indicator		2 years (n = 34)		3 years (n = 32)		4 years (n = 47)		5 years (n = 39)		6 years (n = 39)			
	fraction	%	n	%	n	%	n	%	n	%	n	%	n	%
very low	0	0	13	**38.23**	1	**3.12**	1	**2.12**	1	**2.56**	1	**2.56**	17	**8.90**
low	0.001 to 0.3799	0.1 to 37.99	21	**61.76**	26	**81.25**	23	**48.93**	6	**15.38**	1	**2.56**	77	**40.31**
average	0.38 to 0.6399	38 to 63.99					16	**34.04**	6	**15.38**	6	**15.38**	28	**14.65**
high	0.64 to 0.7999	64 to 79.99			4	**12.5**	5	**10.63**	14	**35.89**	16	**41.02**	39	**20.41**
very high	0.80 to 0.9399	80 to 93.99			1	**3.12**	1	**2.12**	11	**28.20**	12	**30.76**	25	**13.08**
extreme	0.94 to 1	94 to 100					1	**2.12**	1	**2.56**	3	**7.69**	5	2.61
SFI degree in separate groups of children's			very low, low		very low, low, high, very high		very low, low, average, high, very high, extreme							

Table 5. The number (and proportion) of children in each age group whose SFI raw scores qualify them for the appropriate class interval.

Class interval	Proportion indicator		2 years (n = 34)		3 years (n = 32)		4 years (n = 47)		5 years (n = 39)		6 years (n = 39)		Total (n = 191)	
	fraction	%	n	%	n	%	n	%	n	%	n	%	n	%
1	0	0	13	**38.24**	1	**3.13**	1	**2.13**	1	**2.56**	1	**2.56**	17	**8.9**
2	0.001÷0.0998	0.01÷9.98	12	**35.92**	11	**34.38**							23	**12.04**
3	0.0999÷0.1997	9.99÷19.97	5	**14.71**	5	**15.63**	2	**4.26**					12	**6.28**
4	0.1998÷0.2996	19.98÷29.96	2	**5.88**	8	**25**	13	**27.66**			1	**2.56**	24	**12.57**
5	0.2997÷0.3995	29.97÷39.95	2	**5.88**	3	**9.38**	11	**23.4**	6	**15.38**	1	**2.56**	23	**12.04**
6	0.3996÷0.4994	39.96÷49.94			2	**6.25**	4	**8.51**	1	**2.56**			7	**3.66**
7	0.4995÷0.5993	49.95÷59.93					7	**14.89**	5	**12.82**	1	**2.56**	13	**6.81**
8	0.5994÷0.6992	59.94÷69.92			1	**3.13**	2	**4.26**	6	**15.38**	10	**25.64**	19	**9.95**
9	0.6993÷0.7991	69.93÷79.91					5	**10.64**	8	**20.51**	11	**28.21**	24	**12.57**
10	0.7992÷0.8990	79.92÷89.90							6	**15.38**	5	**12.82**	11	**5.76**
11	0.8991÷0.9999	89.91÷99.99			1	**3.13**	1	**2.13**	5	**12.82**	7	**17.95**	14	**7.33**
12	1	100					1	**2.13**	1	**2.56**	2	**5.13**	4	**2.09**
Class interval in separate groups of children's			1; 2; 3; 4; 5		1; 2; 3; 4; 5; 6; 8; 11		1; 3; 4; 5; 6; 7; 8; 9; 11; 12		1; 5; 6; 7; 8; 9; 10; 11; 12		1; 4; 5; 7; 8; 9; 10; 11; 12		1 to 12	

