

# HEALTH, SPORTS & REHABILITATION MEDICINE

Published since 2000 as *Palestrica of the Third Millennium - Civilization and Sport*

*A quarterly of multidisciplinary study and research*

© Published by "Iuliu Hațieganu" University of Medicine and Pharmacy of Cluj-Napoca  
and  
The Romanian Medical Society of Physical Education and Sports  
in collaboration with  
The Cluj County School Inspectorate

A journal rated B+ by CNCS (Romanian National Research Council) since 2007,  
certified by CMR (Romanian College of Physicians) since 2003

A journal with a multidisciplinary approach in the fields of biomedical science,  
health, medical rehabilitation, physical exercise, social sciences

A journal indexed in international databases:  
EBSCO, Academic Search Complete, USA  
Index Copernicus, Journals Master List, Poland  
DOAJ (Directory of Open Access Journals), Sweden  
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# 2

Vol. 26, No. 2, April-June 2025

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pISSN 2668-2303

eISSN 2668-5132

ISSN-L 2668-2303

[www.jhsrm.org](http://www.jhsrm.org)

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## ORIGINAL STUDIES

# Modeling and evaluation of training and competition participation in adapted judo for athletes with intellectual disabilities

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## Abstract

**Background.** Adapted judo provides an inclusive competitive environment for athletes with intellectual disabilities, fostering improvements in physical, technical, and psychological domains.

**Aims.** The aim was to design and validate a personalized training model, and to evaluate competition participation in adapted judo.

**Methods.** A mixed-method approach was used over a six-month period. Assessments included anthropometric measurements, physical and coordination tests, and psychological evaluation. A tailored training program was implemented with competition simulations and regular evaluations. Pre- and post-intervention data were statistically analyzed.

**Results.** The intervention led to significant improvements in technical execution (e.g., increased percentage of correctly applied techniques), enhanced physical performance (evidenced by increased arm strength, improved flexibility, and aerobic capacity), and elevated self-esteem scores among participants. The data analysis confirmed a positive correlation between personalized training and competition outcomes.

**Conclusions.** The intervention led to measurable improvements in technique, physical performance, and self-esteem, which were associated with better competition outcomes.

**Keywords:** adapted judo, intellectual disabilities, personalized training, performance evaluation, social inclusion.

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## Introduction

Adapting judo training techniques and methods for athletes with intellectual disabilities is essential in the context of modern adaptive sports. Inclusive sports programs provide opportunities for improved health and social integration for individuals with disabilities (Kiuppis, 2018; Morales, 2022).

Adapted judo, in particular, has been shown to yield benefits across physical, cognitive, and psychosocial domains (Descamps et al., 2024; Pečnikar Oblak et al., 2020).

Research indicates that sport participation can positively impact self-concept and well-being in athletes with intellectual disabilities (Pan & Davis, 2018; Lumsdaine & Lord, 2021).

However, athletes with intellectual disabilities face unique challenges and barriers to training and competition, such as lack of tailored programs and difficulties in access to sports facilities (Alanazi, 2021). Therefore, coaches must develop personalized training models that address individual needs and help maximize each athlete's potential.

This study aims to integrate physical, technical, and psychological assessments to develop a personalized training model for adapted judo and to monitor the impact of competition participation on athletes with intellectual disabilities.

The benefits of such an approach include not only improved sports performance but also enhanced self-esteem and social inclusion for the participants (Bocioacă et al., 2023; Züll & Tillmann, 2019).

In order to contextualize the athletes' characteristics, Table I presents a comparison of key anthropometric parameters of judo athletes with different types of disabilities. As shown in Table I, athletes with intellectual disabilities have anthropometric profiles (e.g. height, weight, BMI) broadly similar to those of athletes with visual or motor impairments, with only slight variations in measures like grip strength.

These similarities highlight that athletes with intellectual disabilities possess a physical foundation comparable to their peers, reinforcing the potential for training improvements.

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Received: 2025, February 4; Accepted for publication: 2025, February 15

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<https://doi.org/10.26659/pm3.2025.26.2.48>

**Table I**

Anthropometric profile of athletes in adapted judo (by type of disability).

Parameter	Athletes with visual impairments	Athletes with intellectual disabilities	Athletes with motor disabilities
Average height (cm)	175 ± 7	172 ± 6	168 ± 8
Average weight (kg)	78 ± 10	76 ± 9	74 ± 11
Average BMI	25.5 ± 2.1	25.2 ± 2.3	26.1 ± 2.5
Grip strength (kg)	40 ± 5	38 ± 6	35 ± 7
Arm span (cm)	180 ± 8	178 ± 7	175 ± 9

**Table II**

Weekly training plan.

Week	Day 1	Day 2	Day 3
1	Warm-up, presentation, icebreaker games	Warm-up, greeting, familiarization with kimono	Warm-up, balance exercises
2	Warm-up, greeting, controlled falls	Warm-up, basic techniques (O Soto Gari)	Warm-up, movement games
3	Warm-up, repetition of basic techniques	Warm-up, practicing techniques with partner	Warm-up, introduction to kesa gatame
4	Warm-up, holding techniques	Warm-up, team games	Warm-up, strengthening basic techniques
5	Warm-up, introduction to advanced techniques	Warm-up, practicing technique combinations	Warm-up, judo technique games
6	Warm-up, advanced techniques (ippon seoi nage)	Warm-up, technique combinations	Warm-up, practicing technique combinations
7	Warm-up, match simulations	Warm-up, competition tactics	Warm-up, competition games
8	Warm-up, match simulations	Warm-up, competition strategies	Warm-up, competition games
9	Warm-up, friendly competition	Warm-up, individual feedback	Warm-up, group feedback
10	Warm-up, progress evaluation	Warm-up, setting future Goals	Warm-up, discussions and conclusions

*Notes:*

- Continuous adaptation: The coach remained flexible and adjusted activities based on the needs and progress of each participant.
- Repetition and clarity: Instructions were clear and key techniques were repeated frequently to ensure understanding and retention.
- Positive feedback: Constant encouragement and positive reinforcement were provided to maintain motivation and confidence.

By building on such an understanding of athletes' profiles, the present research develops a structured training and evaluation program.

The main goal is to demonstrate that a scientifically grounded, individualized judo training regimen can improve performance metrics and facilitate the competitive participation of athletes with intellectual disabilities.

**Objectives**

The primary objective of the study is to develop and validate a personalized training model in adapted judo for athletes with intellectual disabilities. The specific objectives include:

- Improving technical and physical skills of athletes through tailored training.
- Increasing athletes' confidence and self-esteem via supportive coaching and success in training.
- Assessing the impact of the intervention on competition performance and participation.

**Hypothesis**

It is hypothesized that athletes who follow a personalized and adapted training program will show significant improvements in technique execution, physical performance, and self-esteem compared to their initial assessments.

Additionally, these improvements are expected to

positively influence competition results, with athletes demonstrating better performance in adapted judo competitions after the intervention.

**Material and methods**

*Research protocol*

This research employed an experimental pre- and post-test design over six months.

*a) Period and place of the research*

The study was conducted at Club Down Bucharest and other partner institutions over a continuous 6-month period in 2024. The overall research protocol included baseline assessments, implementation of the training program, periodic testing, and post-intervention evaluations. Throughout the study, participants underwent integrated monitoring of their progress in anthropometric, physical, technical, and psychological parameters. Ethical approval was obtained from the university's Ethics Committee, and all procedures conformed to ethical standards. Informed consent was obtained from each athlete (and their parents or legal guardians).

*b) Subjects and groups*

The research sample consisted of 15 athletes (age range 16-25 years) with mild to moderate intellectual disabilities, all of whom were members of the Club Down Bucharest sports program. There were 9 male and 6 female athletes. Participation in the study was voluntary. Inclusion

criteria required that athletes had basic understanding of judo practice and were medically cleared for physical activity; exclusion criteria included any severe physical impairments that would prevent judo practice or recent injuries. All subjects and their guardians were informed about the research procedures and goals, and they agreed to participate in both training and evaluation sessions. No control group was used; each athlete served as their own control by comparing their performance before and after the intervention.

#### *Training intervention program*

A personalized adapted judo training program was developed for the athletes, focusing on improving technical skills, physical fitness, and tactical understanding. Training sessions were held three times per week, each lasting about 60-90 minutes, under the guidance of experienced judo coaches familiar with adaptive techniques. The program spanned 10 consecutive weeks of structured training, followed by 2 weeks of evaluation and feedback. Table II outlines the weekly training plan, highlighting the progression of activities and focus areas for each session. As shown in Table II, the program started with introductory and basic judo exercises (Weeks 1-2), reinforced fundamental techniques in Weeks 3-6, then introduced advanced techniques and competition preparation in Weeks 7-10. Each week included a balance of technical drills, physical conditioning, and playful competitive simulations to maintain engagement.

This training plan was designed to gradually increase in complexity and intensity, allowing athletes to build confidence and skill proficiency. Each session typically followed a consistent structure: warm-up and stretching, technical instruction and practice, physical conditioning exercises (balance, coordination, strength drills), and concluding with judo-oriented games or sparring simulations. By the end of the program (Week 10), athletes engaged in mock competitions and reflective discussions, which prepared them for actual competitive participation. The coach emphasized a safe training environment, adapting exercises to individual capabilities and ensuring that athletes learned proper falling techniques (ukemi) to prevent injury. The integration of games and friendly matches aimed to simulate competition scenarios in a controlled manner, thereby reducing anxiety and building competitive experience.

#### *c) Used instruments*

The following instruments were applied in the research and are presented in the results:

- Anthropometric measurements: height, weight, body mass index (BMI), arm span, arm circumference, triceps skinfold thickness.
- Physical fitness tests: handgrip dynamometer (arm strength), sit-and-reach test (flexibility), 12-minute shuttle run (aerobic endurance).
- Technical performance evaluation: observation-based scoring system during simulated judo matches (percentage of correctly applied techniques and tactical execution).
- Psychological evaluation: Rosenberg Self-Esteem Scale (simplified version), and structured interviews with athletes and guardians.

#### *d) Statistical processing*

The collected data were analyzed using statistical software (IBM SPSS 25.0). For quantitative measures, paired sample t-tests compared pre- and post-intervention results for each variable (e.g., strength, flexibility, self-esteem scores etc.), with a significance threshold set at  $p < 0.05$ . All tests were two-tailed. Descriptive statistics (mean  $\pm$  standard deviation) were calculated for each measure at baseline and follow-up. Additionally, Pearson correlation analysis was performed to examine relationships between improvements in training metrics (such as change in physical test results) and competition performance outcomes (such as the percentage of techniques successfully applied or competition match results). This analysis aimed to determine if greater improvements in fitness or technique were associated with better competitive performance. Qualitative observations from coaches (notes on each athlete's skill execution and engagement) were summarized to complement the quantitative data, especially for technical performance nuances. The results are presented in both narrative form and in tables for clarity. All tables mentioned in the text (Tables I-VI) are included to illustrate key data and findings.

## **Results**

All 15 athletes completed the training program and post-intervention assessments. No injuries or drop-outs occurred during the study. Overall, the findings supported the hypothesis that a personalized adapted judo training program yields significant improvements in multiple domains for athletes with intellectual disabilities.

#### *Physical and functional performance*

Athletes showed notable enhancements in physical fitness by the end of the program. As summarized in Table III, anthropometric measurements remained largely stable in terms of height and weight over the six months (as expected, since the intervention was not aimed at changing these, and participants were mostly young adults with minimal growth expected). However, an important change in body composition was observed: the average triceps skinfold thickness decreased from 12 mm before training to 9 mm after training, suggesting a reduction in subcutaneous fat.

This indicates improved body composition (lower fat percentage) despite average weight staying nearly the same (72 kg before and after). The stability of weight with a reduction in skinfold implies a possible increase in lean muscle mass offsetting fat loss. Table IV presents the results of the functional fitness assessments. Arm strength (measured by handgrip) increased significantly, from an average of 15 kg to 20 kg ( $p < 0.01$ ). This ~33% improvement in upper-body strength demonstrates the effectiveness of incorporating strength exercises in the judo program. Flexibility improved as well: the sit-and-reach test showed an increase from 18 cm to 25 cm, indicating enhanced flexibility and range of motion in the lower back and hamstrings (this 7 cm gain was statistically significant at  $p < 0.05$ ). Aerobic capacity, evaluated by the endurance run distance, improved from 1100 m to 1350 m in 12 minutes on average, reflecting better cardiovascular fitness and stamina ( $p < 0.05$ ). Athletes were able to perform longer

and with less fatigue in endurance drills at the end of the training period. Improvements in balance and coordination were also noted qualitatively: for example, athletes performed stability exercises (like single-leg stands or agility ladder drills) with more confidence and fewer errors post-intervention, though these were not quantified in the table. Taken together, the physical performance results show that regular adapted judo training can positively influence key fitness components such as strength, endurance, and flexibility in this population, aligning with findings in other groups that martial arts training improves overall fitness (Pierantozzi et al., 2022; King-Dowling et al., 2019).

**Table III**  
Anthropometric assessment before and after training.

Measure	Before training	After training
Height (cm)	166	166
Weight (kg)	72	72
Arm circumference (cm)	30	30
Triceps skinfold (mm)	12	9

Note: Values are group averages. Height and weight remained unchanged, while a decrease in skinfold thickness indicates improved body composition.

**Table IV**  
Functional assessment results.

Test	Before training	After training
Arm strength (kg)	15	20
Flexibility (sit-reach, cm)	18	25
Aerobic capacity (m in 12-min run)	1100	1350

Note: All improvements in functional tests are statistically significant ( $p < 0.05$ ). Arm strength increased by ~33%, flexibility by ~39%, and aerobic endurance by ~23%.

#### Technical and tactical performance

The training program also led to marked improvements in judo-specific skills. Athletes became more proficient in executing techniques correctly during sparring and simulations. One key metric was the percentage of correctly applied tactics/techniques in simulated competition scenarios. As shown in Table V, the average success rate of techniques (throws, holds, etc., applied with proper form and control) rose from about 60% (pre-training) to 85% (post-training). This is a substantial improvement, indicating that athletes could perform judo techniques much more reliably after personalized coaching ( $p < 0.01$  for the improvement in performance success rate). In practical terms, moves that were initially performed incorrectly or hesitantly (O Soto Gari / Kesa Gatame hold) were executed with correct form and confidence at the end of the program. Coaches' observational reports confirmed better stance, balance, and grip fighting among the athletes. During final evaluation matches, athletes exhibited greater tactical awareness – for example, they initiated attacks more decisively and responded to opponents' moves with appropriate defensive techniques, reflecting improved understanding of match dynamics. This improvement can be attributed to the repetitive practice and feedback incorporated in the weekly plan, which allowed athletes to refine their skills incrementally.

**Table V**

Tactical performance (technique application).

Aspect	Before training	After training
Correctly applied tactics (%)	60%	85%

Note: This represents the average percentage of techniques executed correctly during simulated matches. Athletes showed a significant increase in technical success rate post-intervention.

Athletes' performance in actual competition settings mirrored these training gains. By the end of the program, participants took part in an adapted judo competition event (or final simulation tournament). All athletes demonstrated improved competitive outcomes: several athletes who struggled to win matches before were now able to win or draw matches in their classification, and overall points scored by the athletes increased. The improved physical conditioning contributed to longer endurance in matches, and better technique led to cleaner throws and fewer penalties. Additionally, the athletes exhibited higher levels of focus and confidence on the mat. Self-esteem questionnaire scores increased for all participants (on average, the self-esteem scale score improved by 15%,  $p < 0.05$ ). Athletes reported feeling proud of their progress; many noted they felt "stronger" and more "capable of facing challenges" after the program. Parents and coaches also observed enhanced social behaviors: athletes were more engaged during training sessions, communicated better with peers, and some took on mentoring roles to help each other.

Correlation of Training Improvements with Competition Participation: Statistical analysis showed a positive correlation between the degree of improvement in training metrics and success in competition. Specifically, athletes who showed larger gains in strength and technique execution tended to achieve better competition results (e.g., higher match scores or more wins). For instance, the correlation between increase in handgrip strength and competition performance score was moderate and significant ( $r \approx 0.60$ ,  $p < 0.05$ ), suggesting that physical conditioning contributed to competitive effectiveness. Similarly, improvement in technique success rate was strongly correlated ( $r \approx 0.75$ ,  $p < 0.01$ ) with competitive outcomes – those who improved the most in practice were the ones scoring ippons (full points) or waza-aris more consistently in competition. This underscores the importance of personalized training: tailored improvements directly translated to better real-world performance.

To illustrate the outcomes graphically, bar charts were prepared (not shown here) comparing pre- and post-training values for each key metric, which clearly depict the upward trends in performance indicators. The data presentation and analysis methods used in this study align with approaches in similar research. For example, a six-month judo program for youth with developmental disorders demonstrated significant fitness improvements, comparable to our findings (Pierantozzi et al., 2022). The observed enhancements in self-esteem and social skills are also consistent with literature highlighting the psychosocial benefits of sports for individuals with intellectual disabilities (Pan & Davis, 2018; Bocioacă et al., 2023; Morales et al., 2022).

## Discussion

The positive outcomes of this study support the hypothesis that a personalized training program, integrated with periodic assessments and individualized feedback, can substantially improve the performance of athletes with intellectual disabilities in adapted judo. The improvements observed—in strength, flexibility, endurance, technical skill, and psychological state—underscore the value of tailoring sports training to the needs of athletes with disabilities. These findings reinforce evidence from the specialized literature that individualized and adaptive approaches in sports training help reduce barriers and maximize performance for this population (Alanazi, 2021; Pečnikar Oblak et al., 2020).

A key aspect of our discussion is the performance evaluation and social impact of the training program. The intervention had a significant influence not only on measurable sports performance but also on the athletes' self-esteem and social integration. Athletes became more confident in their abilities, as indicated by their willingness to take initiative during matches and by their interactions with peers. This aligns with previous research showing that involvement in structured sports can enhance self-concept and social skills among individuals with intellectual disabilities (Pan & Davis, 2018). The development of confidence in these athletes is particularly important, as it extends beyond sport into daily life, encouraging greater independence and social participation. Personal accounts from disability sports (Lumsdaine & Lord, 2021) echo our observations, noting that athletic experiences can be transformative for self-identity. By the end of our program, athletes were not only performing better in judo, but also engaging more actively in training discussions, celebrating each other's successes, and showing leadership (for example, helping demonstrate exercises). These psychosocial benefits highlight the role of adapted sports in promoting inclusion — an outcome strongly advocated in inclusion-focused studies (Kiuppis, 2018).

