

“Balancing” children’s physical risks: relationship between balance and risk propensity in developmental age of an Italian children group

Mara Pischetola,¹ Simona Boncompagni,^{2,3} Danilo Bondi²

¹*School of Medicine and Health Sciences, University “G. d’Annunzio” Chieti-Pescara, Chieti, Italy;* ²*Department of Neuroscience, Imaging and Clinical Sciences (DNICS), University “G. d’Annunzio” Chieti-Pescara, Chieti, Italy;* ³*Center for Advanced Studies and Technology (CAST), University “G. d’Annunzio” Chieti-Pescara, Italy.*

This article is distributed under the terms of the Creative Commons Attribution Noncommercial License (CC BY-NC 4.0) which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

Abstract

Children are not fully able to associate severity and injury probability with cognitive, emotional, and social factors. This study focused on physical risk-taking by exploring the associations between risk propensity and physical balance during the developmental age. Specifically, sixteen girls aged 58 to 108 months (\approx 5 to 9 years), of whom 43.75% normal-weighted and all were active in rhythmic gymnastics, were subjected to a combination of physical tests (i.e., static and dynamic) and questionnaires to evaluate balance, sensation seeking, and risk propensity, respectively. Our results showed that the better the static balance, the higher the sensation seeking and risk propensity, while age had a negligible effect on these associations. Our study suggested that balance affects propensity towards risky behaviors in children.

Key Words: girls, rhythmic gymnastics, coordination, sensation seeking.

Eur J Transl Myol 35 (4) 13404, 2025 doi: 10.4081/ejtm.2025.13404

Risk-adjusted behavior has been studied extensively in children, adolescents, and adults.^{1,2} However, the main focus is usually on children, as they are the most vulnerable to accidental injuries.^{3,4} Several factors seem to influence the assumed physical risk, that is, the result of all behaviors associated with numerical probabilities of undesirable results such as wounds, bruises, or fractures. As for children in the early years of life, it seems that the incidents are mainly due to the willingness for exploration and to the skills not yet fully developed, which, often, are overestimated by the children themselves. Both cognitive and emotional factors lead to children’s physical risk-taking, as they often assume «behaviors that could result in physical injury when there are alternative behaviors that do not do so».⁵ There is a difference between the perception of a child’s risk and that of an adult: adults use criteria like severity and probability of occurrence and associate them with cognitive, emotional, and social factors. On the contrary, children, due to the lack of experience, are not able to combine these factors and thus commit errors of estimation about the extent of the risk. The difference in risk-taking behaviors across ages has been suggested to rely on the relative strength of inhibitory control over positive impulses as age increases.⁶ First, it was noticed that the character is conditioned by

the sex of the child. The male sex, in fact, involves a greater emotional activation, with consequent impulsiveness and a greater tendency to exploration, implying in turn, a preference for physical games and aggressive and oppositional conduct. This is confirmed by studies carried out by Morrongiello and Dowber:⁷ by observing the behaviour of children and by applying IBC (Injury Behavior Checklist) questionnaires to mothers with children between 30 and 42 months old, the authors concluded that boys tend to approach and touch potentially dangerous objects, while girls have a greater tendency to listen to the indications of their mothers. In addition to the biological conditions of the sex itself, the impetuous temperament of the male is also likely due to social and cultural conditions. A study by Granié in 2010⁸ showed that, especially at preschool age, there is a stereotype that activities taken as masculine are more dangerous than those taken as feminine. Secondly, we have the temperament of the child himself. The studies carried out are different and focus on different aspects of temperament. Schwebel in 2004,⁹ for example, focused on impulsiveness, Boles and his collaborators in 2005¹⁰ on hyperactivity, as well as Garzon, Huang and Todd in 2008.¹¹ Morrongiello, Corbett, and Brison in 2009¹² focused on poor inhibitory control. One of the features that has mostly attracted attention is the search