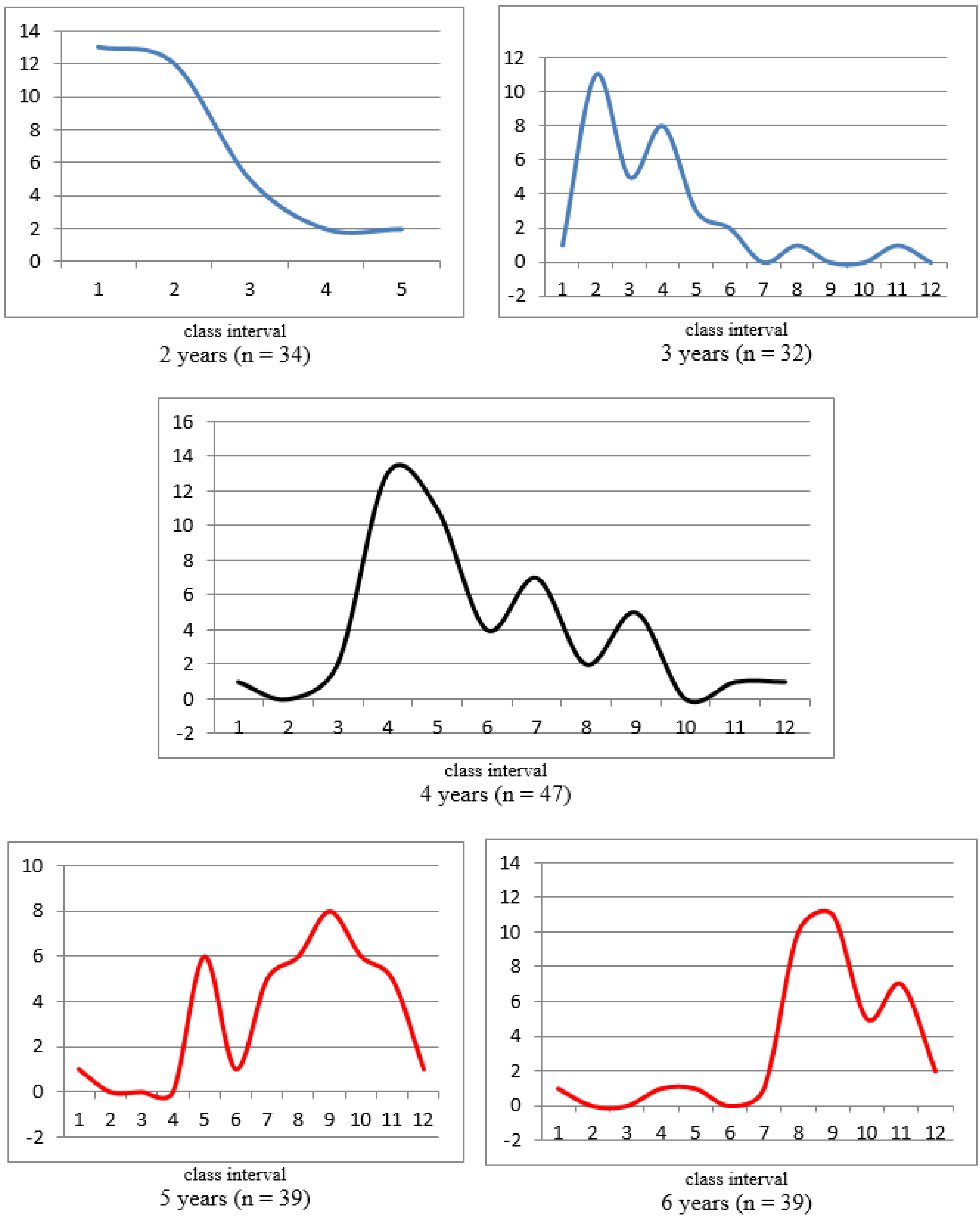


Figure 2. Visualization of the distribution of raw SFI scores (according to the criterion of class interval) in the age groups of the examined children.

DISCUSSION

Our greatest discovery is a phenomenon that definitely starts to increase in the fourth calendar year of life: an increasing number of children, every time they fall backwards, expose their upper limbs and, to a lesser extent, their head to damage during a collision with the ground, and only a few retain the ability characteristic of the majority of two-year-olds (under these circumstances, they always protect their upper limbs and head in such a way as to avoid colliding these parts of the body with the ground – Figure 2). Thus, this phenomenon is organic in nature and the FFF-based method of revealing it makes it possible to diagnose it as early as toddlerhood.