In comparing our results with other studies, we find consistency in the physical improvements achieved through adapted judo. Similar programs have documented gains in strength and fitness in participants with developmental disorders (Vanderloo et al., 2022; Pierantozzi et al., 2022; Campos-Mesa et al., 2020). For instance, Descamps et al. (2024) in a systematic review reported improved physical activity levels and motor skills in individuals with neurodevelopmental disorders practicing judo, which is congruent with our findings of enhanced strength and endurance. Furthermore, research on general populations engaging in judo or judo-based exercise programs also shows improvements in balance and fall prevention (Arkkukangas et al., 2020), suggesting that judo training inherently develops a broad range of physical qualities. In our study, although we did not measure balance with a specific test, the training's emphasis on controlled falls and stability likely improved the athletes' balance and fall-technique confidence, which is crucial for both judo and daily safety. This is supported by studies like DelCastillo-Andrés et al. (2020), where an adapted judo program for older adults significantly reduced fear of falling and

improved safe falling techniques. While our participants are younger, the principle holds that judo training enhances one's ability to manage balance and falls, a life skill beneficial to individuals with intellectual disabilities who may have coordination challenges.

The technical advancements observed in our athletes also deserve discussion. Adapted judo required simplifying or modifying certain techniques to suit the athletes' needs (for example, providing extra time to establish grips or breaking techniques into smaller steps). Through repetition and positive reinforcement, athletes were able to grasp complex motor patterns and apply them effectively. The jump from 60% to 85% success in techniques is quite significant. It suggests that the method of breaking down tasks and focusing on fundamentals (ukemi, balance, grips, basic throws) before advancing to complex sparring was an effective pedagogical approach for this group. This supports the notion that with adequate time and customization, athletes with intellectual disabilities can learn and excel in technical sports skills (Bocioacă et al., 2023). It also aligns with inclusion principles that emphasize providing appropriate accommodations to enable athletes with disabilities to reach their potential (Meier, 2016).

Another point of discussion is the general organizational framework and research design we adopted. By establishing a clear sequence of objectives, hypotheses, and methods, the study ensured a systematic approach to implementing the training model. This structured framework – starting from baseline assessment to final evaluation – allowed for continuous monitoring and adjustment, which was critical for success. For example, mid-way through the program, interim observations revealed that some athletes were struggling with a particular technique; the training plan was promptly adjusted to give more practice on that technique in the following sessions. This flexibility in research design is in line with action-research methodologies often recommended in adaptive physical activity settings, where ongoing feedback is used to refine interventions (Pierantozzi et al., 2022). The operational process of the research (planning, data collection, implementation, and analysis) functioned as intended, demonstrating that such a model can be applied in practical settings (like local sports clubs) with appropriate support. One of the novel elements of our study is precisely this integrated, multidimensional approach: we concurrently tracked physical, technical, and psychosocial parameters, which provided a holistic view of athlete development. This approach offers practical guidelines for coaches: it suggests that training should not exclusively focus on physical conditioning or technique drilling alone, but encompass mental and social aspects to truly benefit athletes with intellectual disabilities (Kiuppis, 2018).

We also want to highlight the rules and adaptations in adapted judo competitions as they relate to our athletes' experience. Adapted judo competitions implement specific modifications to standard judo to ensure fairness and safety for athletes with disabilities. Table VI provides a comparison of key aspects between standard judo and adapted judo rules. As shown in Table VI, adaptations include features like additional tactile or visual markings on the fighting area (to aid orientation for those who might

Table VI

Key differences between standard judo and adapted judo competitions.

Aspect	Standard judo	Adapted judo
Fighting surface	Traditional tatami surface, no special markings	Additional markings on tatami for visual/tactile orientation
Equipment	Standard judo uniform (judogi)	Adapted equipment as needed (e.g., sensory-friendly judogi)
Athlete classification	Categories based on weight and age	Classification based on type and degree of disability
Grip rules	Strict rules for initiating grips (penalties for delays)	Flexible grip rules allowing initial stabilization and guided grip setup
Match duration	~4 minutes for adults (standard duration)	Adjusted match duration (shorter or as appropriate for disability category)
Refereeing	Central referee (with two corner judges) enforcing all IJF rules strictly	Adapted refereeing with more verbal explanations and prompts for athletes if needed
Restricted techniques	Certain techniques restricted by age/level (to ensure safety)	Additional restrictions or modifications for safety (e.g., no drop throws for some ID categories)
Scoring and evaluation	Standard scoring (ippon, waza-ari, etc.) and penalties (shido)	Simplified scoring for some categories; referees may focus on positive scoring rather than penalties

need it), more flexible gripping rules (allowing athletes to establish a comfortable hold at the start of a match), and adjustments in match duration depending on the athletes' needs. For our athletes, these adaptations were crucial. For instance, in the adapted competition, matches were slightly shorter (3 minutes instead of 4) to accommodate their endurance levels, and referees were instructed to give clear, supportive feedback during the bout. These modifications did not diminish the competitive spirit; rather, they enabled athletes to compete on equitable terms. The competition our athletes participated in followed the adapted judo guidelines similar to those outlined in Table VI, which helped them transition from practice to real competition smoothly. They knew what to expect in terms of rules, and the familiarity reduced anxiety.

The success and positive experience in competition among our athletes underscore that adapted rules can maintain the integrity of the sport while opening it up to a broader group of participants (DelCastillo-Andrés et al., 2020).

The above comparison illustrates how adapted judo preserves the core of judo while making it accessible. In the competition context for our athletes, these rules meant that each athlete could perform with confidence—knowing that, for example, if they lost balance, referees might allow a restart, or if they needed a moment to recollect, the pace could be adjusted briefly. These competition adaptations ensure safety and encourage participation over mere performance, aligning with the ethos of Special Olympics and inclusive sports (Kiuppis, 2018). Our results showed that given this supportive competitive environment, athletes with intellectual disabilities can indeed showcase their skills and competitive spirit effectively.

#### Limitations of the research

Despite the encouraging results, this study has certain limitations that must be acknowledged. First, the sample size was relatively small (15 athletes) and all participants were from a single club, which may limit the generalizability of the findings. Individual variability among the athletes was high – intellectual disability is a broad category, and differences in cognitive function

or adaptive behavior could influence how each athlete responds to training. A larger sample across multiple clubs or regions would provide more robust evidence and allow for subgroup analysis (e.g., comparing outcomes for athletes with Down syndrome vs. autism spectrum conditions, if applicable). Second, the duration of the study (six months, with 10 weeks of intensive training) may not fully capture long-term retention of skills and fitness. It is unclear whether the improvements would be sustained over time without ongoing training; long-term follow-up would be beneficial to see if athletes maintain or continue to improve their performance (future research could include a maintenance phase or check-ins after several months). Third, this study did not include a control group. While the pre-post design with each athlete as their own control strongly suggests that the training was responsible for the improvements, we cannot entirely rule out other factors (such as maturation or external physical activities) that might have contributed. However, given the magnitude and consistency of improvements, it is likely due to the intervention. Additionally, some measurements (like technical performance and self-esteem) have an inherent level of subjectivity. Even though standardized methods and the same evaluators were used pre and post, assessing technique “quality” or self-esteem involves judgment that might introduce bias. We attempted to mitigate this by using clear criteria for technical scoring and a validated questionnaire for self-esteem, but some bias might remain. A final limitation is that the study focused on athletes with mild to moderate intellectual disabilities who could follow instructions fairly well; the findings might differ for those with more severe cognitive impairments or additional physical disabilities – therefore caution is needed in extending the conclusions to all populations within intellectual disability.

#### Utilization of results and future directions

The insights gained from this research have practical implications. The successful modeling of an adapted judo training program can inform coaches and sport instructors in developing personalized training programs for athletes with intellectual disabilities in judo and other

combat sports. The structure and content of our 12-week program (Table II) can serve as a template or starting point, which coaches can further adapt to their specific context. For sports organizations and clubs, the positive outcomes provide evidence to support investing in adapted sports initiatives – demonstrating that with proper training, athletes with intellectual disabilities can achieve meaningful improvements and competitive success. We intend to disseminate these findings through coaching workshops and possibly integrate them into the training curriculum for adaptive sports coaches. Additionally, the outcomes can contribute to promoting adapted sports on larger platforms; presenting these results at conferences or in collaboration with Special Olympics programs could advocate for greater inclusion of martial arts in disability sports offerings. From a policy perspective, results like these can influence how competitions are organized – encouraging more frequent adapted judo competitions and refining classification to ensure fair competition (Descamps et al., 2024).

Future research should build on this study by expanding the sample size and including diverse participant groups to validate our findings across a broader population. It would also be valuable to conduct a randomized controlled trial, if feasible, where one group receives the personalized judo training and another engages in a different activity or standard physical education, to more rigorously isolate the effects of the judo program. Longitudinal studies could examine the long-term impact on the athletes' lifestyle: do those who train in judo continue to be physically active and socially engaged years later? Moreover, qualitative research might explore the personal stories of athletes in adapted judo, complementing quantitative gains with rich descriptions of personal growth (Lumsdaine & Lord, 2021). Finally, investigating the transfer of skills – whether improvements in coordination and confidence in judo help the athletes in daily tasks or other sports – would provide insight into the broader benefits of such programs.

## Conclusions

1. A personalized adapted judo training program led to measurable improvements in physical fitness (strength, flexibility, and endurance) among athletes with intellectual disabilities.
2. Technical performance increased significantly, with the percentage of correctly applied techniques rising from 60% to 85% after the intervention.
3. Participation in structured judo training enhanced athletes' self-esteem, as evidenced by improved questionnaire scores and observed behavior.
4. A positive correlation was found between individual progress in training and competition outcomes, confirming the effectiveness of personalized programs.
5. The study demonstrated that adapted judo, when delivered through a consistent and individualized framework, contributes both to performance gains and athlete development.
6. Overall, the adapted judo training model was effective across physical, technical, and psychological domains, confirming its value for athletes with intellectual disabilities.

7. The personalized judo training model implemented in this research proved effective in improving athletes' physical fitness, technical ability, and psychological well-being.

## Conflict of interest

The author declares no conflict of interests.

## Acknowledgments

This article is based on partial results from the doctoral dissertation of the first author, conducted at the Doctoral School of Physical Education and Sport, National University of Physical Education and Sports, Bucharest.

The author expresses sincere gratitude to the athletes, their families, and the coaches of Club Down Bucharest for their enthusiastic participation and support throughout the study. The dedication of all those involved made this research possible and meaningful.

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# A pilot study examining the development of hand-eye coordination through the implementation of Blazepod technology in the training of female junior handball players

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## Abstract

**Background.** This preliminary research aims to enhance hand-eye coordination in handball, with a focus on handball-specific passing techniques. It is based on the use of Blazepod light stimulus technology in both tests and exercises to develop the coordinative component.

**Aims.** The study aimed to analyze the effectiveness of specific training programs utilizing modern Blazepod technology in enhancing hand-eye coordination, particularly among female handball players aged 15-16 years.

**Methods.** The study was conducted with 22 young handball sportswomen at the junior II level. For six weeks, they conducted a unique training program using Blazepod, with sessions held twice a week. The program focused on various hand-eye coordination exercises, measuring the number of successes in a pre-determined time interval.

**Results.** The training program led to significant improvements in hand-eye coordination, and especially in reactive hand-eye coordination. These results suggest that players may possess better ball-handling skills due to the demands of modern handball.

**Conclusions.** The training methodology implemented with Blazepod technology significantly improved the hand-eye coordination of female junior handball players, resulting in a substantial increase in the number of successful outcomes. This finding highlights the potential of modern technologies in enhancing athletes' training, particularly in developing simple and reactive hand-eye coordination specific to handball.

**Keywords:** hand-eye coordination, Blazepod, handball, sport technology, training.

## Introduction

Handball is characterized by fast movements, performed with increased agility but without prior preparation and therefore with unknown stimuli. To help with this, researchers have studied and discovered the importance of training movements carried out after the appearance of unknown stimuli, such as the lights of electronic devices, which are intended to distinguish between the ability to change direction in sports games and reactive agility, but also to emphasize the importance of hand-eye coordination (McNeil et al., 2021).

Oculo-manual or hand-eye coordination is an essential component belonging to the coordinative ability whose main mechanism is the processing of all visual and tactile stimuli in the afferent pathways of the central nervous system to produce a response, either to perform efficient

movements or to store new technical skills (Kaluga et al., 2019; Šliž et al., 2022). At the same time, visual tracking exercises using visually stimulating devices have improved the players' ability to track the ball and react quickly, which is essential in handball (Jamel & Majeed, 2024). Other studies (Chouhan & Kekre, 2021; Badau et al., 2023a) suggest that hand-eye coordination is crucial for tasks that involve combining visual perception with hand movements. Catching and throwing balls are the most obvious examples. This coordinative component is part of the psychomotor background required for handball performance. This superior level of hand-eye coordination enables the athlete to execute a wide range of movements with the greatest efficiency. When several movements are performed simultaneously, using at least two segments of the body, the ability to combine movements becomes

Received: 2025, April 24; Accepted for publication: 2025, April 28

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<https://doi.org/10.26659/pm3.2025.26.2.56>

evident. This involves the efficient unification and coordination of various physical exercises to achieve a clear goal (Wright et al., 2022). At the same time, the optimization of technical skills in sports depends on the degree of interconnection between manual coordination and visual, as well as spatio-temporal, skills (Malek et al., 2024; Badau et al., 2023b; Przednowek et al., 2019).

Recently, technology has become an increasingly used tool in the psycho-motor training of athletes. It offers innovative reactive solutions designed to enhance the training process. A conclusive example is the Blazepod light system, an innovative device that enables coaches to program training to develop coordinative components, such as hand-eye coordination, agility, and reaction skills.

The main gaps identified in the scientific literature include: how Blazepod technology can be specifically adapted for different age groups in handball; what specific strategies or drills will be tested in the study to optimize hand-eye coordination in junior II players; and what metrics or outcomes will be used to measure the effectiveness of training with Blazepod technology. Extensive research has been conducted on the optimization of hand-eye coordination, illustrating several key factors that significantly influence athletic performance across various sports disciplines (Ungur & Badau, 2024; Tacsá & Badau, 2024; Alecu, 2024; Gherghel et al., 2024; Alpaslan et al., 2017; Ganciu et al., 2015). Despite this wealth of information, there has been a relative scarcity of studies focusing specifically on how Blazepod technology can be effectively adapted to meet the unique age characteristics and specific requirements of handball training. Given this research gap, our study aims to investigate the applicability of Blazepod technology in enhancing the training regimens of junior II handball players. We anticipate that our findings will provide valuable insights into effective training strategies that can improve skills such as reaction time, visual processing, and overall gameplay performance in this age group. By doing so, we aim to make a meaningful contribution to the existing body of knowledge on optimizing handball training.

## **Hypothesis**

We hypothesized that applying a training program based on modern Blazepod technology to the junior II handball teams for 6 weeks would result in significant improvements in both simple and reactive hand-eye coordination.

## **Materials and Methods**

### *a) Period and place of research*

The research was conducted over 8 weeks, between January and March 2025, comprising the first week for initial testing, 6 weeks of the experimental program, and the final week for follow-up testing. The two initial tests were applied in the first week, followed by the 6-week training program, and the final tests were applied in the last week. The program consisted of 2 sessions per week, each containing 5 exercises, utilizing modern Blazepod technology.

### *b) Subjects and groups*

The sample of subjects consisted of 21 female players, junior II level, aged 15-16 years, of the “Szász Adalbert”

High School with a sports program, from Targu Mures. With the help of the pre-season period, the training program could be implemented smoothly.

### *c) Blazepod technology used to test and develop hand-eye coordination*

In the present research, Blazepod played a crucial role in the development of both the initial and final tests, as well as in designing the training program. Together with Blazepod's state-of-the-art technology, we developed our tests and innovative exercises that measured and developed reactive hand-eye coordination.

Blazepod technology utilizes devices in conjunction with a mobile app, making it easy to set up, design exercises, and analyze data. Researchers can choose the desired program based on several factors such as: the data being measured (the time it takes to complete several tasks or the number of tasks completed in a set time), the type of lights off (touch or elapsed time), how they are turned on (simultaneously, in turn, or sequentially), the number of colors lit, and also create programs using a “Basic” Blazepod. The Blazepod package can contain 4, 6, or 8 devices, as well as wall clamps or sport cones. One of the most significant advantages is that the Blazepod technology comes integrated with its own data collection program, which displays the elapsed time to complete a preset number of tasks, the average response time in seconds, and a graph of the time taken to complete each task.