for exciting sensations, the «sensation seeking», which deserved a questionnaire for its own assessment, released by Morrongiello, Sandomierski and Valla¹³ based on previous observations by Sundelin and colleagues¹⁴ called the Sensation Seeking Scale. Last, but not least, is the role played by adult supervision and their perception of children's attitudes. Supervision is defined by Saluja and her collaborators in 2004¹⁵ as the union of three factors: i) attention in listening and observation, ii) physical proximity, and iii) continuity of supervisory behaviors. Just one of them, physical proximity, is defined as a probable cause of the increased probability of accidents, as with increasing age, the adults tend to move further and further away from supervision. Although parental and environmental strategies reduce children's risk of in-home injury, continuous and close supervision does not always lead to a lower incidence of unwanted events; indeed, the occurrence of child injuries results from multiple interacting factors^{16,17}. The significant difference in the outcomes is probably due to the adults' involvement, whether they are extremely protective or completely intolerant of risk. Differences in the approaches of parents, which rely on different methodologies and cultural characteristics, may also determine differences in outcomes across studies.

The child factors in pre-school children have been reported to rely on search for exciting sensations and recklessness, associated with risk propensity behavior, at least for light injuries.¹⁸ Greater balance skills improve the developmental trajectories for coordination,^{19,20} thereby likely reducing the rate of sustaining injuries and falls, which in turn may influence the choice of risky behaviors. However, the relationship between physical performance, risk propensity, and the search for exciting sensations, although empirically plausible, has been poorly investigated, particularly during developmental ages.

This work aimed to find original new factors which may determine an increase in propensity to physical risk by investigating the associations between risk propensity and balance, on an Italian group of young girls involved in rhythmic gymnastics.

Materials and Methods

Participants

The study includes sixteen female children of Italian nationality aged between 58 and 108 months. Girls were members of the «Leviosa Amateur Sports Association», where the girls engage in both recreational activities, motor activities, and sports specialization toward rhythmic gymnastics. All the subjects except one lived and attended schools in the same municipality. One subject lived and attended school in an adjacent municipality. None of the participants had diagnosed neurological, neuromotor, sensorial, psychological or behavioral disorders.

Following the signing of the authorizations by parents or legal guardians, the project was carried out in the Lev-

iosa ASD's facilities; a sports technician conducted all activities. Participants underwent: i) two specific motor function assessment tests to discriminate balance ability, ii) two balance assessment tests, and iii) two questionnaires to assess risk propensity.

Inclusion criteria of non-pathological balance were based on two assessments.

The first assessment was the Oseretsky-Guilman battery test²¹, which requires: children of 4-5 years to maintain balance on united tiptoes with eyes opened and arms extended along the sides for at least 10 s, children of 6 years old to support themselves on one leg with the other flexed at 90° for at least 10' s in both sides, children of 7 years old to maintain on tiptoe position with closed heels and knees bent apart, eyes closed and arms extended out for at least 10' s, and children of 8 years to remain on tiptoe with trunk flexed to 90° and arms behind for at least 10 s; outcome of functional development requires success in at least one out of three trials; rocking, stepping, loss of balance, falling and loss of position were counted as failures.

The second assessment was the Babinsky and Weil test,²² which requires participants to advance four steps forward and four steps backward with eyes closed; success was considered when the subject was able to draw a straight line, while pathological outcomes include typically either star gait, slight deviation towards one side, or irregular steps with excessive deviation and hesitant gait.

Procedures

The participants that were considered approved in tests 1 and 2 had then weight and high registered and followed the tests required to answer the main study's questions: i) the Fleshman test, consisted in a version modified by Italian Olympic Committee (CONI) - section Carrara:²³ the participant stands with one foot on a metal board \cong 30 cm long and 2 cm thick while supporting with one hand to a side wall; following the start signal, the hand must be detached from the wall and participant holds the position as long as possible; two attempts per leg were carried out and the average of the trial times was registered; this test was used for assessing static balance; ii) the Walking Test named as «ant» test, which is part of the MABC-2 battery²⁴ and requires subjects to walk in a straight line for 4.5 m while alternately placing the heel of front foot touching the toe of the rear foot; one familiarization trial and two effective trials were conducted thus registering the lowest; failures were marked if leaving the line, losing balance, and not following directions for foot position; this test was used to assess dynamic balance.