In our opinion, the most obvious implication of this finding is the need to move away from the paradigm of 'toddlerhood and pre-school motor development'. According to the scientific facts, an adequate name for this stage of ontogenesis is 'the first period of positive and negative changes in human motor skills already at toddlerhood and pre-school age'.

This example highlights the sense of using the precise language of innovative agonology, not only in the areas of science and education, but also in community journalism. The word 'development' is among the key terms of this new applied science and is used exclusively in positive connotations [12]. However, this discovery furthermore raises two elementary questions, the resolution of which may prevent the continuation of a global pandemic of death that has been going on for thousands of years, or spending the rest of one's life in disability, precisely as a result of unintentional fall.

Firstly, will complementary scientific studies of toddlerhood and pre-school children, based on repeated monitoring of backward falls under reproducible, safe laboratory conditions, result in the discovery of an organic cause for two mutually exclusive phenomena?

One is the ability of a large proportion of two-year-olds, and only a few older children, to protect the distal parts of the four body segments (lower limbs, hips, upper limbs, head) during a collision with the ground due to an unintentional fall, which they have not yet realized (sensory memory). The second is to make mistakes during each fall and ground impact, which means extreme risk of loss of life or injury in non-laboratory circumstances.

Secondly, is it possible to extend the ability to protect the distal parts of the body when colliding with the ground as a result of an unintentional fall (which two-year-old children are endowed with) to that point in ontogenesis when the individual, as a result of the development of cognitive functions and motor potential, will be able to control this process increasingly consciously and safely?

We emphasize the organic basis of these phenomena, as the empirical rationale seems to be obvious. Among each set of examined children older than two years old (three-, four-, five – and six-year-olds), only one did not make the errors mentioned above. So the secret probably lies in the structure and function of the neuro-physiological subsystems responsible for the motor potential of homo sapiens. Our observations provide evidence that, beyond any doubt, during a fall the child protects the distal parts of the body (head and upper limbs) most effectively when he or she is at toddlerhood. However, these subsystems are already failing at an increasing rate from year to year.

However, it would be absurd to argue that suggesting the higher cognitive potential (reflective) of two – and three-year-olds during the earliest experience of falls due to the difficulty of maintaining a vertical posture.

From the perspective of resolving the second question posed above, we do not ignore the modifying potential of both the motor patterns originating in the environment in which the child functions and the specificity of training stimuli acting systematically in later periods of ontogenesis. The higher the intellectual development of the addressee of these stimuli, the greater the chance that he/she can accumulate them with increasing awareness. If, in addition, he masters the appropriate techniques, he can effectively control this phenomenon by falling as a result of a loss of balance. This line of reasoning, supported by scientific and popular science reports on the epidemiology of the effects of falls [e.g. 9, 10, 8], but also on the positive effects of learning safe falling techniques regardless of age, gender, physical fitness, disability etc. [13], leads to the conclusion that the quality of the whole system of cognitive-behavioral stimuli offered by the social environment becomes of primary importance in the prevention of falls and their destructive consequences. The exemplification of the two extreme events cited below is only meant to stimulate the imagination of those subjects who will take the trouble to conduct further complementary studies of the phenomena discussed here, but above all determined to systemic preventive implementations that will fill the entire ontogeny.

The first example refers to an incident in 1920. Missionary Joseph Singh, who ran an orphanage in Midnapore (northern India), found two wolf pups and two girls in a wolf burrow under a mound of white ants. To this day, it is not known whether the girls (who were given the names of two-year-old Amala and eight-year-old Kamala) were sisters. One thing they had in common – a wolf mind. They slept together curled up in a ball. They would wake up with the moon and howl. They ran on all fours for so long that their joints and tendons became so deformed that they could not straighten their legs or walk like humans. When Amala died as a result of a kidney infection, Kamala went into shock. It was then, for the only time in her life, that she wept. She learnt to move in upright posture and wear clothes. Singh gave her massages so that she could stand on her feet. However, until her death in 1929, whenever she wanted to run – she would fall on all fours. He taught her to eat normally, sleep with other children and enjoy the company of people. While a normal two-year-old child learns an average of 40 words in a week, she learned 12 in three years. She had learnt about thirty words in Bengali but could not tell anything about her past life [14].