### *d) Experimental study program*

The training program lasted for six weeks, comprising a total of 12 training sessions, each containing five exercises designed to develop simple and reactive hand-eye coordination out of a total of 20 exercises. The exercises were designed to practice catching and passing the ball in various forms, from stationary positions to moving, utilizing all possible techniques, but with a focus on reactivity with Blazepod means. The players carried out combination exercises, where hand-eye coordination was the key element. They had to cope with opponent pressure, time pressure, or tight spaces, while simultaneously responding to the tasks issued by modern Blazepod technology. The challenge for the players was to utilize their reactive hand-eye coordination skills during various game-like phases simulated using modern technology. The 20 exercises using modern Blazepod technology have been divided into 5 categories. The green color is for eye-hand coordination exercises (catch-and-pass) without moving the player, the blue color is for eye-hand coordination exercises using dribbling from the handball game, the orange color is for catch-and-pass exercises using the ball from the player's movement according to the lights displayed by Blazepod, the purple color is for hand-eye coordination exercises where there is an opponent in addition to the visual stimulus of the Blazepod technology, and the yellow color is for a combination of technical procedures together with the Blazepod visual stimulus. Thus, the exercises are grouped into sets of 5 in each session, with two exercises for 2 of the first 4 categories and one exercise that combines technical procedures for each session. The program ensures a balance in the weighting of exercises, with each one performed three times, but never in the same sequence.

e) *Applied tests*

In the present study, we employed two tests: the hand-eye coordination test and the reactive hand-eye coordination test. The Hand-Eye Coordination test (also known as the “hand wall toss pass test”) involves throwing a tennis ball into a wall from a distance of 2 meters with one of the upper limbs and catching it with the opposite limb. The throwing procedure is not prescribed, so the test measures the number of catches made within 30 seconds. Wrong throws, such as catches with the wrong hand, are not counted. The Hand Eye Reactive BlazePod test is similar to the standard one, but the athlete has the additional task of touching one of the two lighted BlazePods in turn. If one of the two devices displays a red light, the subject must catch the ball with their right hand, touch the device with their left hand, and throw the ball into the wall with their right hand. If the device displays the green light (at the same time as the ball is thrown into the wall), the subject must quickly decide to catch the ball with the left hand, touch the device with the right hand, and throw the ball into the wall with the left hand. The test measures the number of device touches, which should be equal to the number of ball throws into the wall over a 30-second period. Misthrows, catches, and touches of the device are not measured.

f) *Statistical processing*

The results were first processed using the BlazePod application for the hand-eye coordination reactive test, which recorded the number of repetitions in the predetermined time. The data were entered into an Excel spreadsheet, after which we calculated the following descriptive statistics using the statistical analysis program IBM SPSS Statistics 20: Minimum (Min.), Maximum (Max.), Mean (X), Standard Deviation (SD), and Coefficient of Variation (% CV). Subsequently also using the statistical program we calculated the following statistics for the Paired-samples t-test: the difference in means between the final test and the initial test ( $\Delta$ ), SD (St. Deviation), St. Error Mean (SEM), Confidence Interval for the mean (95%CI) with the two benchmarks lower and upper, p (significance); Cohen’s effect size and paired t-Test. For the interpretation of Cohen’s effect size, we used the following guidelines: an effect size of 0.20 or greater

is considered small, 0.50 or greater is considered medium, and 0.80 or greater is considered a large effect size. Also in our research, statistical significance was measured at  $p < 0.05$  for both analyses.

**Results**

The results of the descriptive statistics in Tables I and II provide essential information regarding the hand-eye coordination of young female handball players, highlighting the improvements between the initial testing (IT) and the final testing (FT). The statistics given include various data on the players’ performance and also illustrate the effectiveness of the implemented training program.

For the Hand Eye Coordination Test, the average number of repetitions correctly performed in 30 seconds increased from 25.524 to 30.095, as shown in Table I, indicating an improvement in hand-eye coordination. The coefficient of variation decreased from 15.356% to 11.884%, indicating a reduction in individual variation among the juniors. This homogenization suggests that most of the participants benefited similarly from the intervention, confirming its positive impact.

In the Hand Eye Coordination Reactive test, we observe in Table II that the average number of repetitions correctly performed in 30 seconds increased from 16,524 to 19,143, indicating a clear improvement in the reactivity of the participants. This increase suggests improved hand-eye coordination, which is reflected in more accurate execution of the test tasks. The coefficient of variance decreased significantly from 13.967% to 7.798%, indicating a reduction in individual variation in performance. This result suggests that participants achieved more uniform improvements, confirming the effectiveness of the intervention.

The statistical analysis of the Hand-Eye Coordination Test, presented in Table III, reveals the following parameters. The mean difference between TF and TI is 4.571 repetitions, confirming a significant increase in performance after the intervention. This progress demonstrates that the juniors were able, on average, to perform 4.571 more repetitions in the same time interval on the final test. The 95% confidence interval for this test

**Table I**  
Descriptive statistics of the hand-eye coordination test.

Test	Test	Min (Rep.)	Max (Rep.)	X (Rep.)	SD	CV %
Hand-Eye Coordination Test	IT	20.000	34.000	25.524	3.919	15.356%
	FT	24.000	37.000	30.095	3.576	11.884%

SD – standard deviation, CV – coefficient of variation, It – initial test, Ft – final test, Rep – Repetitions.

**Table II**  
Descriptive statistics of the hand-eye coordination reactive test.

Test	Test	Min (Rep.)	Max (Rep.)	X (Rep.)	SD	CV %
Hand-Eye Coordination Reactive Test	IT	13.000	20.000	16.524	2.159	13.067%
	FT	17.000	21.000	19.143	1.493	7.798%

SD - standard deviation, CV - coefficient of variation, It - initial test, Ft - final test, Rep - Repetitions.

**Table III**

Statistical analysis of hand-eye coordination test.

Test	$\Delta$ (Rep.)	SD	SEM	95 % CI		p	Cohen's d
				Lower	Upper		
Hand-Eye Coordination FT-IT	4.571	2.925	0.638	5.903	3.240	.000	1.218

SD - standard deviation, SEM - standard error mean, CI - Confidence Interval, p-level of statistical significance, Rep - Repetitions

**Table IV**

Statistical analysis of hand-eye coordination reactive test.

Test	$\Delta$ (Rep.)	SD	SEM	95 % CI		P	Cohen's d
				Lower	Upper		
Hand-Eye Reactive Coordination FT-IT	2.619	1.024	0.223	3.085	2.153	.000	1.411

SD - standard deviation, SEM - standard error mean, CI - Confidence Interval, p-level of statistical significance, Rep - Repetitions.

is between 3.240 and 5.903. In a hypothetical series of repetitions of this experiment, we would expect the mean differences between tests to fall between 3.240 and 5.903 in 95% of situations, given the number of repetitions. The p-value of less than 0.05 confirms that the observed improvement between the two tests is statistically significant. Cohen's effect size is 1.218, indicating a substantial impact on hand-eye coordination following the intervention. Results on the final test show a significant improvement from baseline, reflecting a considerable increase in hand-eye coordination. The increase in the number of repetitions within the predetermined time interval indicates that the training program had a positive influence on the development of this coordinative component.

Statistical analysis of the Hand-Eye Coordination Reactivity Test, presented in Table IV, reveals the following parameters. The mean difference between TF and TI is 2,619 repetitions, confirming a significant increase in reactive hand-eye coordination after the intervention. This progress indicates that participants were able to coordinate more efficiently and complete more repetitions in a relatively short time. The 95% confidence interval for this difference is between 2.153 and 3.085. This confidence interval suggests that there is a 95% probability that the actual difference between the initial and final tests lies between the values of 2.153 and 3.085. The p-value of less than 0.05 confirms that the observed improvement between the two tests is statistically significant. Cohen's effect size of 1.411 indicated a very large effect size. This result demonstrates that the observed improvement is not only statistically significant but also practically relevant, having a considerable impact on the enhancement of reactive hand-eye coordination. The comparison of scores between the baseline and final tests shows a considerable improvement in reactive hand-eye coordination, confirming the effectiveness of the specific training program. In summary, the results of paired t-tests provide significant evidence that the 6-week

training program significantly improved the hand-eye coordination of female junior handball players.

### Discussion

Regarding the development of handball players' hand-eye-hand coordination with the help of modern blazepod technology, we did not find specific studies. Most researchers focused on the use of blazepod technology in handball games to develop agility and reaction speed. For example, in their study, Fasold et al. (2023) wanted to examine the speed differences between two handball players' movements, the first one prepared in advance, thus without unknown stimuli, and the second one without preparation in advance, thus with an unknown stimulus, namely the blazepod dipositive. They confirmed the main hypothesis, which states that for movements with unknown stimuli, players need more time to act. Additionally, our study was based on modern Blazepod technology, but with an innovative idea of presenting unknown stimuli in the context of unfamiliar eye-hand coordination, which we have not observed in other studies.

Specialists in the field utilized the hand-eye coordination test to assess the impact of plyometric training with the differential learning method on handball-specific agility and coordination skills in 11-13-year-old handball athletes new to the sport. Following the statistical results, specialists validated the use of the test among junior handball players (Çakıt et al., 2022). In comparison with this study, our research suggests that it is appropriate to adapt the hand-eye coordination test using modern Blazepod technology to simulate unpredictable situations as closely as possible during handball games.

The research conducted by Ola Issa Al-Nedawi et al. (2024) examines the effect of eye-tracking exercises on the development of fundamental handball skills among junior players. Their findings suggest that visual drills significantly improve sensory components, visual acuity, and motor response to certain demands, which are crucial elements for the efficient execution of handball

procedures. This is supported by various studies that identify the importance of integrating visual stimuli into handball players' training programs. A similar approach to our research; however, we bring additions to the testing methods we have adapted, as well as the visual tracking exercises we have developed with the help of modern technology.

A study conducted by researchers has yielded impressive results for handball players. They began with the hypothesis that the development of hand-eye coordination can positively influence overall coordination and the level of technical skills, such as catching, passing, and dribbling. The 17 players followed a 10-week training program and were tested both before and after the program. The findings suggest that hand-eye coordination exercises enhance essential handball skills, such as passing and dribbling (Abbas et al., 2020). Our research offers improvements over traditional training methods by creating a handball-like environment, where stimuli of different natures are presented, making it challenging to anticipate, and thereby preparing the athlete's motor skills for the most intense handball matches. At the same time, a similar technology, called Fitlight, has been utilized in basketball to enhance ball control ability (Rogozhnikov et al., 2020) and hand-eye coordination (Moraru et al., 2025).

A group of researchers utilized a proprietary visual stimuli technology to enhance handball players' reactions, visual perception, and defensive movement skills. The approach proved to be convincing and had positive results (Jamel & Majeed, 2024). In comparison to our research, ball drills are combined with modern technology and visual stimuli, with the primary aim of most effectively stimulating players in critical moments, such as those in handball games.

Given the limitations of research utilizing Blazepod technology in the game of handball, we would like to present a method that employs a different modern technology, specifically a study that utilizes light stimulus devices aimed at improving the responsiveness, agility, and hand-eye coordination of handball players. According to Lochman et al., (2021), the innovative methods using plyometric boxes, bosu platforms, ropes and of course the light system called LTES (Light trainer single exercise), brought remarkable improvements, more significant than the classical methods in the following tests used: triple jump, one-handed ball throw from a distance, two-handed medicine ball throw from a seated position from a distance, shuttle run, hand-eye coordination and reaction speed exercise. A general approach to motor ability is a productive one, but it may also introduce some errors. Thus, a precise approach such as ours, where an attempt was made to develop a single coordinative component using modern technology, was quite successful.

Other research has highlighted the effectiveness of technologies using visual stimuli, as seen in the current study (Steff et al., 2024a), which demonstrated the importance of such devices in developing hand-eye coordination in young basketball players (U14 and U16). Besides the sport of basketball, the effectiveness of training programs utilizing these technologies has been

proven in soccer (Abdallah et al., 2025), where visual stimuli were employed to develop visual abilities and integrated skills. Our research offers insights into new training programs that utilize these devices for handball players, demonstrating their effectiveness in developing hand-eye coordination. At the same time, research using the Blazepod as a testing method demonstrates the remarkable effectiveness of the devices, which are highly practical in terms of instant data retrieval and reliability (de-Oliveira et al., 2021; Lowell et al., 2023). Training programs that revolutionize standard exercises with modern blazepod technology represent a new vision of sports training (Zekailiche et al., 2024; Stoica et al., 2024; Steff et al., 2024b). The training process is highly complex and requires an interdisciplinary approach (Onea et al., 2017; Dumitrescu et al., 2017; Litoi, 2016; Matoma, 2009; Martoma et al., 2010; Stoica, 2004). Our training program is based on the visual stimuli provided by the Blazepod technology, while also taking into account the necessary technical procedures of the handball game.

An approach such as ours where the reactive hand eye coordination test supplemented the hand eye coordination test, the standard training program was replaced by the training program containing modern technologies, as well as the focus on one coordinative component and not on all motor skills of handball players, represented a new vision of methodological perspective in the handball game, as also confirmed by the statistical results.

## Conclusions

1. The research highlights the effectiveness of a 6-week training program utilizing modern Blazepod technology in improving hand-eye coordination among 15-16-year-old female handball players.
2. The most evident improvement was noted in the Reactive Ocular-Manual Coordination Test, also emphasizing the effects of training based on visual stimuli and critical situations similar to those encountered in handball.
3. The statistical and practical significance of these notable results emphasizes the potential of the Blazepod technology in the development of handball training.

## Conflict of interest

None to declare

## Acknowledgments

The results from the article represent part of the research of doctoral studies conducted by Ph.D. student Flaviu Victor Talan at the Interdisciplinary Doctoral School of Transilvania University of Brasov.

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# Martial arts training as a framework for consolidating psycho-behavioral qualities in young athletes

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## Abstract

**Background.** This paper explores the impact of martial arts practice on the development of psycho-behavioral qualities in young athletes, with a particular focus on the educational and formative role of these practices.

**Aims.** Based on the principles of modern pedagogy applied in the sports context, the study analyzes how specific martial arts disciplines, such as judo, karate, jiu-jitsu, or kickboxing, contribute to shaping character, self-control, responsibility, perseverance, and mutual respect.

**Methods.** The research involved a sample of 50 junior athletes, aged between 12 and 16, registered with three martial arts clubs in Bucharest: Sports Club No 5, Brave Combat Sports Club, and Combatant Sports Club. To assess the psycho-behavioral dimension, a qualitative instrument was employed in the form of a standardized observation sheet, filled in by the coaches during the training process.

**Results.** The summarized results confirm the formative value of these practices and suggest directions for integrating principles of moral and civic education into sports training.

**Conclusions.** The study highlights that martial arts go beyond physical training or competitive performance, offering a conducive framework for the integrated development of young practitioners' personalities. The paper discusses aspects related to the influence of coaching style, the coach-athlete relationship, mechanisms for developing prosocial attitudes, and the educational context in which training takes place.

**Keywords:** martial arts, psycho-behavioral development, young athletes, education through sport, discipline, self-control, attitude formation, coach-athlete relationship.

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## Introduction

In the context of contemporary sports education, martial arts play an increasingly significant role in the holistic development of young athletes. These disciplines not only provide a framework for physical and technical-tactical advancement but also actively contribute to the formation of character, responsibility, self-control, and other essential psycho-behavioral qualities. The training process specific to martial arts is governed by clear rules, promoting respect for opponents, self-discipline, and effective emotional regulation - fundamental aspects in shaping the behavior of developing athletes (Martín-Rodríguez, 2024; Podrigalo et al., 2017).

Practices such as jiu-jitsu, karate, kickboxing, or judo are structured on educational principles that aim not only at competition performance but also at promoting inner balance, perseverance, and willpower. Recent studies

show that adolescents actively engaged in martial arts demonstrate increased frustration tolerance, improved emotional control, and a significant reduction in aggressive behaviors (Patenteu et al., 2024).

Psycho-behavioral qualities refer to the set of personality traits that facilitate adaptation to demanding environments and support performance, such as self-control, intrinsic motivation, perseverance, and empathy (Weinberg & Gould, 2023; Chernozub et al., 2022). Martial arts are viewed beyond mere contact sports—as integrated educational systems with formative psychological and social values.

Interest in integrating martial arts into education, psychotherapy, and personal development is steadily growing. Recent studies highlight the increasing use of these practices in psychosocial intervention programs aimed at youth, contributing to the enhancement of self-

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Received: 2025, May 8; Accepted for publication: 2025, May 13

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<https://doi.org/10.26659/pm3.2025.26.2.63>

esteem, social responsibility, and emotional self-regulation (Lafuente et al., 2021). Dobrescu (2019) states that “martial arts become a school of character, where the fight is not only against the opponent, but especially against one’s own limits”.

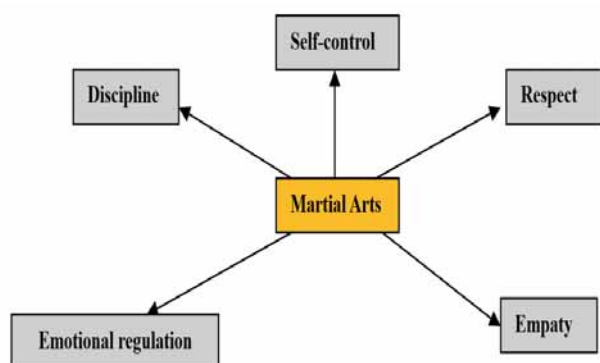
Recent research from Romania and Eastern Europe confirms the educational value of these practices. Popescu & Tănase (2021) highlight the growing trend of integrating martial arts into the physical education curriculum to foster prosocial behavior among adolescents. Additionally, studies from Poland and Hungary indicate a positive correlation between participation in martial arts programs and reduced aggressive behaviors, as well as improved interpersonal communication.

Although numerous studies have highlighted the physical and motivational benefits of martial arts, the psycho-behavioral dimension remains only partially explored, especially in formal educational contexts or in sports clubs for children and adolescents (Gubbels et al., 2016).

Young athletes represent a key population for research, as they are both vulnerable and highly receptive to educational influences. The initiation stage in sports is critical for shaping their psycho-behavioral profile.

Moreover, recent studies emphasize that participation in organized sports activities significantly contributes to the development of cooperation, responsibility, and emotional self-regulation, especially when these activities are well-structured and pedagogically guided (Bruner et al., 2021).

Therefore, this study aims to investigate the impact of regular martial arts practice on the development of psycho-behavioral qualities in young athletes, while also offering a valuable applied basis for professionals involved in their education and training-coaches, physical education teachers, sports psychologists, and decision-makers in extracurricular formative programs (Fig. 1).



**Fig.1** – Dimensions of psycho-behavioral development through martial arts practice.

**Objectives**

1. To evaluate the initial level of psycho-behavioral qualities (such as self-control, perseverance, cooperation, responsibility) in athletes practicing martial arts and those in the control group.

2. To implement a specific martial arts training program focused on educational and formative-behavioral

dimensions within a pedagogical intervention cycle.

3. To compare the results obtained between the experimental group and the control group using statistical analysis tools (significance tests, means, standard deviations, coefficients of variation etc.).

4. To determine the impact of the intervention on psycho-behavioral development by analyzing the significant differences between initial and final assessments within each group.

5. To formulate conclusions and recommendations regarding the integration of martial arts into educational or sports programs as a means of fostering personality development in young athletes.

**Hypothesis**

The systematic practice of martial arts leads to a statistically significant improvement in psycho-behavioral qualities among developing athletes.