Both i) and ii) tests constituted the coordination assessment.

The two questionnaires were administered by ensuring not too much time to answer in order to leave the true inclination come out and to avoid influences from external thoughts and factors.

The «Sensation Seeking Scale» for children (SSS) was used as described by Hoyle²⁵ The Scale is composed by

Balancing children's physical risks

Eur J Transl Myol 35 (4) 13404, 2025 doi: 10.4081/ejtm.2025.13404

14 items in which responses range from «totally disagree» (score 1) to «totally agree» (score 5). The higher the total average, the greater the risk propensity. When the final score reaches above 3.10 points the SSS and consequently risk propensity is considered high.

The Risk Propensity Scale (RPS) was adapted from Meertens & Lion, 2008²⁶ and consists of 7 items with a rating scale from 1 («totally disagree») to 9 («totally agree»); for calculating the total score, 1, 2 and 3 items' scores are considered in reverse order. We removed item 5 due to the girls' difficulty in understanding the double negation of the text. Nevertheless, the adaptation of items, the score was not adapted, since it relies on the average. The higher the total average, the greater the risk propensity. When the final score reaches above 4.29 points, the degree of risk propensity is considered high.

Statistical analysis

After all the tests were completed, we compared results from the coordinative tests and risk propensity questionnaire. Before that, in order to confirm that weight wouldn't influence the main results, we analyzed three variables by separating the participants in categories using the FitBack Class Report (www.fitbackeurope.eu/en-es/fitness-report).²⁷ After categorization, one-way

ANOVA was used to compare the 3 graphs, considering $p \leq 0.05$ as significant. Pearson's Correlation was also applied, and r was considered a strong correlation when > 0.7 . After that, and in order to verify if there was any correlation between the test's results, questionnaires and age. Statistical analyses and graphs were made with Jami (v. 2.3.21.0) and GraphPad Prism (v. 10.0.1).

Results

The results generated four categories: i) underweight, ii) normal weight, iii) overweight, and iv) obese. All sixteen girls successfully completed the two pre-assessments for non-pathological balance and were then considered for this study. BMI categorized using Fitback data,²⁷ a large-scale European survey on fitness in developmental age, revealed that 43.75% of them were categorized as normal weight, 25% as overweight, 25% percent as underweight, and only one subject categorized as obese. Summary of descriptive age and BMI characteristics and the main results of Linear, Fleshman, RPS, SSS tests are shown in Table 1.

The comparisons by weight categories were far from statistically different for all the tests, as demonstrated in Table 2. Considering all these results, we can assume that weight does not influence the test results.

Table 1. Descriptive characteristics of participants and results of physical tests and questionnaires.

	Age (months)	Linear test (seconds)	Fleshman test (seconds)	RPS	SSS
N	16	16	16	16	16
Mean	86.31	20.81	3.46	4.29	3.10
St. dev.	15.76	3.82	0.80	2.21	0.63

RPS, risk propensity scale; SSS, sensation seeking scale.

Table 2. Statistical results of comparisons grouping all weight categories; one-way ANOVAs were carried out with Welch method.

	F	df1	df2	p
Linear	0.262	2	5.204	0.779
Fleshman	0.133	2	6.191	0.878
RPS	0.208	2	7.085	0.817
SSS	0.238	2	6.529	0.795

df, degree of freedom; RPS, risk propensity scale; SSS, sensation seeking scale.

Table 3. Statistical correlation between variables using Pearson's method.