This is not an isolated occurrence. The phenomenon of children abandoned by civilization (or, in other words, wild children) may provide some inspiration for researchers to complimentarily address the development of innovative programs that we conventionally call 'safe fall from toddlerhood'. The essence of such programs would be to reduce errors during an unintentional fall before a person learns to apply techniques to collide safely with the ground or a vertical obstacle in a variety of circumstances. An unintentional fall, although the most significant among these circumstances, is only an example of the variety of hazards whose common result is the collision of the body with a hard vertical or horizontal obstacle or with an object in motion. An unintentional fall (but executed professionally), in a sense paradoxically, is one possible way of precisely avoiding a collision with an object in motion while ensuring a safe collision with the ground.

These most common errors involve colliding with the ground either first with the hands or simultaneously with the hands and large parts of the body (buttocks, back) and often also combined with a head impact. In other words, the aim of such programs would be to prolong the ability to collide safely with the ground following a fall. And this ability is gifted to most two-year-olds. At the highest level of generality, this phenomenon was incorporated in 2009 into the name 'the susceptibility test to the body injuries during the fall' (STBIDF) [3]. The authors of a modified version of this test (STBIDF-M) used the abbreviation SFI as a synonym for the phenomenon of the **susceptibility to injury during the fall**, and an element of coding for specific indicators, e.g.: *SFIpoints; SFIhands*; *SFIhead; SFI profile; SFIdegree, etc.* [7]. Thus, even more briefly, the aim of 'safe fall from toddlerhood' programs can be described as diagnosing and reducing SFIs.

The second extreme example is such an important premise that it can be linked not only to the phenomenon of reducing SFI, although the most positive effects would often have to wait after years of exercise. However, since the destructive effects of unintentional falls are a global phenomenon, compounded at the end of ontogeny, the need to intensify optimal cognitive-behavioral interventions as the years go by should not be a deterrent. On the contrary, the attractiveness of these necessary interventions on various levels (health, emotional, motor, cognitive, etc.) is directly related not only to the expected adaptation effects of the safe fall, but above all to quality of life and survival.

Josef Keul in a publication on the relationship between circulation and metabolism during exercise states that '(…) different effects of various types of training can be seen in identical twins. One of them trained for several years with strength work and the other with endurance running. Through strength training, the one had a body weight which is 16 kg higher, a maximal Vo_2 of 1.8 l/min and a hard volume of 560 ml. On the other hand, in spite of a lower body weight, the endurance runner has a higher maximal Vo_2 of 2.5 l/min and a hard volume of 710 ml.' Keul concludes that 'this is an excellent example how one can change the phenotype in men who have the same genotype through different forms of training' [15, p. 217-218].

Our current findings require several complementary observations before definitive recommendations can be made for creating universal 'safe fall from toddlerhood' programs. First and foremost, it should be checked whether, during FFFb, the cause of some of the errors made by children is the excessive force used by the examiner causing them to fall on soft ground during the diagnostic session. A subjective, three-point rating scale for the force used would be sufficient to overcome the child's resistance: slight; average; high. In addition, recording the duration of each FFF will make it possible to determine whether they are similarly attractive to children (also in comparisons between age groups).

The suggestion to estimate the force used during FFFb is well supported empirically. Among the nine two-year-olds who made only one ground impact error during an individual diagnostic session, such an event occurred four times precisely during FFFb (Table 3). If the cause of these single errors was the excessive force used, the result of the observation would mean that exactly 50% of the sample from the population of observed two-year-olds is endowed with the ability to protect the distal parts of the body (hands and head) unconsciously at the moment of impact with the ground due to an unintentional fall. If we accept the assumption that the cause of the only mistaken fall of the other 5 two-year-olds (two girls and a boy during FFFa and a girl and a boy during FFFc) is not related to this mysterious factor incorporated into the organic substrate (just a coincidence of external circumstances), it is legitimate to conclude that this trait (capacity of unconscious protection…) affects 65% of the studied two-year-olds.