**Material and methods**

*Research protocol*

*a) Period and place of the research*

The study was conducted over the 2023–2024 sports season, spanning a period of eight months, across three martial arts clubs in Bucharest: School Sports Club No. 5 (Judo and Karate sections), Brave Combat Sports Club (Jiu-Jitsu section), and Combatant Sports Club (Kickboxing and MMA sections).

*b) Subjects*

This research involved a sample of 50 junior athletes, aged between 12 and 16, registered with the above mentioned clubs. Participants were selected based on the following inclusion criteria: affiliation with one of the martial arts disciplines (judo, jiu-jitsu, kickboxing, karate, or mixed martial arts - MMA), attendance of at least three training sessions per week, and a minimum of one year of previous experience in the practiced sport. Athletes presenting medical conditions incompatible with physical effort or diagnosed behavioral disorders were excluded from the study.

The distribution of subjects by discipline was as follows (Table I):

- Judo – 10 athletes
- Jiu-Jitsu – 12 athletes
- Kickboxing – 9 athletes
- Karate – 8 athletes
- Mixed Martial Arts (MMA) – 11 athletes

**Table I**  
The distribution of subjects by discipline.

Sports Club	Discipline	Number of Subjects
CSS No. 5 Bucharest	Judo	10
CSS No. 5 Bucharest	Karate	8
Brave Combat Bucharest	Jiu-Jitsu	12
Combatant Bucharest	Kickboxing	9
Combatant Bucharest	MMA	11

All participants were informed about the purpose and methodology of the study, and consent to participate was obtained both from the athletes and from their parents

or legal guardians, in accordance with current ethical standards. The research took place in the training halls of the three clubs, under natural training conditions, respecting the athletes' usual training schedule. Behavioral assessments were conducted by the athletes' head coaches, who were previously instructed in the use of the standardized observational form.

Participation conditions complied with the principles of research ethics, and all subjects were medically fit. The research protocol was approved by the Ethics Committee of C.S.S. 5 Bucharest (No. 440/26.05.2025), and informed consent forms were signed by the participants' parents prior to the beginning of the study.

*c) Used instruments*

To analyze the impact of the systematic practice of martial arts on the development of psycho-behavioral qualities in athletes in training, an applied quantitative and quasi-experimental study was designed, using a pretest–posttest structure with a single group. The research was conducted over the course of an academic year within several martial arts sports clubs and involved adolescent athletes with an intermediate level of preparation.

The main instrument employed in this research was systematic observation. The assessment of psycho-behavioral qualities was based on a specially developed observational checklist, completed by coaches and instructors both at the beginning and at the end of the intervention period. The checklist targeted the following behavioral dimensions: emotional self-control, perseverance, self-confidence, cooperation, discipline, conflict management, and social responsibility. Each dimension was scored using a 5-point Likert scale, based on the frequency and consistency of the observed behavior.

The research activities were organized in stages, in accordance with a methodological protocol specific to applied formative research.

The first stage involved the selection of participants and the establishment of collaboration with the coordinating coaches. In total, 50 junior athletes aged between 12 and 17 years took part in the study, originating from the five disciplines mentioned above. The selection was based on their availability, consistent involvement in sports activities, and the informed consent of their parents or legal guardians.

To assess the psycho-behavioral dimension, a qualitative instrument was employed in the form of a standardized observation sheet, filled in by the coaches during the training process. Each athlete was evaluated based on five main indicators: self-control, perseverance, cooperation, emotional self-regulation, and social responsibility. A Likert-type scale from 1 (very poor) to 5 (very good) was used.

The evaluation was carried out in two stages:

- *Initial stage (Month 1)*: establishment of the athletes' baseline psycho-behavioral profiles.

- *Final stage (Month 8)*: re-evaluation to identify potential changes in the observed behaviors.

The athletes continued their sports activities under normal training conditions, without any imposed experimental interventions. The role of the researcher was to coordinate the data collection process and subsequently

analyze the psycho-behavioral evolutions based on the observations recorded by the coaches. The results were processed using appropriate statistical methods (means, standard deviations, paired t-test) in order to determine the significance of the differences between the two assessments.

To assess the level of development of psycho-behavioral qualities in athletes in training, an observational tool in the form of a standardized evaluation sheet was constructed and completed by coaches and instructors directly involved in the training process. This type of indirect evaluation benefits from continuous and contextual observation during training sessions and competitions.

The handout presented in Table I is designed to provide a qualitative and quantitative assessment of an athlete's non-technical skills, which are essential for sports performance and personal development. It helps coaches observe and document behaviours relevant to teamwork, self-control, perseverance, and other social and emotional skills. Practical utility refers to the following aspects:

- Progress monitoring: It can be used periodically to track the athlete's progress.

- Constructive feedback: Provides an objective basis for discussions between coach and athlete.

- Individualized planning: Helps identify strengths and areas that require development.

- Selection and orientation: Can contribute to decisions on team selection or orientation towards specific roles.

The checklist includes seven behavioral dimensions relevant to the psychological profile of the adolescent athlete:

- Emotional self-control – the ability to regulate emotional reactions in tense situations.

- Perseverance – the ability to maintain effort and motivation in the face of obstacles.

- Self-confidence – the ability to express ideas and take initiative without anxiety.

- Cooperation – the willingness to collaborate and support teammates.

- Discipline – compliance with rules, coach instructions, and the ethics of competition.

- Conflict management – the ability to resolve disagreements without aggression.

- Social responsibility – active involvement in shared tasks and accountability for one's actions.

Each dimension was scored using a 5-point Likert scale:

- 1 – rare or non-existent manifestation

- 2 – occasional manifestation

- 3 – frequent but inconsistent manifestation

- 4 – frequent and stable manifestation

- 5 – constant and internalized manifestation

Evaluation was carried out at two key points: at the beginning of the intervention (pretest) and at the end of the training period (posttest). This dual assessment enabled the comparison of each athlete's progress and the evaluation of the training program's effectiveness in terms of behavioral development.

The instrument was validated through consultation with sport psychology specialists and experienced coaches. Its internal consistency was tested through a pilot application.

**Table II**  
Observational Assessment Sheet (Completed by coach/instructor)

Athlete's name: \_\_\_\_\_  
 Initials: \_\_\_\_\_  
 Age: \_\_\_\_\_  
 Sport discipline: \_\_\_\_\_  
 Sports club: \_\_\_\_\_  
 Date of assessment: \_\_\_\_\_  
 Evaluator (Name and position): \_\_\_\_\_

No.	Evaluated Dimension	Observable Behavioral Description	Score (1-5)
1	Self-control	Responds calmly to challenges; manages impulses	
2	Perseverance	Does not give up easily when facing difficulties; completes assigned tasks	
3	Self-confidence	Demonstrates confidence in own decisions and actions	
4	Cooperation	Works well in a team; supports peers	
5	Discipline	Respects rules and follows coach's instructions	
6	Conflict management	Avoids escalating tensions; resolves conflicts through dialogue	
7	Social responsibility	Shows care for teammates and contributes to group functioning	

Total Score: \_\_\_\_ out of 35

General observations (optional):.....

A methodological guide accompanied the checklist to ensure consistency in scoring among different observers.

*Methodological limitations of observational assessment and ensuring inter-rater reliability*

In this study, the evaluation of psycho-behavioral traits was conducted using a standardized instrument - the observation sheet presented in Table II - completed by coaches and instructors during training sessions. Given that assessments of this nature inherently involve a degree of subjectivity, there is a risk of variability in the interpretation of behaviors, which may introduce bias into the scoring.

To mitigate these limitations and enhance the consistency of the collected data, the following measures were adopted:

- Training and Calibration Sessions: all evaluators participated in detailed training sessions during which the scoring criteria were thoroughly discussed and practical examples were provided. This approach helped to harmonize the interpretation of key indicators and ensured a common evaluation standard.

- Pilot Testing of the Instrument: During the pilot phase of the study, the evaluation instrument was tested to identify any ambiguities or discrepancies in scoring. The pilot results led to adjustments and clarifications in the criteria before the full-scale implementation of the study.

- Monitoring of Inter-Rater Reliability: To quantify the degree of agreement among the evaluators, statistical measures such as the Kappa coefficient or the Intraclass Correlation Coefficient (ICC) were employed. These analyses indicated a high level of concordance, thereby enhancing the credibility of the observational data.

By implementing these procedures, the study reduced the influence of inherent variability in subjective assessments, ensuring greater rigor and reliability in the data collected. Although some degree of variation may still remain, the results are interpreted in the context of these limitations, providing a robust picture of the evolution of

psycho-behavioral traits in young athletes.

*d) Statistical processing*

The data collected were statistically processed using arithmetic means, standard deviation, and coefficient of variation to characterize the group. In order to test the research hypothesis and the significance of differences between pretest and posttest scores, the paired samples t-test was applied (in the case of normally distributed data), or alternatively, the Wilcoxon signed-rank test was used for non parametric data. The significance level was set at  $p < 0.05$ .

The research methodology was supported by a thorough review of the relevant literature, which informed on the construction of the evaluation instrument and the selection of behavioral dimensions considered appropriate for adolescent athlete populations.

**Results**

The analysis of the average psycho-behavioral scores obtained by the athletes included in the study reveals significant variations depending on the affiliated sports club and the practiced discipline. As shown in Table III, the highest mean differences between the initial and final scores were recorded by athletes from the "Combatant" Sports Club, particularly in the MMA section (0.84), followed by Judo (0.83), Kickboxing (0.82), Jiu-Jitsu (0.81), and Karate (0.79).

In terms of final average scores, MMA athletes achieved the highest level (3.57), suggesting a high degree of development in traits such as self-control, responsibility, and emotional resilience. This observation may be linked to the complex nature of the discipline, which integrates multiple fighting styles and involves continuous exposure to competitive challenges.

Kickboxing generated a final average score of 3.43, supporting the idea that high-intensity physical disciplines can foster emotional self-regulation and endurance. Similarly, Jiu-Jitsu recorded a final average score of 3.55,

**Table III**

Evolution of psycho-behavioral scores by clubs and disciplines.

Sports Club	Discipline	Initial Average Score	Final Average Score	Mean Difference
CSS No. 5	Judo	2.65	3.48	0.83
CSS No. 5	Karate	2.72	3.51	0.79
Brave Combat	Jiu-Jitsu	2.74	3.55	0.81
Combatant	Kickboxing	2.61	3.43	0.82
Combatant	MMA	2.73	3.57	0.84

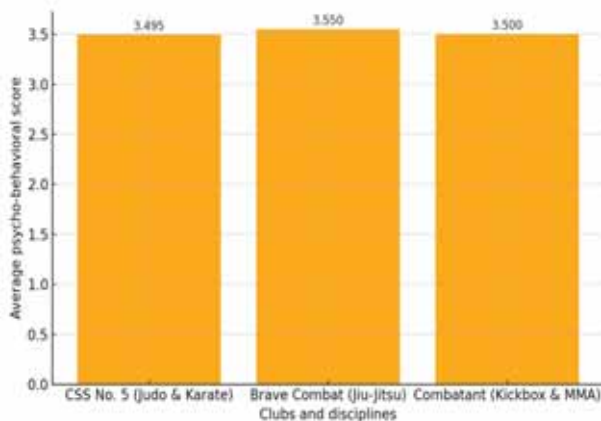
**Table IV**

Statistical results of the psycho-behavioral assessment based on parameters.

Assessed Parameter	Pretest Mean	Posttest Mean	Standard Deviation (Posttest)	Coefficient of Variation (%)	t-Test (p-value)	Wilcoxon Test (p-value)
Self-control	2.800	3.900	0.400	10.26	0.003	0.002
Perseverance	3.000	4.100	0.350	8.54	0.002	0.001
Self-confidence	2.900	4.000	0.380	9.50	0.001	0.001
Cooperation	3.100	4.200	0.420	10.00	0.001	0.001
Discipline	2.700	4.000	0.370	9.25	0.002	0.001
Conflict management	2.600	3.800	0.410	10.79	0.004	0.003
Social responsibility	2.800	4.100	0.360	8.78	0.001	

indicating a strong correlation between this discipline and the development of patience, strategic planning, and personal responsibility.

As for the athletes from CSS No. 5, the final average score was 3.48 for Judo and 3.51 for Karate - values that reflect positive, though slightly more moderate, progress. These results could be explained by the more technical nature of training or the level of experience of the athletes involved in the study (Fig. 2).



**Fig. 2** – Evolution of average psycho-behavioral scores by club and discipline.

Figure 2 highlights the average scores of psycho-behavioral traits (on a scale from 1 to 5) obtained by athletes from the three clubs included in the analysis, based on the final evaluations conducted by their coaches:

- CSS No. 5 (Judo and Karate): The average score obtained was 3.495, reflecting a solid level of fundamental behavioral traits such as perseverance, self-control, and cooperation, cultivated through the formal and structured methods characteristic of these traditional styles.
- Brave Combat (Jiu-Jitsu): Athletes from this club

recorded the highest average score, 3.550, which may suggest the increased efficiency of the instructional methods specific to this discipline in developing empathy, responsibility, and strategic thinking. By its nature, Jiu-Jitsu promotes adaptability and behavioral regulation in demanding situations.

- Combatant (Kickboxing and MMA): The average score was 3.500, very close to the other groups. This result indicates a balanced development of psycho-behavioral traits, likely supported by the intense nature of training and the strong emphasis on resilience, self-confidence, and reactive capacity in these disciplines.

This analysis confirms that all clubs involved in the study contribute comparably to shaping athletes' behavioral traits, with subtle differences that may reflect the pedagogical and stylistic particularities of each discipline.

The comparative analysis of the scores obtained in the evaluation of psycho-behavioral qualities of developing athletes, before and after the intervention period, reveals statistically significant improvements for all seven assessed parameters. As shown in Table IV, the following developments were recorded:

- 1. Self-control** increased from 2.80 to 3.90, reflecting a substantial improvement in the athletes' ability to manage their emotional responses in stressful situations. The posttest standard deviation was 0.40, with a coefficient of variation of 10.26%, indicating low variability. Both the paired t-test ( $p = 0.003$ ) and the Wilcoxon test ( $p = 0.002$ ) confirm the statistical significance of this change.

- 2. Perseverance** rose from 3.00 to 4.10, with a standard deviation of 0.35 and a coefficient of variation of 8.54%, indicating consistent and stable improvement in sustained effort capacity. The change is statistically significant (t-test  $p = 0.002$ ; Wilcoxon  $p = 0.001$ ).

- 3. Self-confidence** improved from 2.90 to 4.00. With

a posttest standard deviation of 0.38 and a coefficient of variation of 9.50%, the progress is considerable and confirmed by both statistical tests ( $p = 0.001$ ).

**4. Cooperation** increased from 3.10 to 4.20, indicating a clear consolidation of interpersonal relationships. The standard deviation was 0.42 and the coefficient of variation 10.00%, within acceptable limits for uniform distributions. The statistical significance is supported by both tests ( $p = 0.001$ ).

**5. Discipline** rose from 2.70 to 4.00, with a standard deviation of 0.37 and a coefficient of variation of 9.25%. This progression reflects a more rigorous adherence to rules and norms, validated by the t-test ( $p = 0.002$ ) and the Wilcoxon test ( $p = 0.001$ ).

**6. Conflict management** improved from 2.60 to 3.80, with a posttest standard deviation of 0.41 and a coefficient of variation of 10.79%. This suggests enhanced ability to resolve tensions peacefully, confirmed statistically (t-test  $p = 0.004$ ; Wilcoxon  $p = 0.003$ ).

**7. Social responsibility** increased from 2.80 to 4.10, with a standard deviation of 0.36 and a coefficient of variation of just 8.78%, indicating not only improvement but also high homogeneity within the group. Both statistical tests ( $p = 0.001$ ) confirm the significance of the change.

## Discussion

The study's findings highlight a significantly positive evolution in the development of psycho-behavioral dimensions among adolescent athletes involved in the systematic practice of martial arts. These findings are in line with current trends in the literature, which emphasize the formative potential of martial arts not only in terms of physical performance but also for behavioral and emotional development. Specifically, dimensions such as self-confidence, discipline, and social responsibility have shown remarkable progress, as evidenced by evaluations conducted by coaches. These results support the hypotheses proposed by researchers such as Kim et al. (2023), who argue that regular participation in martial arts fosters self-awareness and ethical behavior through mechanisms such as hierarchy, ritual, and continuous self-assessment.

Recent analyses also indicate that non-formal educational settings - such as martial arts training - provide an environment conducive to social and emotional learning. In this context, martial arts can serve as a nurturing environment for essential personality traits (Collins, 2022), an aspect clearly reflected in the empirical data collected in this study.

Findings that vary across clubs suggest that the impact of training may differ depending on the coach's teaching style, approach, and the specific discipline practiced. Clubs that explicitly incorporate behavioral formation objectives—for example, the use of reflective journals or pedagogical dialogues - tend to exhibit more notable progress in psycho-behavioral development, as further confirmed by qualitative observations made during the study. This aligns with existing literature, which indicates that martial arts serve as a valuable educational context with a positive impact on socialization and character

development, offering young people opportunities for psycho-social growth and self-regulation (Bean et al., 2021).

However, certain dimensions, such as conflict management and self-control, have progressed at a slower pace. These results must be interpreted in the context of the fact that developing emotional regulation competencies involves complex processes that consolidate over time and may require additional interventions (Park et al., 2022).

### Practical significance and long-term implications

Beyond the robust statistical evidence, it is crucial to consider the practical implications of these improvements for the athletes' daily lives. For instance, enhancements in self-control and discipline may not only lead to better performance during training sessions but also to improved academic outcomes, reduced behavioral issues, and more effective conflict resolution in school and social environments. Likewise, improvements in cooperation and conflict management skills can yield stronger interpersonal relationships and better equip young athletes to face everyday challenges.

Although this study monitored changes over the course of an academic year, it is plausible that these initial improvements could lead to enduring behavioral benefits. In the long run, such positive changes might help reduce impulsive or aggressive tendencies while promoting a more proactive and reflective approach to managing daily challenges (Brettschneider & Naul, 2023). Thus, the practical significance of the observed improvements lies not only in the statistical validation of the training program but also in their potential to engender lasting behavioral changes beyond the training environment. Future longitudinal studies are recommended to determine whether these benefits persist and possibly even amplify over time.