	Dynamic balance	Static balance	Risk propensity
Static Balance	p=0.015 r=-0.595		
Risk propensity	p=0.443 r=-0.207	p=0.020 r=0.575	
Sensation seeking	p=0.257 r=-0.301	p=0.002 r=0.715	p=0.004 r=0.674

Correlation analysis among variables without weight grouping revealed that static balance is positively related (Fleshman test) with seeking sensation (SSS) ($r=0.715$, $p=0.002$). Static balance showed to be borderline correlated to risk propensity (RPS) ($r = 0.575$, $p = 0.020$). Dynamic balance showed no correlation with sensation seeking or risk propensity. See Table 3 for data. In addition, static and dynamic balance were revealed to be inversely associated: the longer participants maintained the static balance, the lower the time for the «ant» test ($r=-0.595$, $p=0.015$). In the same way, SSS and RPS were positively associated, as to confirm both focus on the same psychological construct ($r=0.674$, $p = 0.004$).

When age was used as a controlling factor (pairwise correlation), it had a negligible effect in all associations. These results are shown in Figure 1 by plotting test results on age.

Discussion

The main objective of this study was to find a novel variable that determines an increase in propensity to physical risk, which has not been studied yet. By observing the behaviors of girls in the developmental age group, we hypothesized that balance was a good candidate to investigate. All the tests used proved to be greatly feasible for the evaluation of skills in girls of developmental age, both for their simplicity and for the speed at which they can be performed. None of the participants felt discouraged or frightened by the tests; on the contrary, they enjoyed their involvement in the test. The two questionnaires proved to be useful and comprehensible. The speed and simplicity of the administration were useful in order to avoid boredom and unwillingness in the compilation by the girls. Both static and dynamic balance were herein considered pillars for building movement patterns during early childhood, relying on the complexity of balance, which results from multiple sensorimotor processes. In addition to the clinical assessment of children who struggle with their balance or experience dizziness, we considered stability skills at the forefront of fundamental motor

skills for leading the differences in motor behaviors and sensation seeking during early childhood.

The most important result was that the better the static balance, the higher the risk propensity and sensation seeking of girls. Therefore, in the model that strongly links self-reported sensation seeking to a child's risk-taking and history of injuries,¹⁸ balance can represent a novel layer of interest. Overweight did not affect our results, since differences in performance by weight category were negligible. Age only partially mitigated the associations between variables. An explanation for our results can rely on self-esteem and self-confidence as a result of a better ability to maintain balance. Other explanations could, instead, be found by analyzing the effect of the vestibular apparatus on the general vision, *i.e.*, the appearance of the world, but this last possibility should be investigated in future studies through appropriate instruments and by including children with dysfunctions.

Obviously, the nature of this work - *i.e.*, pilot study - limits the possibility to infer our insights, and it has to be considered a starting point for broader and more general future studies with more participants, wider age groups and both genders. However, our insights contribute to extending the model of risk propensity during developmental ages. During infancy, to limit unintentional injuries, in addition to parents' supervision, attention can be paid to hazard removal, particularly during the emergence of motor milestones,²⁸ since the greater the motor skills development, the more frequent the individual infant injury-risk behaviors.²⁹ During pre-school and school ages, risk propensity can result in unintentional injuries, when the fine trade-off between risk acceptance and avoidance, necessary for motor development through physical activity, does not guarantee the safety of children. More frequently, unintentional injury occurrence during school age has been linked to psychological difficulties, behavioural problems, and risk-taking behaviour; however, other child factors such as history of injury, having a sensory deficit, and poor learning ability have not often been explored³⁰. In our sample of pre-school, early and middle-aged school