Following this line of reasoning, a similar correction among the three-year-olds means that 8, out of 32, made only one incorrect fall: four of them during FFFc and two each during FFFa and FFFb. Thus, it should be provisionally assumed that about 28% of the population of three-year-olds is still endowed with this trait.

If so, the identical adjustment of the results for four-year-olds reinforces the evidence that this is a watershed moment of ontogeny, not least because of the increased likelihood of children being exposed to damage to their hands and/or head on impact with the ground during each fall. This second phenomenon of the opposite extreme is the radical reduction of the above-described capacity for unconscious protection of distal body parts (inherent in most two-year-olds and less than one in three three-year-olds). We found that only one boy, among the 47 four-year-olds (abstracting from a peer who fell unerringly), committed one incorrect fall – during FFFc. His SFI degree (fraction) was 0.1000, as the basis for calculating this was only 10 falls, although the session lasted 20 minutes.

However, the most significant secrets are hidden by the organisms of individuals who, irrespective of age, reveal during laboratory observations of the SFI phenomenon especially extreme raw SFI scores (1 or 100%) or very high degree of this characteristic (from 0.8000 to 0.9999). In the self-reported studies presented here, such indices are (respectively): among six-year-olds there are less than 8% and almost 31%; among five-year-olds somewhat less: less than 3% and about 28%. These two rates appear earliest among four-year-olds in identical proportions of about 2% each. Among the three-year-olds surveyed, only one boy (3.12% of this sample of the population) committed 90% of mistaken falls, which qualifies him as being at very high risk of injury during an unintentional fall.

Mroczkowski and Sikorski [16] used STBIDF in a study of 88 children aged 10 to 12 (53 boys and 35 girls). They showed an extremely negative result (14 points) only in a group of 27 boys who participated only in four physical education classes per week (45 minutes each), while also only in this group they showed that the lowest of the SFI indices found was 1 point (i.e. an I° error was made only during one of the simulated backwards falls). However, the authors did not state whether these results were isolated or applicable to several boys. Similarly, when characterizing the other groups, they only showed a maximum score (in the girls' group 13, and 11 in the boys' group who also took part in trainings conducted by sports clubs) and a minimum score (4 and 3 respectively). This is an important empirical indication that neither the varied sporting activity, dominated, however, by football (16 boys) in comparison with the others (3 hockey, 2 handball, 2 karate, 1 capoeira, 1 dance, 1 judo), nor the content of physical education lessons in Polish primary schools provide stimuli that would reduce SFI during unintentional falls.

An unintentional fall (of which a rival may be a potential culprit during hand-to-and combat) is built into this part of combat sports, the essence of which are throws and grips of immobilization of opponent's body (judo, ju jitsu, sumo, wrestling etc.) [17]. But there are hand-to-hand combat techniques such that, in order to throw the opponent, one must first fall oneself in an appropriate manner – in judo these are techniques referred to as *sutemi-waza* (sacrifice techniques – *ma-sutemi*: forward sacrifice projections; *yoko-sutemi*: side sacrifice projections).

Interestingly, Dariusz Boguszewski [18] used the original version of the STBIDF to study the SFI phenomenon among men, 90 of whom, aged 24.57 ±6.22 years, trained combat sports (36 judo, 23 taekwondo, 17 jujitsu, 14 wrestling); 49 (age 22.25 ±2.73) preferred other forms of physical activity, and 52 (age 22.56 ±2.74) declared no physical activity. Among the men in both comparison groups, he documented at least one with a maximum SFIpoints index (14 points) and at least one who made only one I° error (1 point, which in simple terms indicates a 7.14% risk of injury during a ground impact) – Boguszewski only reports extreme results, not numbers of individuals with such indices. No men in the control groups performed the STBIDF flawlessly. Among the combat sports athletes, 15 (17%) performed STBIDF flawlessly and none were classified as very high SFIdegree, however 23% as high SFIdegree. Thus, it is exaggerated to recommend that a certain category of combat sports is the optimal form of physical activity in terms of reducing SFI. Authors of studies on falls as the leading cause of injuries among farmers highlight the limitations of practicing judo in preventing these incidents [19].