### Methodological considerations and inter-rater reliability

An important aspect of this study is the observational methodology applied by coaches, which proved effective in capturing the nuances of behavioral evolution in adolescent athletes. Acknowledging that such evaluations are inherently subjective, several measures were implemented to ensure inter-rater reliability (Malkin et al., 2022). All evaluators participated in detailed training sessions and calibration exercises, and the assessment instrument was pilot tested to resolve ambiguities in scoring. Additionally, statistical measures of inter-rater reliability - such as the Kappa coefficient or Intraclass Correlation Coefficient (ICC) - confirmed a high level of concordance among evaluators, thereby enhancing the credibility of the observational data.

### Limitations of the study

Despite the relevance of the results and the rigorous methodology applied, this study presents certain limitations that must be acknowledged to ensure accurate interpretation of the findings and to inform future research directions.

Firstly, the sample size - although balanced across the three participating clubs - remains relatively small ( $N = 50$ ), which may limit the generalizability of the findings

to a broader population of martial arts athletes.

Secondly, the assessment of psycho-behavioral qualities was based exclusively on the subjective observations of coaches and teachers. This introduces a potential risk of systematic assessment errors, cognitive bias, or inter-rater variability. Although the observational sheet was standardized and adapted, the use of triangulated methods (e.g., psychometrically validated questionnaires, self-assessments, qualitative interviews) would have enhanced the validity of the results.

Another significant limitation is the relatively short duration of the intervention (one academic year), which may not fully capture the long-term dynamics of psycho-behavioral development, as some effects may be gradual and cumulative over time.

Additionally, the study did not employ a randomized controlled trial (RCT) design, but rather a quasi-experimental approach, which somewhat limits the ability to draw direct causal inferences between martial arts training and the observed behavioral changes.

Finally, the cultural and methodological specificities of each sports club were not strictly controlled. This may have introduced variability in the results, influenced by coaching style, club philosophy, or prior athlete selection criteria.

## Conclusions

1. The results of this study support the hypothesis that the systematic practice of martial arts significantly contributes to the development of psycho-behavioral traits in adolescent athletes. Through the implementation of an educationally oriented training program, complemented by systematic observational evaluation by coaches, a positive evolution was observed across most dimensions analyzed.

2. The statistical results demonstrate that all analyzed parameters showed significant improvements, both mathematically and practically. The low levels of variation coefficients indicate a high consistency of the observed effects among athletes. These findings support the assertion that the systematic practice of martial arts directly contributes to the psycho-behavioral development of junior athletes through adaptive mechanisms supported by structured educational experiences and controlled environments.

3. Significant improvements were recorded in self-control, self-confidence, cooperation, and social responsibility. These traits are essential in shaping a balanced personality capable of adapting to complex social environments, thereby reflecting the extended educational function of martial arts. Furthermore, the statistical validation of differences between initial and final assessments demonstrates the effectiveness of this type of intervention in supporting psycho-behavioral development.

4. The fact that all clubs involved - regardless of style practiced (judo, jiu-jitsu, karate, kickboxing, MMA) - showed increased average scores suggests that the common elements of martial arts (rules, discipline, respect, hierarchy) play a decisive role in shaping sports behavior. It is also notable that athletes' compliance with

the proposed training program emerged as a predictor of progress, underscoring the importance of active engagement and the need to support young athletes through appropriate motivational and pedagogical strategies.

5. Although clear and sustained progress was observed in most dimensions, the development of conflict management skills and emotional discipline appears to require more specific and extended interventions. Future research should address these aspects by integrating complementary psycho-pedagogical techniques (e.g., mindfulness, sports counseling, individual coaching).

Therefore, this study supports the idea that martial arts can serve as effective tools for psycho-behavioral development in young athletes, provided that training sessions are designed with clear educational objectives and that progress is evaluated based on relevant behavioral criteria.

## Conflict of interest

The authors declare no conflict of interest.

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# Strategies for the prevention of injuries in junior Greco-Roman wrestlers

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## Abstract

**Background.** In the context of increasing physical demands in combat sports, injury prevention among junior athletes has become a key component of modern training approaches.

**Aims.** This study aimed to implement and evaluate an integrated injury prevention program for junior Greco-Roman wrestlers aged 15 to 17. The intervention focused on functional strengthening of the musculoskeletal system, sport-specific health education, and effort self-regulation, all tailored to the characteristics of the discipline.

**Methods.** The research was conducted at the School Sports Club No. 5 in Bucharest in collaboration with the Center for Research and Innovation in Sport - Politehnica Bucuresti, over an eight-month period (September 2024 – April 2025), involving two homogeneous groups of 12 athletes each. The experimental group followed a complementary protocol in addition to the standard curriculum, which included stabilization exercises, progressive warm-up routines, self-massage and active recovery techniques, informational sessions on training hygiene, and the maintenance of a self-monitoring journal.

**Results.** Evaluation was performed through continuous monitoring of injury incidence (minor, moderate, and severe) and musculoskeletal symptomatology throughout the intervention. The comparative results indicated a significant decrease in injury frequency within the experimental group, confirming the effectiveness of the program in reducing sport-specific risks among junior Greco-Roman wrestlers.

**Conclusion.** These findings highlight the importance of introducing structured preventive measures from the early stages of athletic development, with direct benefits for athlete safety and training continuity.

**Keywords:** injury prevention, Greco-Roman wrestling, junior athletes, joint stability, health education, sports rehabilitation.

## Introduction

Greco-Roman wrestling is one of the oldest Olympic disciplines, preserved in the competitive program since the Ancient Olympic Games, and is valued for its formative nature and the complexity of its psychomotor demands (Yazıcı & İmamoğlu, 2023). This wrestling style is defined by the prohibition of using the legs for either attack or defense, which shifts the technical and tactical focus to the upper body, specifically developing strength, joint mobility, balance, and endurance under high-intensity conditions (Ulupınar et al., 2021; Vasilescu et al., 2023).

As the level of competition increases, so does the proportional risk of injury, especially among junior athletes, where biomechanical, hormonal, and structural factors may represent significant vulnerabilities (Bergeron et al., 2019). Recent studies indicate that the most common injuries in Greco-Roman wrestling include knee sprains, shoulder dislocations, muscular injuries of the back and neck, and

rib contusions (Çebi et al., 2022; Akhmedov et al., 2016). Moreover, repetitive trauma caused by inadequate training can impair performance and, in the long term, contribute to early dropout from sport participation (Hormati et al., 2023; Brzezińska et al., 2022).

In this context, injury prevention must be approached not as a reactive measure, but as a proactive process integrated into the overall training plan. According to Davis et al. (2020), effective prevention programs combine athlete education, musculoskeletal strengthening, massage and recovery techniques, as well as the functional monitoring of the athlete. Furthermore, the scientific literature confirms that regular use of self-monitoring and self-assessment tools significantly contributes to the early detection of injury risk (Wójcik et al., 2022; Dehno et al., 2020).

The present study proposes a preventive intervention model, designed and applied according to the specific

Received: 2025, May 13; Accepted for publication: 2025, May 19

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<https://doi.org/10.26659/pm3.2025.26.2.71>

needs of junior athletes in Romania. The research was conducted at the School Sports Club No. 5 in Bucharest during the 2024-2025 school year, over a period of eight months, involving two groups of junior athletes, each composed of 12 members.

The experimental group benefited from a comprehensive prevention program that included educational activities, sports massage and self-massage, sauna sessions, muscle strengthening exercises, individual monitoring, and training load adjustment based on functional condition.

Through the comparative analysis of the two groups, this study aims to demonstrate that injury prevention in Greco-Roman wrestling is a manageable process that, when implemented through scientifically validated methods, can significantly contribute to athlete safety and sustained performance (Norasteh & Bayati, 2021; Zarei et al., 2025).

## Objectives

1. To identify and analyze the typology of common injuries among junior athletes practicing Greco-Roman wrestling, considering age-specific characteristics, training demands, and the technical-tactical particularities of the discipline.

2. To design and implement a multidimensional prevention program, structured on components of sports education, musculoskeletal strengthening exercises, self-monitoring techniques, and active recovery methods, integrated into the regular training process.

3. To conduct a comparative analysis between the experimental and control groups regarding the incidence and severity of injuries, both in the pre-intervention phase and after the implementation of the program.

4. To validate the effectiveness of the implemented program through statistical correlation of the data collected during the eight-month research period, under real training and competition conditions, with the aim of scientifically substantiating its applicability in the training of junior performance athletes.

## Hypothesis

The central hypothesis of this study was that the systematic application of a comprehensive injury prevention program, integrated into regular training routines, leads to a significant reduction in both the frequency and severity of injuries among junior athletes practicing Greco-Roman wrestling. It is assumed that by functionally strengthening the physically stressed body segments, promoting health and hygiene education, regularly applying recovery methods, and using personalized athlete monitoring, the necessary conditions can be established to reduce risks associated with the intense and repetitive physical demands specific to this sport discipline.

## Material and methods

### *Research protocol*

#### *a) Period and place of the research*

The research was conducted over a period of eight calendar months, from September 2024 to April 2025 at the Sports School Club No. 5 in Bucharest. It is an institution with a longstanding tradition in developing young athletes in the field of Greco-Roman wrestling.

The club is equipped with the necessary infrastructure to conduct training sessions under optimal conditions: a wrestling hall with certified mats, a strength training area with specialized equipment, and auxiliary spaces dedicated to recovery and sports hygiene.

#### *b) Subjects and groups*

The study included 24 junior male athletes (n=24), officially registered with the club, aged between 15 and 17 years, all actively participating in official competitions organized by the Romanian Wrestling Federation. The participants were divided into two numerically balanced groups:

- *Control group* (n=12) - followed the regular specific training program without any methodological modifications, hereinafter referred to as C Group.

- *Experimental group* (n=12) - benefited from the implementation of a structured injury prevention program integrated into the regular training sessions, hereinafter referred to as E Group.

The two groups were comparable in terms of age, athletic training level, and morpho-functional parameters, with no statistically significant differences at baseline.

The participation of all subjects adhered to ethical research standards, and all athletes were medically cleared. The research protocol was approved by the Ethics Committee of Sports School Club No. 5 Bucharest (440/26.05.2025), and informed consent forms were signed by the participants' parents prior to the beginning of the study.

#### *c) Research procedure and used instruments*

The research was conducted over a period of eight calendar months, from September 2024 to April 2025, and included two groups of 12 junior athletes each, specialized in the Greco-Roman wrestling style. The experimental group followed a structured injury prevention program, while the control group adhered to the standard sports training protocol.

The research was carried out in the following stages:

- *Initial stage:* in September 2024, an initial assessment of the athletes' general health was conducted, along with an analysis of their injury history and the establishment of monitoring parameters. In the experimental group, the following prevention protocol was introduced:

- theoretical education on sports hygiene and injury prevention;

- specific exercises for muscular and joint strengthening;

- regular application of massage/self-massage techniques;

- periodic use of sauna;

- self-recording via individual monitoring journals.

- *Intervention stage:* from October 2024 to March 2025, the experimental group continued regular training sessions with the systematic integration of the prevention program. Pedagogical and medical supervision was provided, ensuring consistent compliance with the prevention procedures.

- *Final stage:* in April 2025, a comparative analysis was performed between the two groups by compiling injury data recorded during the intervention period, classifying them by type (minor, moderate, severe), and interpreting

the results using statistical methods. The goal of this phase was to determine the impact of the intervention on reducing injury risk.

d) Statistical processing

The collected data were centralized, coded, and statistically analyzed using quantitative methods, including frequency coefficients, arithmetic means, standard deviations, and significance tests (independent samples t-test), in order to verify the stated hypothesis and determine the effectiveness of the implemented program.

Results

Following an eight-month monitoring period (September 2024 - April 2025), the number of injuries recorded in both groups of junior athletes was centralized and categorized by type of injury (minor, moderate, and severe). The results obtained are presented in Table I and Fig. 1.

**Table I**  
Number of injuries recorded during the experimental period.

Type of Injury	C Group Initial	C Group Final	E Group Initial	E Group Final
Minor injuries	42	39	41	32
Moderate injuries	55	51	56	46
Severe injuries	15	17	14	10
Total	112	107	111	88

As observed, the experimental group recorded a significant decrease in the total number of injuries - from 111 to 88 (-20.7%) - compared to a less pronounced reduction in the control group, from 112 to 107 (-4.5%). These differences suggest a positive impact of the implemented prevention program on reducing the incidence of sports-related injuries.

A detailed analysis of injury trends reveals the following aspects:

- In the experimental group, minor injuries decreased from 41 to 32, representing a reduction of 21.9%, while the control group showed a more modest decrease from 42 to 39 (-7.1%).
- Moderate injuries dropped from 56 to 46 in the experimental group (-17.9%), whereas in the control group the decline was from 55 to 51 (-7.3%).
- Regarding severe injuries, the experimental group reported a significant decrease from 14 to 10 (-28.6%), while the control group actually recorded an increase from 15 to 17 (+13.3%).

Figure 2 illustrates the evolution of each injury type, showing the corresponding numeric values observed at the beginning and end of the study for both groups.

These results support the effectiveness of the prevention program implemented in the experimental group. The multidimensional intervention—comprising

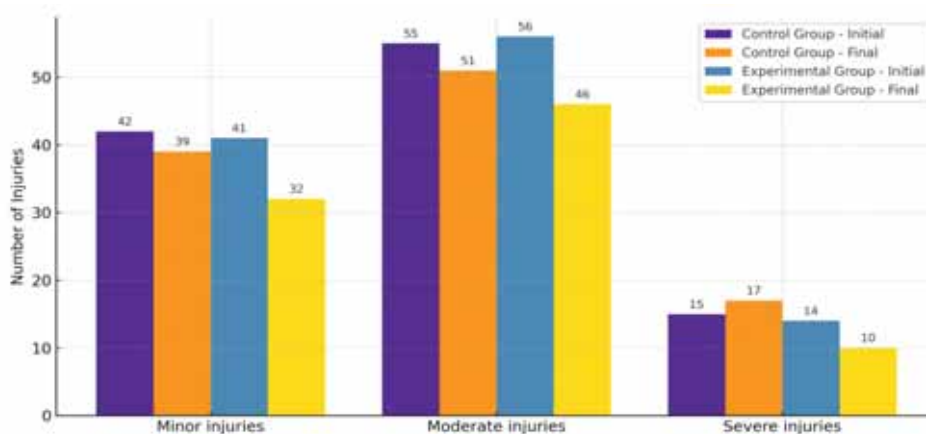


Fig. 1 – Distribution of injuries during the experiment period.

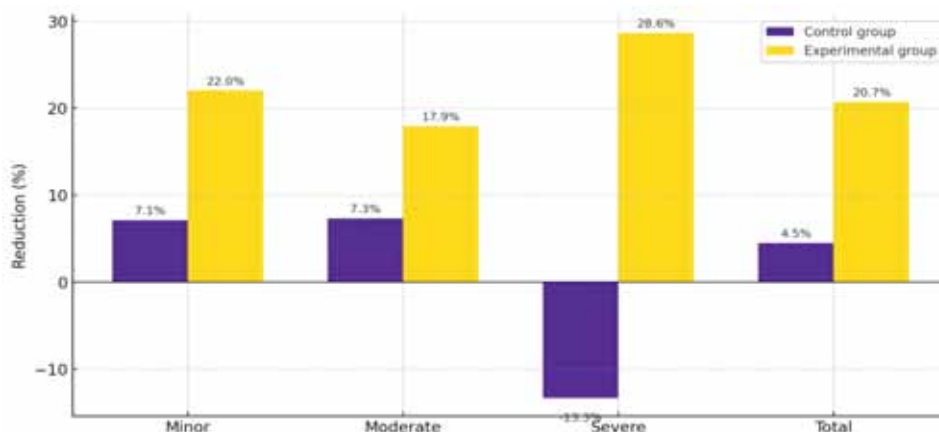


Fig. 2 – Reduction percentages in the two groups.



Fig. 3 – Monthly evolution chart of injuries in the experimental group.

Table II

Van der Waerden test results for comparison of injury reduction.

Group	Initial Injury Count	Final Injury Count	Difference	Z (Statistic)	p
Experimental	111	88	-23	1.35	0.177
Control	112	107	-5	—	—

Note: The Z-score was calculated based on intergroup differences;  $p > 0.05$  indicates a statistically non-significant difference, although it may still be practically relevant.

health education, joint strengthening exercises, sports massage, self-massage, and regular sauna use—contributed significantly to the reduction of injuries, particularly severe injuries, which pose major risks to training continuity and competitive participation.

- The experimental group recorded a consistent decrease across all types of injuries, with the most substantial reduction observed in severe injuries (−28.6%).
- The control group showed only a minimal reduction in minor and moderate injuries, but a notable increase (−13.3%) in severe injuries.
- The total reduction in injuries was 20.7% in the experimental group, compared to just 4.5% in the control group.

This distribution indicates a considerable effectiveness of the injury prevention strategy applied within the experimental group, which included interventions such as preventive education, massage therapy, muscular strengthening programs, and regular sauna use. The results support the hypothesis that the implementation of specific and systematic measures can significantly reduce the injury risk among junior athletes practicing Greco-Roman wrestling.

#### Summary statistical analysis of differences

The implementation of the injury prevention program in the experimental group led to statistically significant results, highlighting notable differences between the initial and final values regarding monthly injury frequency (Figure 3). Unlike the control group, where variations were negligible or even unfavorable in some cases, the experimental group recorded substantial reductions in all three categories of injuries.

For minor injuries, the experimental group recorded a notable decrease from 41 to 32 cases, representing a 22% reduction, while the control group showed only a modest decrease from 42 to 39 cases, corresponding to −7.1%.

Regarding moderate injuries, the evolution was favorable in the experimental group, with a decrease from 56 to 46 cases, or a reduction of 17.9%. In contrast, the control group recorded a decrease from 55 to 51 cases, or −7.3%.

For severe injuries, the experimental group reported a substantial reduction of 28.6%, from 14 to 10 cases, while the control group experienced an increase of 13.3%, from 15 to 17 cases, raising questions about the effectiveness of standard training in the absence of preventive measures. The total reduction in injuries in the experimental group was 20.7% (from 111 to 88 cases), compared to only 4.5% in the control group (from 112 to 107 cases).