Balancing children's physical risks

Eur J Transl Myol 35 (4) 13404, 2025 doi: 10.4081/ejtm.2025.13404

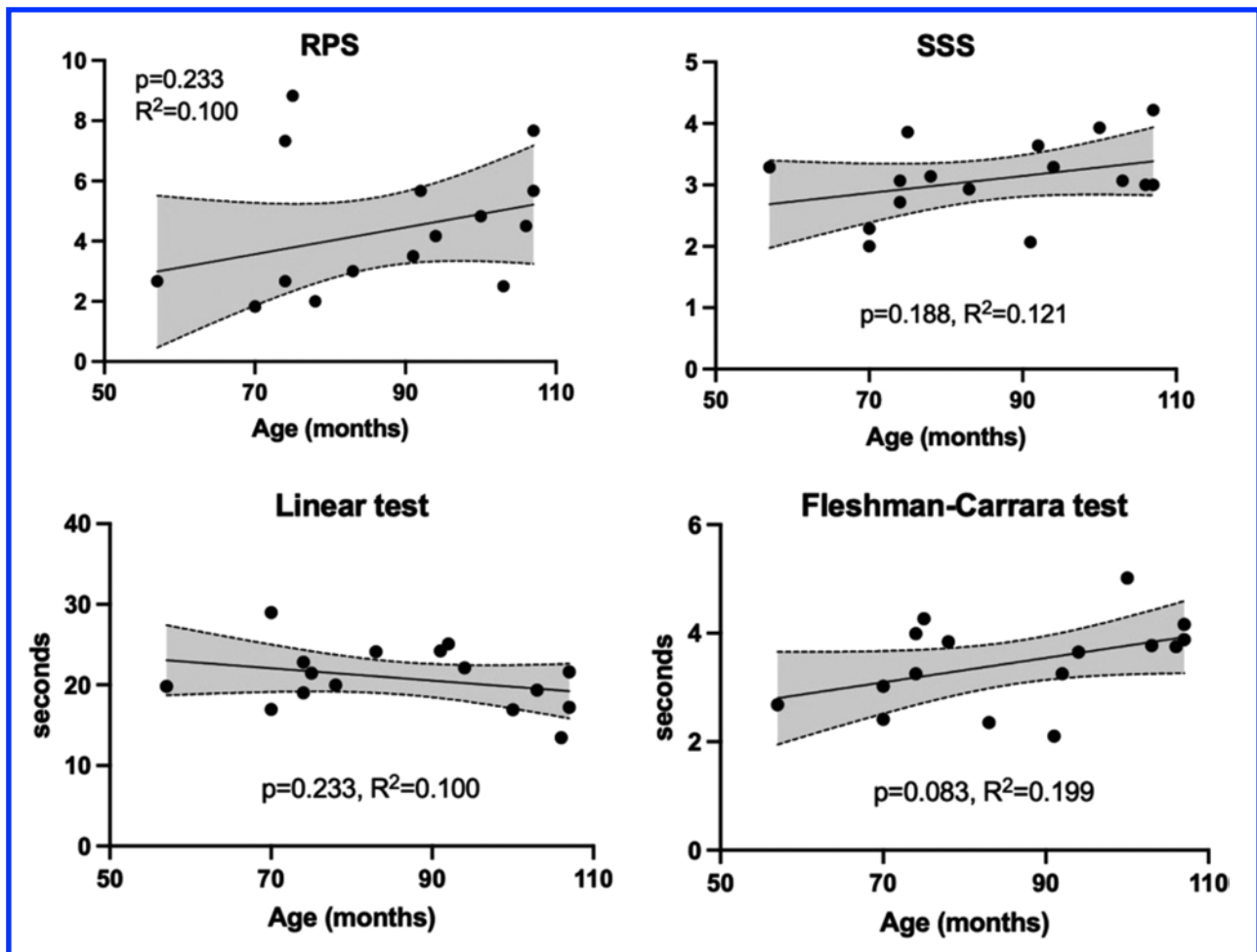


Figure 1. Linear regressions with age as predictor variable. RPS, risk propensity scale; SSS, sensation seeking scale.

children, we found a positive association between static balance and self-reported sensation seeking and risk propensity.

In conclusion, our study suggests that broadly motor skills proficiency, and particularly balance, are important factors to be considered in studies aiming to determine the propensity towards risky behaviors.