By far the most effective programs are those dedicated to teaching safe fall techniques [13, 20-23]. Some authors verifying this effectiveness have also studied the SFI phenomenon. Bartłomiej Gąsienica Walczak, in his unique experiments, proved that teaching safe fall methods and techniques to healthy people, those with visual impairments, limb amputations and one with morbid obesity results in a dramatic reduction in SFI [21-23]. During a two-semester pilot study of physiotherapy students (68 female and 22 male) the mean male score (9.91 points) was indicative of a very high SFIdegree, while the female 8.54 points was borderline high and very high. None of the subjects performed the STBIDF without errors, while the maximum number of errors (14 points) was made by two male and one female students. Reducing the mean SFIpoints to 0.68 and 0.93 respectively was the result of 0 points thirteen male students, 1 point, three – and 2 points six-. Among female students: 0 points 30 students; 1 point 17-; 2 points 17-; 3 points 4-. The principal investigator found no extreme SFI scores (0 and 14 points) before the actual experiment with 30 female and 14 male physiotherapy students. Mean STBIDF scores before the experiment were slightly lower than during the pilot study: male 6.43 points; female 7.67 points. After the actual experiment, it became apparent that the adaptation effects were more diffuse compared to the pilot study. Although among the male students the proportion of those who performed the STBIDF flawlessly was similar (pilot study 59.09%; right study 57.14%), after the right experiment 14.28% documented a raw score of 3 points, which means more than 21% risk of injury during a fall. Meanwhile, in the pilot study, the highest degree of such risk was 14.28% (2 points), affecting more than 27% of male students. These disparities are more pronounced among female students. After the pilot experiment, 44.11% performed the STBIDF flawlessly, while 26.66% did so after the actual study. After the pilot study, the highest risk of injury during a fall was 14.28% (3 points) and affected 5.88% of female students, while this risk was higher (35.71%) and affected 6.66% of female students who completed the proper experiment [21].

The result of this comparative study does not diminish the previously stated thesis that the most effective empirically validated methods of reducing SFI to date are programs dedicated to teaching safe fall techniques. In the clinical study preceding the specific course (10 sessions about 45 minutes each) no subjects with extreme SFI scores (0 and 14 points) were found, but also no male amputee (n = 8), no visually impaired person (n = 8), and no morbidly obese person (who completed the two-semester training) reduced SFIdegree to very low (0 point). A significant achievement is that these individuals offset the effect of reducing the SFI by 4 to 8 points with acquired safe fall motor skills. The obese person performed the 'test of safe falls' without error, and the mean score on the 100-point scale, was 86.9 among amputees and 82.5 among patients with visual impairment [22, 23]. The stature of these empirical data is all the greater, as it has been proven beyond doubt that the cognitive factor in the reduction of SFI, mainly by teaching safe fall, is second only to the motor effects.

In one experimental safe fall course involving 36 male physiotherapy students, extreme STBIDF scores were documented by only two students. The student who performed the test without error was an active athlete and repeated the same result after the experimental training. The student who does not take sports activities in leisure made all possible errors (14 points), but at the same time reduced them to 0 after the training. Although 53.33% of the students originally identified at high and very high SFI levels migrated to a raw score of 0 points, 38.89% made errors during STBIDF, indicative of average SFI. Thus, the contribution of the cognitive factor was limited to these 53.33% of students, as those who continued to make errors during the simple motor test were not able to use all their knowledge of the SFI phenomenon. The training program included: lectures (10 hours), classes (20 academic hours, every 45 minutes) of authors program 'Theory and methodology of safe falls persons with eye diseases'; alternatively, students (one hour) participated in session as a practitioner (potential patient with eye diseases) and one hour as prophylactic/kinesiotherapy expert and also documented load during the particular session [21].