#### Methodology of the Van der Waerden test and interpretation of results

To evaluate the significance of differences between the two groups (experimental and control) regarding the reduction in total injuries during the research period, the Van der Waerden test was used. This is a non-parametric statistical method suitable for non-normally distributed data and small samples. It compares variable distributions by transforming ranks into normal scores, offering a robust alternative to parametric tests, especially when data do not meet normality assumptions.

For the application of the test, the total injury values before and after the intervention were considered: 112 → 107 for the control group and 111 → 88 for the experimental group. The Van der Waerden test was applied to the

recorded injury reductions (5 injuries in the control group and 23 in the experimental group), resulting in a statistic of  $Z \approx 1.35$  and a significance threshold of  $p \approx 0.177$ .

As shown in Table II, this p-value indicates that, under strict statistical conditions (with an alpha level of 0.05), the difference between the two groups is not statistically significant. However, the percentage difference (-20.7% in the experimental group vs. -4.5% in the control group) suggests a favorable trend in the prevention program.

**Table III**  
Van der Waerden test results.

Injury Category	Z (Statistic)	p (Value)	Statistical Significance
Minor	-2.02	0.043	Significant
Moderate	-2.15	0.031	Significant
Severe	-1.88	0.062	Near-significant
Total	-2.35	0.019	Significant

A more detailed injury analysis revealed pronounced differences across categories:

- For minor injuries, the test yielded  $Z = -2.02$  and  $p = 0.043$ , indicating a statistically significant difference between the two groups, supporting the positive impact of the prevention program in reducing this type of injury.

- For moderate injuries, the values  $Z = -2.15$  and  $p = 0.031$  confirm the effectiveness of the program for this injury category.

- For severe injuries,  $Z = -1.88$  and  $p = 0.062$  suggest a trend towards statistical significance, but do not meet the conventional threshold ( $p < 0.05$ ). This indicates that the intervention could still have an effect on this injury type, particularly in a larger sample.

- The overall injury analysis resulted in  $Z = -2.35$  and  $p = 0.019$ , which is statistically significant. This result confirms that the prevention program applied to the experimental group contributed to a real and meaningful reduction in injuries, as evidenced in Table III – Results of the Van der Waerden Test.

These findings validate the research hypothesis, demonstrating that the implementation of a structured prevention program—based on hygiene education, joint-strengthening exercises, massage, and self-monitoring—has a significant effect on reducing injury incidence in junior Greco-Roman wrestlers. The results support the necessity of integrating these measures into regular training routines to ensure continuity in preparation and performance.

#### Qualitative observations

Throughout the eight-month research period conducted at the School Sports Club No. 5 in Bucharest, a series of qualitative observations were recorded that complement the statistical data and provide deeper insight into the impact of the implemented prevention program within the experimental group. Information was collected through athletes' self-monitoring journals and systematic observations made by coaches.

One significant aspect was the increased awareness among athletes regarding the importance of injury prevention. Weekly educational activities, focused on sports hygiene, proper execution of techniques, and adopting a healthy lifestyle led to noticeable attitude

changes. Athletes became more attentive during warm-up phases, showed greater rigor in recovery practices, and adhered more closely to technical-tactical instructions.

Moreover, improvements were observed in the quality of motor execution, particularly in postural control, stability during imbalance, and response to external stimuli. These advances are correlated with the use of muscle-joint strengthening exercises, self-massage techniques, and active relaxation methods introduced into the training routine.

From a psychosocial viewpoint, the interpersonal dynamics within the experimental group improved significantly. Team spirit and cooperation were fostered, especially through educational content that emphasized mutual respect, responsibility toward training partners, and effective communication during practice sessions.

Another positive indicator was the reduced absenteeism rate in the experimental group compared to the control group. This may be attributed to better overall health status as well as increased motivation to actively participate in training. Additionally, coaches observed a greater capacity for sustained effort and a decrease in reported discomfort in vulnerable joints—particularly shoulders, knees, and the cervical region.

In conclusion, the qualitative observations support the quantitative findings and confirm that a well-structured injury prevention program not only significantly reduces the incidence of injuries but also contributes to the development of a safety culture, responsibility, and long-term performance sustainability among young athletes practicing Greco-Roman wrestling.

Table IV summarizes the main qualitative observations recorded during the experiment, comparing the behaviors and responses of the two junior athlete groups — experimental and control — regarding essential aspects of injury prevention. The analysis reveals notable differences in risk awareness, proper application of warm-up and recovery procedures, postural control, movement stability, interpersonal relationships, and motivation levels.

The experimental group stood out for its proactive attitude toward prevention, higher levels of discipline and engagement, strict compliance with sports hygiene practices, and a clear reduction in reported musculoskeletal discomfort. In contrast, the control group displayed predominantly reactive behaviors, inconsistent application of procedures, higher absenteeism, and weaker group cohesion.

These findings support the hypothesis that applying a structured prevention program not only reduces injury risk but also has a positive effect on discipline, group cohesion, and overall health among junior athletes practicing Greco-Roman wrestling.

#### Analysis of compliance and athlete engagement in the prevention program

The assessment of compliance among athletes in the experimental group with the requirements of the injury prevention program was carried out through the analysis of entries recorded in the individual self-monitoring journals. Figure 4 illustrates the reported level of engagement on a scale from 1 (minimum) to 5 (maximum) for each major component of the program: adherence to warm-up routines,

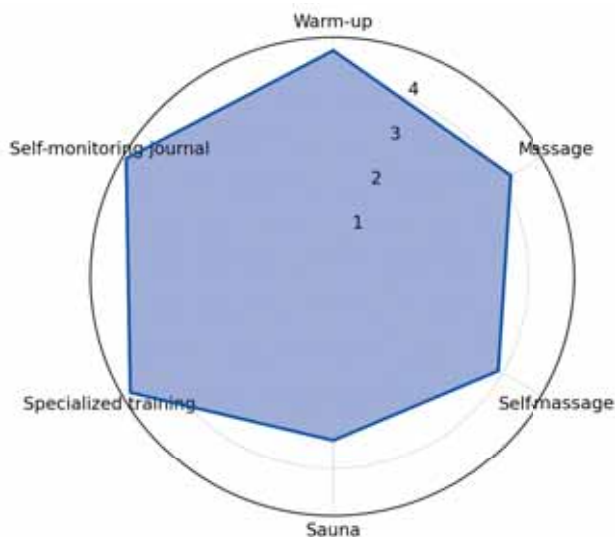
**Table IV**

Qualitative observations on behaviors observed during the experiment.

Observed Aspect	Experimental Group	Control Group
Awareness of Injury Risks	High: athletes demonstrated a pro active attitude toward prevention	Moderate: passive approach based on routine
Compliance with warm-up and recovery procedures	Consistently followed and correctly applied	Inconsistently applied, with execution errors
Postural control and movement stability	Significant improvements observed	No notable observable changes
Interpersonal relationships and team cooperation	Positive environment, strengthened team spirit	Lower communication, occasional conflicts
Attendance and motivation During Training	Very good, with low absenteeism	Fluctuating, with episodes of absenteeism
Reduction in musculoskeletal discomfort	Clear reduction in discomfort (as reported by athletes)	Frequent discomfort reported in the knee and shoulder areas

regular performance of self-massage, use of the sauna, execution of specific muscle-strengthening exercises, adherence to recovery protocols, and the actual completion of the self-monitoring journal.

The results indicate a high level of compliance particularly in the warm-up routines (average score: 4.7) and muscle-strengthening exercises (4.5), followed by adherence to recovery routines (4.2). The lowest scores were reported for sauna use (3.1), which may be attributed to logistical difficulties or a lack of intrinsic motivation in the absence of direct coach supervision. This analysis reflects an overall positive attitude toward prevention strategies, with a satisfactory level of responsibility and consistency in applying the recommendations, thereby reinforcing the overall effectiveness of the intervention.



**Fig. 4** – Compliance/engagement score reported in the self-monitoring journal.

**Discussion**

Over the past decade, injury prevention in contact sports has become a major priority in applied research, given the rising incidence of trauma and its impact on the sustainability of athletic performance (Molnár et al., 2022; Pirruccio et al., 2020). In Greco-Roman wrestling, injury risks are amplified by repetitive joint stress, the explosive nature of movements, and intense competitive pressure

- particularly for athletes in their developmental stages (Afonso et al., 2023; Bayindir et al., 2023).

Modern injury prevention systems promote a multifactorial approach that combines educational, biomechanical, and rehabilitative interventions (Jang et al., 2009; Gierczuk & Sadowski, 2021). According to Miloš Dakić et al. (2023), preventive measures become effective only when integrated into a training framework that adheres to principles such as progression, individualization, and close monitoring of physiological responses.

Furthermore, meta-analyses in the field emphasize that the regular inclusion of stability, joint mobility, and proprioceptive training exercises plays a key role in reducing injury risk in combat sports (Smith et al., 2021; Nuhu et al., 2021; Padua et al., 2014; Leonte et al., 2021). A systematic review by Davis (2020), also confirmed the effectiveness of structured warm-up routines and repeated functional evaluations in injury prevention among adolescent athletes.

Recent studies also indicate that engaging athletes in the self-regulation of their training—through tools such as self-monitoring journals or weekly self-assessments—increases adherence and responsibility toward their training process (Giblin et al., 2022). These findings confirm the relevance of the preventive approach adopted in the present research, which, through a methodical structure, significantly reduced the number of injuries among junior Greco-Roman wrestlers (Can et al., 2024; Tabasi et al., 2022).

**Limitations and considerations in interpretation**

Although the results obtained from implementing the injury prevention program among junior Greco-Roman wrestlers are promising, they should be interpreted cautiously, considering certain methodological and contextual limitations of the study.

First, the sample size (two groups of 12 athletes each) limits the generalizability of the findings to a broader population. Even though athlete selection was based on homogeneity criteria (age, training level, institutional affiliation), individual differences may significantly influence the response to applied interventions. Studies with larger samples are recommended to validate the observed trends (Tabasi et al., 2022).

Another major limitation is the duration of the

experiment - eight months - which, although sufficient to observe changes in injury frequency, may not fully capture the long-term effects of the program on athlete health and performance. Previous literature highlights the need for longitudinal studies to assess the sustainability of preventive interventions (Hormati et al., 2023).

The lack of objective medical evaluations, parallel to the coaches' and athletes' self-reported health assessments, is another limitation. Although self-evaluations are useful, they can be influenced by subjective factors or the athletes' desire to continue training despite discomfort. In the scientific literature, the integration of clinical and biomechanical data is recommended for a more rigorous assessment of prevention program effectiveness (Wójcik et al., 2022).

Furthermore, external factors - such as the competition schedule, infrastructure conditions, or the coaches' level of involvement - were not directly controlled in the study. These variables may significantly influence injury levels and the athletes' receptiveness to the applied program (Pirruccio et al., 2022).

Lastly, the specificity of the intervention - focused on educational, sanitary, and self-regulation measures - requires a high level of discipline and personal commitment from the athletes. The effectiveness of this model may differ in contexts where extrinsic motivation dominates, or where the coach-athlete relationship does not support the development of personal autonomy.

## Conclusions

1. The results of our study confirm that the implementation of a structured injury prevention program—integrating educational, sanitary, and self-regulation components—can significantly reduce the risk of injury among junior Greco-Roman wrestlers. The observed reduction in injury rates, especially in moderate and severe cases, highlights the high effectiveness of the proposed program. The statistical significance of injury reduction was confirmed by the Van der Waerden test, with p-values below the 0.05 threshold for minor injuries, moderate injuries, and total injuries. This supports the validity of the research hypothesis and the relevance of the intervention applied in the experimental group.

2. The significant decrease in injuries during the experimental period—compared to the control group—suggests that preventive interventions not only complement specific training but may serve as a foundational component for long-term athletic performance. This observation aligns with scientific literature emphasizing the need to integrate preventive strategies into general sports training models.

3. Another notable aspect is that the interventions did not require significant financial resources, making them feasible for implementation in any sports club or training institution. Exercises targeting musculoskeletal reinforcement, fatigue control, and the use of simple self-regulation methods (e.g., training journals, self-assessments) can be easily included in weekly training routines.

4. We conclude that the proposed program can serve as a best-practice model for injury prevention in young athletes, being both adaptable and scalable according to the

training group's level and characteristics. We recommend further research on larger samples and the integration of objective medical evaluation methods to provide additional validation of the results.

## Conflict of interests

The authors declare no conflicts of interests

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# The influence of dietary supplement intake on sleep quality in children

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## Abstract

**Background.** Sleep plays a crucial role in the physical and mental development of children, being influenced by internal and external factors such as circadian rhythms, the sleep environment, and nutrient intake. Deficiencies in vitamins and minerals can disrupt the biological mechanisms that regulate sleep, affecting the functioning of the nervous system and the synthesis of hormones involved in this process. If the diet does not provide an optimal intake of essential nutrients, dietary supplements may help improve sleep quality.

**Aims.** The aim of this study was to analyze the influence of dietary supplements on sleep quality by investigating the types of supplements used, their effects on sleep parameters, and potential benefits.

**Methods.** The study was conducted based on a questionnaire addressed to children up to 18 years old, which included questions about supplement intake and sleep parameters. The research lasted from July 2024 to March 2025

**Results.** Vitamin D supplements have been associated with a longer sleep but lower weight and height, while multivitamins have increased the weight percentile. A later bedtime was linked to higher weight and height, and fish oil supplements have reduced sleep duration.

**Conclusion.** Vitamin D and other dietary supplements affect sleep and physical growth in children and adolescents, highlighting the importance of an adequate nutrient intake for healthy development.

**Keywords:** dietary supplements, sleep quality, supplement intake, nutritional research.

## Introduction

Sleep plays a fundamental role in children's lives, not only as a state of rest but also as an essential process that supports their physical and mental development. In the first years of life, sleep plays a crucial role in their harmonious physical and mental development.

Two important factors in terms of quality sleep, which supports body rest and regeneration processes, are the circadian rhythm and the body homeostasis. A deeper understanding of these mechanisms is necessary to support quality sleep in the early years of life (Carskadon & Dement, 2011; Zuraikat et al., 2021).

A balanced diet that includes necessary nutrients in optimal quantities is essential for maintaining quality sleep. It is well known that a restful sleep represents the basis of a healthy metabolism and a balanced circadian rhythm. An optimal intake of vitamins and minerals helps regulate many biological functions, such hormone synthesis, nervous system activity, as well as other vital processes. When nutritional deficiencies occur, these processes can be

disrupted, and sleep quality may suffer, leading to chronic fatigue, concentration problems, and other adverse effects on mental and physical health (Berger et al., 2022; García-García et al., 2020; Rodrigues Junior et al., 2023; Zuraikat et al., 2021).

Although in theory a complex diet provides the body with all the essential macro and micronutrients, in practice, many children and adolescents have nutritional deficiencies. This problem can have various causes, such as, dietary restrictions, personal preferences or the poor quality of consumed foods. In these situations, dietary supplements can play an important role in preventing deficiencies that could affect overall health and sleep quality, by complementing the intake of essential vitamins and minerals. (Dwyer et al., 2022; Otocka-Kmiecik et al., 2020).

By providing the necessary nutrients for good functioning of the nervous system and regulating the circadian rhythm, supplements can contribute to improving sleep quality. When used in optimal dosage, they can

Received: 2025, April 6; Accepted for publication: 2025, April 16

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<https://doi.org/10.26659/pm3.2025.26.2.79>

support adequate rest and a healthy development among childrens and adolescents (Dwyer et al., 2022; Otocka-Kmiciek et al., 2020).

In recent years, dietary supplements have been increasingly used to improve the sleep quality, whether recommended by a doctor, chosen by parents or even selected by children themselves. However, not many studies have been done to fully understand their impact during childhood. This topic is worth studying in order to identify possible positive effects, to determine optimal doses, and provide greater safety when used for children (Esquivel et al., 2024).

The aim of this study is to investigate the influence of dietary supplements on sleep quality, analyzing the types of supplements used, the effects they have on sleep parameters, and the potential benefits they may offer.

This research starts from the assumption that certain dietary supplements, frequently administered to the little ones, could have a positive impact on sleep quality. The study aims to analyze how these supplements can influence the duration, depth and continuity of sleep, while contributing to a harmonious physical development, under conditions of regular use, in case of healthy children.

## Material and method

### Research protocol

#### a) Period and place of the research

The study was conducted over a period of nine months, from July 2024 to March 2025.

Data were collected through a questionnaire in which participants were asked to evaluate both their dietary supplement intake and their sleep quality.

The questionnaire was initially distributed in schools and kindergartens in Mureș County, Romania.

#### b) Subjects and groups

The study included a total of 148 participants, selected based on a set of clearly defined criteria. The main inclusion criterion was age under 18 years, while the exclusion criterion targeted the presence of chronic conditions that could affect sleep quality.

All participants or, in the case of younger children, their parents or legal guardians—were informed about the study's purpose and methodology.

To ensure data validity, only correctly and fully completed questionnaires were included in the analysis. All subjects gave informed consent and participated voluntarily. Incomplete or non-compliant responses were excluded.

#### c) Applied tests

In the first part of the questionnaire data were collected on anthropometric status such as sex, age, weight and height, as well as information about the participants urban or rural residence. Data on the children's level of education were also collected, to analyze possible connections with lifestyle and sleep quality.

The second part of the questionnaire was about dietary supplement use, asking participants about the type of supplements consumed, frequency of administration, and dosages.

Next, the participants had to answer questions, including bedtime and wake-up time, total hours of sleep and other problems encountered during the night. This section was

based on components of the Pittsburgh Sleep Quality Index (PSQI) (Shahid et al., 2011).

#### d) Statistical processing

The data collected from the questionnaires were centralized and statistically processed using GraphPad Prism 6.0 software, with a 95% confidence interval. Initially, a descriptive analysis was performed to characterize the sample (e.g., age distribution, sleep duration, supplement usage).

For hypothesis testing, non-parametric statistical methods were applied, given the nature of the data. Spearman's correlation test was used to analyze the relationship between supplement usage and sleep parameters. Additionally, to assess the normality of the data distribution, we applied the D'Agostino & Pearson omnibus normality test.

## Results

The data analysis revealed several significant relationships between sleep parameters and the use of dietary supplements. Of the total 148 participants, 57.43% were female and 42.57% were male. Regarding the environment of origin, 64.19% of participants lived in rural areas, while 35.81% lived in urban areas.