List of abbreviations

ASD, Associazione Sportiva Dilettantistica (Amateur sports association)
MABC, Movement assessment battery for children
SSS, Sensation seeking scale
RPS, Risk propensity scale
ANOVA, Analysis of variance
BMI, Body mass index

Funding

This manuscript has not been supported by any external funding.

Conflict of interest

The authors declare no conflicts of interest.

Ethics approval

The study is conformed with the Helsinki Declaration. All children participated in this study after a signed informed consent from parents or legal tutors. Ethics approval was not required in accordance with national guidelines as reported in The Italian Ministry of Health circular n. 6, 2002 and The Italian Legislative Decree n. 211/2003, which define interventional and non-interventional trials that are subject to ethical approval; this study did not involve patients and did not involve drugs, genetic samples or invasive techniques.

Contributions

MP conceived the study and performed the experiments. DB and MP designed and directed the study and wrote the manuscript. MP, DB e SB analyzed and interpreted the data, and edited the manuscript.

Corresponding author

Danilo Bondi, Department of Neuroscience, Imaging and Clinical Sciences (DNICS), University «G. d'Annunzio» Chieti-Pescara, Via dei Vestini 31, 66100 Chieti, Italy
 ORCID ID: 0000-0003-1911-3606
 E-mail: danilo.bondi@unich.it

Co-authors

Mara Pischetola
 E-mail: mara.pischetola@studenti.unich.it

Simona Boncompagni
 ORCID ID: 0000-0001-5308-5069
 E-mail: simona.boncompagni@unich.it