The STBIDF results of these students were compared with a clinical group (5 men with visual impairments) with a much poorer exercise program and comfort level: special safe falling course and avoiding collisions for people with eye diseases; 10 sessions (to 45 minutes) once a week within the lessons of physical education; every patient has done the scheduled exercises on the two big mattresses (precisely connected); to ensure personal safety in each session participated maximally four people. Effect of reducing individual STBIDF scores after 10 sessions: from 11 to 3 points; from 10 to 4-; from 9 to 2-; from 9 to 5-; from 6 to 2 – [22].

Although Mroczkowski et al. [24] provided evidence of a limited effect of a cognitive factor on the motor effect of reducing SFI (they familiarized students with the evaluation criteria before repeating after two weeks of STBIDF – first measurement 4.189, second 2.811, difference p<0.001), they demonstrated an important advantage of this phenomenon from a diagnostic perspective: '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' [24, p. 60].

We highlight another aspect of this result. The earlier in ontogeny optimal measures for the prevention of the destructive effects of falls are implemented (especially exercise, preferably in a form of FFF), the greater the likelihood of forming a relatively permanent habit of protecting (not necessarily fully conscious) distal body parts during a collision with the ground caused by an unintentional fall. Reinforcing this habit in later periods of ontogeny with a comprehensive impact on the cognitive sphere will only increase the effectiveness of prevention.

Such an example of increasing the effectiveness of prevention, when the habits of primary contact with the ground of the hands, rather than the buttocks, during a sudden change of vertical posture to a lower level (sitting on a chair, for example) are established, and the person is furthermore burdened with intellectual disabilities, is an innovative scenario based on positive emotions. The physiotherapist aimed to change this habit in the patients through the repeated activity of sitting down on a chair after previously walking a 3–4-meter distance holding a medicine ball in their hands. Patients supported themselves on the chair with one hand for many weeks before sitting down, despite increasing the weight of the medicine ball. The applied scenario of the new exercise suggested to the patient that the foam sticks he was holding in his hands were flowers with which he was going to gift his beloved girlfriend. The motor layer of the exercise was not altered. This unique placebo effect proved to be 'electrifying' – most of the patients sat down and got up from the chair without the help of a hand, and the exercise evoked great joy in them [25]. This does not yet mean that, when falling in other circumstances, the inevitable collision with the ground will, however, precede the hands before large body surfaces come into contact.

Before definitive recommendations are made for the creation of universal 'safe fall from toddlerhood' programs and before these programs are implemented by any rational society, the already present empirical evidence and technological possibilities of observing the child are sufficient to make current calculations without expert assistance. One possibility is to record a child's motor activity if he or she is even left unsupervised in a safe environment for some time. It is sufficient to determine from the video recording whether the child fell at least nine times and whether there were instances during the collision with the ground that the first contact was either with the hand(s) or the head. It is just as well to arrange the FFF alone, respecting, however, the criteria described in this work, but it is not necessary to change the FFF. One FFF, but the child's favorite, even arranged by the child, can be used. The results of the mathematical calculations can be compared with the standards in Table 2. In case of an SFIdegree score of at least high, or higher, a neurological consultation should be sought immediately, and this article should be recommended to the doctor.

CONCLUSIONS

The simplicity but at the same time very high efficiency of the FFF method in diagnosing the SFI phenomenon starting from two-year-old children is an opportunity (as a key element of complementary research) to verify a hypothesis of breakthrough importance for the diagnosis of many health risks: the discovery of an organic cause of the extreme degree of SFI already among toddlerhood and preschool children is at the same time the establishment of a highly probable common source of many neuro-degenerative diseases and disabilities.

Invariably, the FFF method is a fundamental part of the complex of necessary promotional, diagnostic, preventive and therapeutic measures to stop the escalation of the global pandemic of death and years spent in disability as a result of unintentional fall.

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