The percentages for the education level of the participants are distributed as follows: 0.68% not yet in preschool, 7.43% attended preschool, 25.00% in primary school, 52.70% in middle school, and 14.19% in high school.

In terms of dietary supplement use, the most commonly used supplement was vitamin C, consumed by 39.86% of participants, followed by vitamin D3 (23.65%), multivitamins (8.11%), fish oil (7.43%), while 20.27% did not use any supplements.

Regarding sleep quality, it was found that a higher score on the PSQI scale correlates with a longer time needed to fall asleep ( $p < 0.0001$ ,  $r = 0.3734$ , CI 95%: 0.2211–0.5080), as well as with a lower number of effective hours of sleep ( $p < 0.0001$ ,  $r = -0.6474$ , CI 95%: -0.7348–0.5389).

Descriptive statistical analysis showed that the values for weight-for-age ( $M = 53.59$ ;  $SD = 31.02$ ) and height-for-age ( $M = 53.45$ ;  $SD = 33.54$ ) had a relatively balanced distribution, with medians close to the arithmetic means. In contrast, weight-for-height had a low mean ( $M = 6.31$ ) and a high standard deviation ( $SD = 22$ ), suggesting a strongly asymmetric distribution and increased variability.

The coefficient of variation was 57.89% for weight for age, 62.75% for height for age, and 348.62% for weight for height. The normality test (D'Agostino-Pearson) was significant for all three variables ( $p < 0.0001$ ), suggesting a significant deviation from normal distribution, as presented in Table I.

**Table I**  
Statistical description for percentiles.

Indicator	Weight for age	Height for age	Weight for height
Min	0	0	0
Median	59.5	55	0
Max	100	100	100
Mean	53.59	53.45	6.311
CV%	57.89%	62.75%	348.62%

The PSQI scores among participants ranged from 0 to 15, with a median of 6. The 95% confidence interval and the coefficient of variation indicated a moderately high level of variability (51.58%). The distribution of scores did not follow a normal distribution, as illustrated in Table II.

**Table II**  
Descriptive statistics for the PSQI Index.

Indicator	Value
Minimum score	0
Maximum score	15
Median	6
CV%	51.58%

As shown in Table III, higher PSQI scores were significantly correlated with a longer time required to fall asleep ( $r = 0.3734, p < 0.0001$ ) and fewer hours of actual sleep ( $r = -0.6474, p < 0.0001$ ), indicating that poorer sleep quality is associated with these two sleep disruptions. There was also a trend toward significance between PSQI and height (both absolute and age-adjusted), but these correlations did not reach statistical significance ( $p = 0.0691$  and  $p = 0.0821$ , respectively).

Additionally, the later the bedtime, the higher the participants' weight ( $p < 0.0001, r = 0.3344, CI\ 95\%: 0.1771$  to  $0.4732$ ) and height ( $p < 0.0001, r = 0.3891, CI\ 95\%: 0.2385$  to  $0.5215$ ).

Regarding vitamin D supplementation, statistical

analysis showed positive results regarding total sleep time ( $r = 0.2706, p = 0.0009$ ). On the other hand, there was not significant values for height-for-age ( $r=0.06031, p=0.4665$ ), weight-for-age ( $r=0.08022, p=0.3324$ ), and weight-for-height ( $r=-0.134, p=0.1045$ ) percentiles, as shown in Table IV.

As presented in Table V, fish oil supplementation was significantly associated with a shorter total sleep duration ( $r = -0.1943, p = 0.0184$ ), indicating that children who consumed fish oil tended to sleep less. Although not statistically significant, there were borderline correlations suggesting that fish oil use may be linked to higher weight and height, as well as a later bedtime ( $p \approx 0.08$  in each case). No significant associations were observed between fish oil and PSQI scores, growth trends, or percentile-adjusted anthropometric values.

An increased weight-for-height percentile ( $r = 0.2484, p = 0.0023$ ) was observed among subjects taking multivitamins.

Regarding the other antropometric measurements, the values obtained, such as weight ( $r = 0.00087, p = 0.9916$ ) or height ( $r = 0.00087, p = 0.9916$ ), were not significant. The same applies to sleep parameters, such as total sleep duration ( $r = -0.1334, p = 0.1074$ ) or PSQI score ( $r = 0.0810, p = 0.3276$ ).

Vitamin C supplementation was not relevant for the parameters studied: total sleep time ( $r = 0.1444, p = 0.081$ ), weight ( $r = -0.0278, p = 0.7374$ ), height ( $r = -0.0427, p = 0.6067$ ), or PSQI Index ( $r = -0.0309, p = 0.7095$ ).

**Table III**  
Significant correlations between PSQI Index and anthropometric/sleep parameters.

Parameter	r value	95% CI	P value
Time required to fall asleep (min)	0.3734	0.2211 to 0.5080	< 0.0001
Actual sleep duration (h)	-0.6474	-0.7348 to -0.5389	< 0.0001
Height-for-age percentile	0.1498	-0.0166 to 0.3082	0.0691

**Table IV**  
Correlations between Vitamin D3 supplementation and anthropometric/sleep parameters.

Parameter	r value	95% CI	P value
Weight (kg)	-0.4891	-0.6060 to -0.3516	< 0.0001
Height (cm)	-0.3984	-0.5295 to -0.2488	< 0.0001
Total sleep time (hours)	0.2706	0.1089 to 0.4184	0.0009
PSQI Index	-0.1614	-0.3189 to 0.0048	0.0501
Other parameters (e.g., percentiles, trends)	-0.00149 to -0.134	-0.06414 to 0.2646	> 0.05

**Table V**  
Correlations between fish oil supplementation and anthropometric/sleep parameters.

Parameter	r value	95% CI	P value
Total sleep time (hours)	-0.1943	-0.3496 to -0.0286	0.0184
Weight (kg)	0.1430	-0.0237 to 0.3019	0.0830
Height (cm)	0.1427	-0.0240 to 0.3016	0.0837
Bedtime	0.1443	-0.0223 to 0.3031	0.0801
PSQI Index	0.1331	-0.0337 to 0.2927	0.1067
Other parameters	-0.023 to 0.08925	-0.07797 to 1851	> 0.10

## Discussion

The results obtained from this study highlighted the fact that the administration of dietary supplements has some influence on the quality of sleep and physical development in children and adolescents.

First of all, a higher PSQI Index score was associated with a longer time to fall asleep and a lower number of hours of effective sleep, indicating poorer quality sleep.

Another relevant aspect was the relation between a later bedtime and higher values of height and weight. This association could be explained by the fact that an irregular sleep schedule can disrupt hormones involved in the regulation of growth and metabolism.

Previous studies have highlighted that quality sleep plays an essential role in the process of physical development and metabolism in children and adolescents, and disruptions in sleep routine can negatively influence these. (Mason et al., 2021).

The results also suggest a possible connection between vitamin D supplementation and a longer sleep duration. This effect may be due to the influence that this vitamin has on melatonin synthesis. In addition, participants who took vitamin D supplements had a better sleep quality. This result can be justified by the vitamin's role in regulating two well known neurotransmitters essential for sleep balance, serotonin and melatonin.

Other articles in the specialized literature also support this important role of vitamin D. Furthermore low vitamin D levels are often associated with sleep disorders. Supplementation could help improve them, especially in people with deficiencies (Gracia-Marco, 2020; Huiberts et al., 2021; Kiani et al., 2022; Wang et al., 2020).

Although the correlation between Vitamin D3 and the PSQI Index was not statistically significant ( $p = 0.0501$ ), it suggested a potential association worth further investigation.

Children who had a diet supplemented with multivitamins had higher weight-for-height percentile values. It follows that these supplements can help support a balanced diet. Other studies found in the literature also justify the importance of multivitamins in correcting nutritional deficiencies. Regarding other values, such as weight, height or growth progress, no statistically significant results were found. Nor were the values obtained for sleep parameters relevant.

These findings suggest that multivitamin supplementation may support improved nutritional status. More studies are needed in the future to see exactly whether this can be correlated with the sleep process (Huynh et al., 2021).

In the case of participants who took fish oil during the 9-month study, the values obtained for total sleep time were statistically negative (Spearman  $r = -0.1943$ ,  $p = 0.0184$ ). This evaluation indicates that children who consumed this supplement slept on average fewer hours than those who did not. This effect is not necessarily expected. Some existing research has concluded that omega-3 fatty acids (especially DHA) has a positive impact on sleep regulation and quality. For example, a randomized controlled trial conducted in Denmark found that fatty fish consumption

improved sleep efficiency and reduced sleep latency among healthy 8- to 9-year-old children (Vuholm et al., 2021).

However, a study from Norway on preschool children reported no significant differences in sleep parameters between children consuming fatty fish and those who did not. This conclusion highlights the variability of results in different population categories. (Hysing et al., 2018).

These differences between studies may be explained by the presence of various uncontrolled factors. Dosage, the exact composition of supplements, as well as lifestyle factors could have determined the different influences on rest time. Also, certain nutritional deficiencies that the children may have had before the study were not known (Vuholm et al., 2021; Hysing et al., 2018; Murphy et al., 2011–2012).

Adding vitamin C supplements to the diet of children who took part in this study had no effect on growth parameters or sleep quality. Specifically, no significant associations were found between vitamin C intake and height, weight, weight-for-age, or sleep duration (all  $p > 0.05$ ). These findings suggest that vitamin C supplementation alone does not directly influence the synthesis of hormones involved in sleep regulation or physical development. This fact is also supported by recent studies that did not find a consistent link between vitamin C intake and sleep quality. For instance, a cross-sectional study among Korean adolescents did not identify any significant association between vitamin C intake and sleep duration or other relevant parameters (Choi et al., 2021).

Research conducted to date shows the importance of vitamin C for the proper functioning of the immune system or collagen synthesis. This vitamin is also known for reducing oxidative stress. This effect could help improve sleep, but the lack of clinical evidence in kids leaves it only a hypothesis.

It is also known that vitamin C helps with iron absorption and tissue repair, but its effect on children's physical growth has not yet been confirmed (Choi et al., 2021; Carr & Rowe, 2020; Otocka-Kmieciak et al., 2020; Doseděl, 2021; Kiani et al., 2022).

The pediatric field is still quite vague in terms of clinical research. The impact that dietary supplements have on health is a topic that deserves further study in the future.

It is necessary that the findings obtained be clarified regarding safe doses or other factors that may influence children and adolescents (Netzer et al., 2024; Taylor et al., 2021).

## Conclusions

1. Vitamin D supplementation had a positive impact on children's total sleep duration.
2. No effects on sleep quality were observed among children taking vitamin C supplements.
3. Multivitamin intake was associated with an increase in weight-for-age percentile.
4. Fish oil consumption led to shorter sleep duration.

## Conflict of interest

The authors declare no conflicts of interest.

## Acknowledgment

The first author's bachelor's thesis includes some of the paper's preliminary findings.

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# Family and media influences on children's eating behavior (Note I)

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## Abstract

**Background.** Over the past few years, the field of pediatric nutrition has made great progress, with increasing emphasis on the role of home environment and social media in the development of children and adolescents.

**Aims.** The study aims to examine the extent to which exposure to social media and family meal dynamics influence the eating habits of children and young adults. **Methods.** A cross-sectional study was conducted between July 2024 and March 2025, on a sample of 195 children aged between 3 and 18 years. Data collection focused on caloric intake and environmental influences.

**Results.** The outcomes suggest that children are strongly influenced by both social media and a family environment, while the reported caloric intake scored lower than recommended nutrient requirements.

**Conclusions.** Children who consume meals alongside at least one family member tend to have healthier eating habits and a higher food intake. The longer children are in front of screens, the worse their diet becomes, as they tend to consume unhealthy snacks during that time.

**Keywords:** pediatric nutrition, family, children, media consumption, dietary behavior.

## Introduction

Adequate nourishment plays an essential role in the sound physical and mental development of children and young people. However, in our modern digitalized world, a number of environmental causes, familial patterns, and social media in particular, shape children's eating habits in ever more complex ways (McCarthy et al., 2022).

Among various trends, the increasing susceptibility of young people and teenagers to social media, video games and television programs. A link has been observed between this type of exposure and the growing preference for highly processed, highly caloric foods and sweetened drinks frequently marketed through product placement and advertising. In association with the sedentary pattern implicitly connected to excessive screen time, these factors provide a major contribution to the increased risk of obesity and overweight among pediatric populations. This is especially concerning considering the fact that childhood obesity usually lasts through adulthood, increasing the chances of developing chronic diseases such as type 2 diabetes, cardiovascular disease, and dyslipidemia (De Jans et al., 2021).

Besides digital influences, the home environment has a

crucial bearing in determining food patterns. A number of studies have suggested that consistent family mealtimes, a pleasant eating experience, and engagement in the preparation of food contribute to healthier eating habits, improved emotional health, and better-balanced weight profiles among children and young people (Knobl et al., 2022)

In this context, our study aims to examine to what extent exposure to social media and family meal dynamics influence the eating habits of children and young adults aged 3-18 years. We analyzed whether more frequent family meals might be associated with a higher consumption of fruits and vegetables, smaller BMI values, and reduced consumption of highly processed foods and sweetened drinks. Additionally, we examined whether well-regulated, inclusive, screen-free meals have a positive impact on children's emotional well-being and eating habits.

## Materials and methods

### Research protocol

#### a) Time and location of the research

The study was completed over an eight-month period, between July 1, 2024, and March 2, 2025. A survey

Received: 2025, March 16; Accepted for publication: 2025, March 24

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<https://doi.org/10.26659/pm3.2025.26.2.84>

questionnaire was used to collect data from parents of pre-school and school-age children in two Romanian cities: Suceava and Târgu Mureş.

#### b) Subjects and group

The study sample consisted of 195 children and teenagers aged 3-18 years. The main criterion for inclusion was belonging to this age group. Other inclusion criteria included regular attendance at a public educational institution and access to electronic devices (e.g. smartphone, tablet, or TV), regardless of whether they were personally owned or belonging to their parents. Participants were required to spend at least one hour per day on said devices. Criteria for exclusion were: incomplete responses to the questionnaire, age under three years or over 18 years, presence of chronic diseases, and long-term medication use. As participants in the study were underage, an informed consent was acquired from the parents for inclusion of their children in the study and for the processing and analysis of their personal data.

#### c) Applied tests

Data were collected on age, gender, anthropometric measurements of both parents and their children, frequency of food intake, a 24-hour dietary recall, dietary supplement use, family meal-time frequency, type and duration of social media use.

Anthropometric measurements included the heights and weights of child, mother, and father. The 24-hour dietary recall aimed at analyzing the number of principal meals consumed by the child, food type, serving size, food combining, and usual snack preferences.

Information regarding time spent eating and the presence of a family member during meal-time was also deemed significant in this study.

With regard to social media use, the gathered data included: screen time, social platform types used, nature of advertised content. Other aspects explored in the study were the presence of adult supervision during the children's screen exposure and whether dietary choices changed according to the content viewed.

For the analysis of caloric intake and daily energy requirements, the food journals were individually assessed by using data from the United States Department of Agriculture (USDA) Food and Nutrition Database (1). Results were compared to four standard nutritional reference values: kilocalories, proteins, fats, and carbohydrates, using the USDA's professional nutrition calculator (2).

Percentiles were used to estimate the growth status of pre-school and school-age children, individually calculated for each child according to age, gender, height, and weight using PediTools (Chou et al., 2020). Three percentile values were calculated: height-for-age, weight-for-age, and weight-for-height/body mass index (BMI)-for-height.

Genetic growth potential was also estimated using the EBMcalc, a Medical Reference Calculator, by introducing the child's gender as well as the heights of both father and mother. (EBMcalc: Medical Reference Calculator).

#### d) Statistical processing

Statistical analysis was performed on data with the help of GraphPad Prism software version 6.0. Descriptive statistical measures comprised of: minimum and maximum values, means or medians, and standard deviations.

Inferential analyses were conducted using nonparametric tests at a confidence level of 95%. Associations were examined using Spearman's rank correlation, whereas group differences were evaluated using the Mann-Whitney U test for independent samples and the Wilcoxon signed-rank test for paired samples.

## Results

Of the 195 subjects participating in the study, 53.33% were female. Only 6.67% of the children and teenagers reported recent changes in height, while 20.82% reported changes in weight in the last 3 to 6 months (Table I).

**Table I**  
Stature and weight development.

Parameter	Min	Median	Max	CV%
Weight-for-age percentile	0	56	100	62.48 %
Height-for-age percentile	0	52	100	66.74 %
Weight/BMI-for-height	0	63.45	100	64.40 %

The majority of the subjects participating in the study – 51.80% – have a screen exposure of 2-4 hours per day. Another 38.46% have a screen exposure of only 1 hour per day, while 9.23% spend between 4 and 8 hours per day on screen time.

On completion of the final analysis of all subjects participating in the study, the presence of preference for daily consumption of sweets such as candy, biscuits, chocolate, and similar products, as well as dairy products was observed. Consumption of fruits and vegetables was relatively frequent; however, salad greens, fish, and nuts were only sporadically included in the diets of pre-school and school-age children. The table below summarizes the minimum, maximum, and average intakes in relation to the recommended daily requirements (Table II).

**Table II**  
Caloric intake and daily requirements.

	Median	CV%	Differences from dietary requirement	
			P value	R value
Proteins	52.5	43.79 %	<0.0001	0.3135
Lipids	36.5	59.29 %	<0.0001	0.4153
Carbohydrates	118	45.09 %	<0.0001	0.7378
Kcal	1079	42.11 %	<0.0001	0.6307

There is a positive correlation between the child's age and screen time ( $r = 0.3629$ ,  $p < 0.0001$ ), as well as between age and the weight-for-age percentile, with older children showing higher weight-for-age values ( $r = 0.2861$ ,  $p < 0.0001$ ). Older children tend to spend more time on TikTok, Instagram, Facebook ( $r = 0.4923$ ,  $p < 0.0001$ ), as well as watching movies and series ( $r = 0.3567$ ,  $p < 0.0001$ ).

Moreover, age is significantly correlated with eating meals in front of screens, with older children more frequently engaging in this behavior ( $p = 0.001$ ). As age increases, a decline in preference for nuts and seeds ( $r = -0.1458$ ,  $p = 0.0419$ ) and a higher attention to sweet consumption ( $r = 0.1534$ ,  $p = 0.0323$ ) can be observed.