References

- Amato S, Culbreath K, Dunne E, et al. Pediatric trauma mortality in India and the United States: A comparison and risk-adjusted analysis. *J Pediatr Surg* 2023;58:99–105.
- Larsen R, Bäckström D, Fredrikson M, Steinvall I, Gedeberg R, Sjöberg F. Female risk-adjusted survival advantage after injuries caused by falls, traffic or assault: a nationwide 11-year study. *Scand J Trauma Resusc Emerg Med* 2019;27:24.
- Derakhshanfar H, Pourbakhtyaran E, Rahimi S, et al. Clinical guidelines for traumatic brain injuries in children and boys. *Eur J Transl Myol* 2020;30: 8613.
- Kalanjiyam GP, Kanna RM, Rajasekaran S. Pediatric spinal injuries- current concepts. *J Clin Orthop Trauma* 2023;38:102122.
- Morrongiello BA, Matheis S. Understanding children's injury-risk behaviors: the independent contributions of cognitions and emotions. *J Pediatric Psychol* 2007;32: 926–37.
- Shahrabi Farahani F, Khosrowabadi R, Jaafari G. Risk-taking Behavior Under the Effect of Emotional Stimuli Among Children and Adults. *Basic Clin Neurosci* 2022;13:585–93.
- Morrongiello BA, Dawber T. Toddlers' and mothers' behaviors in an injury-risk situation: Implications for sex differences in childhood injuries. *J Appl Develop Psychol* 1998;19:625–39.
- Granié MA. Gender stereotype conformity and age as determinants of preschoolers' injury-risk behaviors. *Acc Anal Prev* 2010;42:726–33.
- Schwebel DC. Temperamental risk factors for children's unintentional injury: the role of impulsivity and inhibitory control. *Personal Individual Diff* 2004;37: 567–78.
- Boles RE, Roberts MC, Brown KJ, Mayes S. Children's risk taking behaviors: the role of child-based perceptions of vulnerability and temperament. *J Pediatr Psychol* 2005;30:562–70.
- Garzon DL, Huang H, Todd RD. Do attention deficit/hyperactivity disorder and oppositional defiant disorder influence preschool unintentional injury risk? *Arch Psychiatr Nurs* 2008;22:288–96.
- Morrongiello BA, Corbett M, Brison RJ. Identifying predictors of medically-attended injuries to young children: do child or parent behavioural attributes matter? *Injury Prevention. BMJ* 2009;15:220–5.
- Morrongiello BA, Sandomierski M, Valla J. Early identification of children at risk of unintentional injury: A sensation seeking scale for children 2–5 years of age. *Acc Anal Prev* 2010;42:1332–7.
- Sundelin C, Rasmussen F, Berfenstam R, Troedsson K. Information through television: does it promote child safety? *Inj Prev* 1996;2:36–40.
- Saluja G, Brenner R, Morrongiello BA, et al. The role of supervision in child injury risk: definition, conceptual and measurement issues. *Inj Control Saf Promot* 2004;11:17–22.
- Morrongiello BA, Ondejko L, Littlejohn A. Understanding toddlers' in-home injuries: I. Context, correlates, and determinants. *J Pediatr Psychol* 2004;29: 415–31.
- Morrongiello BA, Ondejko L, Littlejohn A. Understanding toddlers' in-home injuries: II. Examining parental strategies, and their efficacy, for managing child injury risk. *J Pediatr Psychol* 2004;29:433–446.
- Norcia AD, Marano G, Bombi AS. Injuries in preschool: child's characteristics and parental supervision. *Rassegna di Psicologia* 2016 Dec 20;33(2): 39–48.
- Mnejja K, García-Soidan JL, Romo-Perez V, Sahli S. Postural balance under sensory manipulation predicted fine and gross motor skills in children from 5 to 6 years of age. *Acta Paediatr* 2023;112:1524–9.
- Verbecque E, Johnson C, Rameckers E, et al. Balance control in individuals with developmental coordination disorder: A systematic review and meta-analysis. *Gait Posture* 2021;83:268–79.
- Oseretsky N. Oseretsky tests of motor proficiency. Edgar A. Doll ed. Oxford, England: Educational Test Bureau; 1946.
- Babinski J, Weill GA. Désorientation et déséquilibre spontanée et provoquée. La deviation angulaire. *Comptes-rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie*. 1913;852–855.
- Buonaccorsi A. Manuale di standardizzazione dei test. C.O.N.I. Osservatorio Nazionale Capacità Motorie; 2003.
- Brown T, Lalor A. The Movement Assessment Battery for Children—Second Edition (MABC-2): a review and critique. *Phys Occupat Ther Pediatr* 2009;29:86–103.
- Hoyle RH, Stephenson MT, Palmgreen P, et al. Reliability and validity of a brief measure of sensation seeking. *Personal Individ Diff* 2002;32:401–14.
- Meertens RM, Lion R. Measuring an individual's tendency to take risks: the risk propensity scale. *J Applied Social Psychol* 2008;38:1506–20.
- Ortega FB, Leskošek B, Blagus R, et al. European fitness landscape for children and adolescents: updated reference values, fitness maps and country rankings based on nearly 8 million test results from 34 countries

Balancing children's physical risks

Eur J Transl Myol 35 (4) 13404, 2025 doi: 10.4081/ejtm.2025.13404

gathered by the FitBack network. *Br J Sports Med* 2023;57:299–310.

28. Morrongiello BA, Corbett M, Bryant Ma L, Cox Ma A. sex differences in the relation between supervision and injury risk across motor development stages: transitioning from infancy into toddlerhood. *J Pediatr Psychol* 2022;47:696–706.
29. Morrongiello BA, Corbett M, Colwell S, et al. A longitudinal study of boys' and girls' injury-risk behaviors and parent supervision during infancy. *Infant Behav Dev* 2022;68:101729.
30. Mytton J, Towner E, Brussoni M, Gray S. Unintentional injuries in school-aged children and adolescents: lessons from a systematic review of cohort studies. *Inj Prev* 2009;15:111–24.

Disclaimer

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.

Submitted: 19 November 2024.

Accepted: 11 December 2024.

Early access: 4 September 2025.