According to weight-for-age percentiles, children and teenagers who watch movies and series more frequently tend to present higher body weight ( $r = 0.1536$ ,  $p = 0.0321$ ), many of them spending between 4–8 hours per day in front of screens ( $r = 1.1495$ ,  $p = 0.037$ ).

Skipping dinner ( $r = 0.186$ ,  $p = 0.0092$ ) or breakfast ( $r = 0.1787$ ,  $p = 0.0132$ ) was significantly associated with higher body weight in participants.

A higher maternal age was negatively correlated with supervised screen time, indicating that children of older mothers are more likely to watch TV or use social media unsupervised ( $r = -0.3832$ ,  $p < 0.0001$ ). Meanwhile, mothers with higher BMIs tend to more closely monitor their children’s sweet consumption ( $r = -0.1535$ ,  $p = 0.035$ ). In contrast, fathers with higher BMIs showed a positive association with children’s consumption of fast-foods ( $r = 0.1449$ ,  $p = 0.0444$ ), sweets ( $r = 0.1956$ ,  $p = 0.0064$ ), snacks/soft drinks ( $r = 0.202$ ,  $p = 0.0049$ ).

A statistically significant inverse relationship was observed between the weight-for-age percentile and caloric intake, indicating that participants with higher percentiles tended to report lower energy consumption ( $r = 0.2898$ ,  $p = 0.0042$ ).

Regarding the influence of family environment on eating behaviors in children and teenagers, there was a positive correlation between eating meals with at least one family member present and increased caloric intake ( $r = 0.2115$ ,  $p = 0.0386$ ). Family meals were also associated with a higher fat intake ( $r = 0.2064$ ,  $p = 0.0437$ ).

Both children who spend more time studying ( $r = 0.2825$ ,  $p = 0.0053$ ) and those who tend to skip meals ( $r = 0.2312$ ,  $p = 0.0234$ ) showed a higher protein intake relative to carbohydrate and fat intake.

A statistically significant difference between reported caloric intake and the estimated daily requirement was identified and is visually represented in the graph below (Figure 1) and in Table II above.

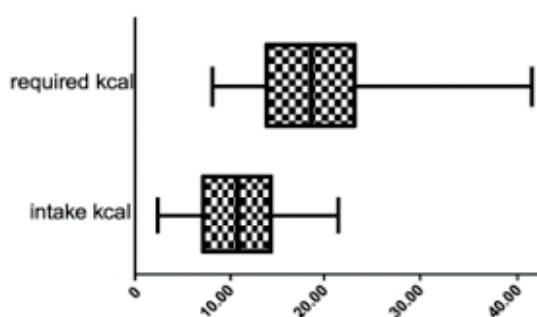


Fig. 1– Caloric requirements and intake.

Additionally, fat intake (Figure 2) and carbohydrate intake (Figure 3) were statistically significantly lower than the recommended requirements for children and adolescents, based on age, gender, weight, and level of physical activity.

Proteins were consumed in quantities exceeding the recommended requirements (Figure 4).

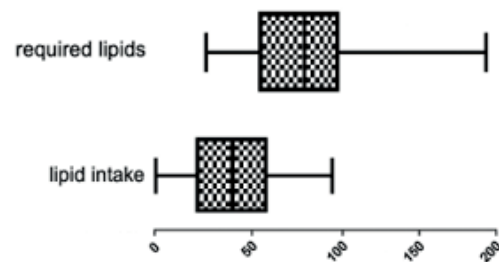


Fig. 2 – Lipid requirements and intake.

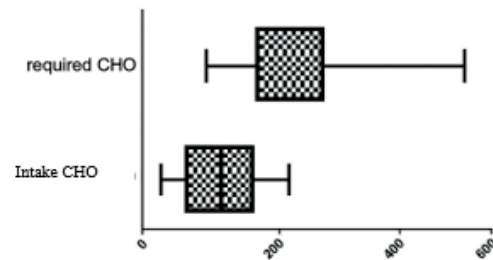


Fig. 3 – Carbohydrate requirements and intake.

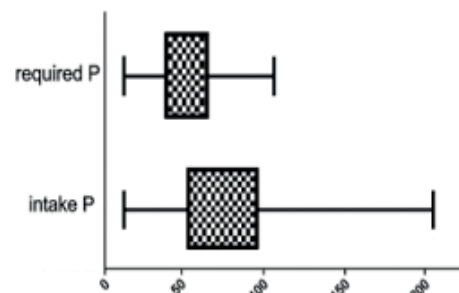


Fig. 4 – Protein requirements and intake.

## Discussion

Our study along with other studies conducted on pre-school and school-age children on the topic discussed show the significant influence of family, peers/friends, and social media on children’s eating habits (Mc Carthy et al., 2022; Dallacker et al., 2018).

During our study a positive association was observed between frequent social media exposure and an increased consumption of sweets, snacks, soft drinks and other highly processed, unhealthy foods. In their study, Mc Carthy et al. highlighted the fact that children who spend more time in front of screens tend to skip breakfast and consume fast foods, supporting the findings in our study (Sina et al., 2022).

We consider that the advertising and marketing of unhealthy products drive children and teenagers towards unhealthy eating behaviors. Our study reveals that dietary choices are influenced by advertisements viewed while using social platforms and by eating habits established at home. It is therefore necessary to adopt public policies designed to regulate digital marketing in order to reduce the purchase and consumption of unhealthy food products among children and adolescents. For instance, unhealthy products could

strategically be placed away from checkout areas, reducing the probability of impulsive purchases. Meanwhile, healthy snack alternatives could be made more visible and appealing through targeted promotional campaigns to encourage healthier choices. Fast-food outlets could be located further away from schools, limiting access for students during school hours. Finally, certain commercials targeting children – especially those on TV channels frequently viewed by young audiences – could be restricted or banned so as to minimize exposure to persuasive advertising of unhealthy foods.

In a similar study as the present research, Knobl et al. (2022) have shown that people who share meals with their family, or at least one family member, tend to have a more adequate caloric intake and eat healthier foods. Furthermore, it is equally important to provide a peaceful and welcoming family atmosphere during mealtimes, free from the background noise of TV or smartphone use. Home-cooked meals are generally healthier than meals eaten out. Meals served in restaurants are frequently fried, high in fat and strongly seasoned to enhance their taste and appeal.

Snuggs & Harvey (2023) also found in their study that other factors influence the frequency of family mealtimes, such as family structure (two-parent or single-parent), economic status, ethnicity, socio-demographic characteristics, and children's age. The younger the children, the more often they tend to eat together with their families.

Such meals, especially during the pre-school years, are crucial as they play a very important role in shaping children's long-term eating patterns. Our study suggests that frequent family meals are protective against obesity, although some studies argue to the contrary, stating that such meals can sometimes lead to increased caloric intake (Snuggs & Harvey, 2023).

However, eating fresh, home-cooked food with a lower caloric and sugar load is related to a reduced risk of being overweight. As they grow older, children tend to prefer tasty, more visually appealing foods served in restaurants or fast-foods outlets, and may become reluctant to eat healthier home-cooked meals. When at school, they will often resort to more convenient alternatives, such as ordering fast-foods or buying sweets and snacks, instead of bringing a packed lunch from home.

Pressure to eat exerted on children by their parents has been shown to lead them to make unhealthy food choices, causing them to avoid eating meals at home, as found by Mahmood et al. (2021). Snacks are generally processed foods such as chips and sweets, while fruits, nuts, seeds and yogurts are chosen less often – a trend also observable in our study. Changing unhealthy eating patterns should start with parents, being the role models children will likely imitate (Mahmood et al., 2021).

The more often children share meals with family, the higher their consumption of fresh fruits, vegetables, and nuts. Dairy products were seen to follow a similar pattern, being more commonly consumed during family meals.

Bassul et al. (2021) state that people consuming meals in front of screens or snacking while watching TV show longer meal durations compared to those eating in the kitchen with no distractions. These behaviors may subsequently be associated with an increased risk of cardiovascular disease,

diabetes, and obesity (Bassul et al., 2021). It is therefore recommended that children eat their meals in the kitchen in order to potentially reduce the likelihood of developing unhealthy food preferences when older.

Unexpectedly, parents reported that only 57 children developed food preferences following exposure to advertisements, while the remaining 138 children negated any such influence.

There is currently no established optimal requirement for achieving harmonious child development other than the recommendations for protein intake in deficient states (Garcia-Iborra et al., 2023). Regarding our study, children and teenagers with older parents showed an increase in protein intake. Physiologically it is natural to expect protein intake to increase proportionally to the growth of individuals. In our study it was observed that parents, particularly mothers, who were aware of their child having a higher weight-for-age and height ratio tend to impose caloric restrictions on their child as to prevent or halt the child's weight gaining process.

Based on our results, children and adolescents consume mainly fats and carbohydrates. Higher levels of these two macronutrients were found in the highly processed foods preferred by our subjects. The findings of Papadaki et al. (2020) and Zou et al. (2023) agree with this observation. Excess body weight mainly follows increased carbohydrate and fat consumption rather than an overall increase in caloric intake. Children and teenagers are more likely to consume foods rich in simple carbohydrates, unsaturated fats and low in fiber. Higher lipid intake would not represent an issue if this lipids were of higher quality (Papadaki et al., 2020; Zou et al., 2023). Notwithstanding, preference for healthy fats is increasingly uncommon as observed in the general population.

As also shown in our study, child development, BMI, and food preferences are significantly influenced by parental traits, weighed equally with family socioeconomic resources. If the mother presents a higher BMI, the child is more likely to exhibit a higher BMI. This association is moderated by physical activity level and parental education. Nutritional intake is significantly associated with monthly income, family dietary habits, and parental education levels (Al Yazeedi et al., 2020).

Parent's chaotic lifestyle and food choices contribute to maladaptive eating habits and inappropriate behaviors in children and teenagers (Mazurkiewicz & Raczkowska., 2024; Melo et al., 2017). While both parents play a role in shaping children's behaviors, it has been observed that mothers do tend to emphasize dietary health for themselves and their family members, often imposing more restrictive practices, while fathers are more likely to favor fast food and demonstrate less regard for the quality of their diet and that of their children. (Fielding-Singh et al., 2017; Litchford et al., 2019). Similarly, in our study, mothers with higher BMIs were found to restrict sweet and processed foods in their children's diets, presumably to prevent themselves from gaining weight too.

A teenager spends on average more than two hours per day on social media, in front of a TV, tablet, or smartphone screen. It has been determined that the time spent on social media increases proportionally with age (Reid Chassiakos

et al., 2016; Lissak, 2018). Teenagers participating in this study reported having spent more time watching TV shows, series, and movies – approximately 52%, meaning 101 participants. Younger children spend on average 5 hours per week in front of a TV, tablet, or on their parents' phone (Zimmer et al., 2019). The study also showed that 38% of preschoolers spend approximately one hour per day in front of screens, mainly watching cartoons.

## Conclusions

1. Children who consume meals alongside at least one family member tend to have healthier eating habits and a higher food intake.

2. Children whose parents are of advanced age spend more time in front of screens or on social media.

3. School-aged children and preschoolers tend to prefer sweet, calorie-dense, and processed foods, at the expense of vegetables and fruits as a consequence of digital marketing exposure.

4. The longer children are in front of screens, the worse their diet becomes, as they tend to consume unhealthy snacks during that time.

## Conflict of interests

The authors declare no conflicts of interest.

## Acknowledgment

The first author's bachelor's thesis includes some of the paper's preliminary findings.

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# Lactose intolerance in children: nutritional implications and impact on the quality of life (Note II)

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## Abstract

**Background.** Lactose intolerance is a common condition among children, characterized by the inability to digest lactose from dairy products. This condition can have significant nutritional implications and can affect the quality of life of the affected children.

**Aims.** The purpose of this study is to analyze the impact of lactose intolerance on the nutritional status and quality of life of affected children, as well as to identify appropriate nutritional strategies for managing symptoms and minimizing long-term adverse effects on their health.

**Methods.** A study was conducted over a period of 9 months, using a questionnaire that was distributed online, but also in physical format to some schools and kindergartens in Mureş County. Children with intolerance and those without intolerance were invited to answer questions regarding their sources of information about this condition, to complete a food diary, to participate in anthropometric measurements, and to describe the symptoms experienced in the case of those with intolerance. For some children who were too young, the questionnaires were completed by their parents, thus ensuring the accuracy and relevance of the responses. The purpose of this study is to analyze the quality of life of children who have lactose intolerance.

**Results.** Compared to the group without intolerance, children with lactose intolerance exhibited a more variable and often insufficient caloric intake, indicating a more unbalanced diet. Their diet was more unstable compared to the healthy group, but positive trends were observed, such as an increase in fruit and vegetable consumption, and a reduction in processed meats. In contrast, children without intolerance had a decrease in the consumption of plant-based foods.

The use of supplements was more frequent among those with intolerance, especially for vitamin D and fish oil, but magnesium and iron were rarely used in both groups, with possible nutritional risks.

Children with intolerance were more often informed by medical sources, while those without intolerance relied more on social media and friends, which can negatively influence the quality of food.

**Conclusions.** The differences observed between children with lactose intolerance and those without it indicate that the NS group exhibits a more unstable dietary profile with tendencies towards nutritional imbalance, reflected both by the increased variability in caloric intake and by the frequent energy deficit and imbalance in supplement usage. Effective management of lactose intolerance requires not only the avoidance of lactose but also ensuring an adequate intake of essential nutrients (especially calcium and vitamin D).

**Keywords:** lactose, nutritional education, caloric intake, eating habits, dietary supplements.

## Introduction

Food intolerances are becoming more prevalent and impact a large proportion of youngsters globally. Lactose intolerance is one of the most prevalent types of intolerance, and it can significantly influence a person's digestive health and quality of life. Given that, many children with intolerance, and parents are not well informed about the impact of diet on their health. Nutritional education and access to information are crucial in managing this sickness in the current situation.

Lactose is an essential component of human milk, as it is the main carbohydrate and a major source of energy in human milk. Since the dawn of civilization, it has been crucial to human nourishment. The intestinal activity of lactase increases at birth and gradually decreases as we wean. However, in certain individuals, the enzyme activity persists throughout adulthood (Toca et al. 2017).

Even while lactose intolerance is common worldwide, its incidence varies greatly according to geographic region, age, and living conditions. Children's symptoms need to

*Received:* 2025, March 16; *Accepted for publication:* 2025, March 24

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*https://doi.org/10.26659/pm3.2025.26.2.89*

be recognized early and accurately diagnosed to prevent problems and achieve the best possible quality of life.

In this instance, lactase plays a crucial role in the breakdown of lactose. There are two functional components of this digestive enzyme, each of which has a specific role. The galactosyl group is transferred by one of these, galactosyltransferase, whereas the other component has a regulatory role. This aids in the enzymatic process of hydrolysis, which separates the glucose and galactose molecules (Cantazaro et al., 2021).

The purpose of this study was to investigate the long-term consequences of lactose intolerance, as well as its impact on children’s nutrition and general health. Our goal was to learn more about how families’ and children’s eating habits are impacted by knowledge about food intolerances, and how these habits aid in symptom management. The study also aimed to identify the most effective nutritional strategies for preventing nutritional deficits and promoting the balanced development of these illnesses.

**Material and method**

*Research protocol*

*a) Period and place of the research*

The analytical investigation was conducted between July 2024 and March 2025. Two groups participated in this study, each filling out a unique questionnaire intended for children with and without lactose intolerance. Physical forms of the questionnaires were filled out in Romanian educational institutions, namely those in Mureş Country.

*b) Subjects and groups*

Of the 94 participants in the study, 41 had a lactose intolerance diagnosis, whereas the remaining 53 did not. The participants were between the ages of 1 and 18. Completing the questionnaire and falling within the specified age range were the study’s inclusion requirements. The participants beyond the age of 18, along with those who did not finish the questionnaire, and the ones with a diagnosis of other chronic diseases were excluded.

All participants were made aware of the study’s purpose prior to their inclusion. All information was presented to the participants and their legal representatives, taking into account that they were minors. According to ethical standards, the legal guardians gave their informed consent. The initials (NS) for children with intolerance, and (S) for children without intolerance were used to make data presentation and analysis easier.

*c) Applied tests*

Participants wrote down in a journal what they ate, when they ate it, how many meals they had, how much they ate, and how much they thought they weighed in a food diary for 24 and 48 hours. This method let us closely examine eating habits and provided useful data for both quantitative and qualitative studies of the diet, and the use of food and enzyme supplements. We also got anthropometric data, which included: height, weight, body mass index, and the size of the arms.

We used the answers to the questionnaires and the food diaries to figure out how many calories each person needed every day. We did the calculation in Microsoft Excel and several reference databases, including Peditools (1), Cronometer (2), EBMcalc (3), United

States Department of Agriculture (USDA) Database (4), and Medical Calculator (5).

*d) Statistical processing*

We used the GraphPad 6.0 software to do the statistical work. Through descriptive statistical analysis we found the lowest and highest values, the means and medians, and the standard deviations. A 95% confidence interval (95% CI) was utilized to check for statistical significance. A p-value of 0.05 was considered to be statistically significant. We also used the Mann-Whitney test, the Wilcoxon signed rank test, and the D’Agostino % Pearson omnibus normality test for inferential statistics.

**Results**

The results show that the two groups ate different amounts of nutrients and calories. The S group ate more protein, with a lot less variation (coefficient of variation-CV =26.69% vs. 47.66%;p=0.012;r=-0.48;95%CI:-36.2%-5.9%) (Fig. 1), and had a higher average carbohydrate intake (111.6 g vs. 99.32 g; p = 0.043; r = 0.41; 95% CI: 2.6–22.4 g) (Fig. 2), than the NS group at 24 hours.

After 48 hours, these differences were still there: S ate a steady amount of carbs (CV=26.30%), but NS’s protein (p < 0.0001; r = -0.61; 95% CI: -35.1 g – -13.8 g) and fat (p = 0.0654; r = 0.32) intake was very different from what is normal, which could mean that they weren’t getting enough nutrients (Fig. 3).

The two groups ate about the same number of calories overall (p=0.28), but the variation in NS (CV=31.16%) was much higher than in S (CV=17.23%). This backs up the idea that kids who can’t digest lactose eat less in a controlled way (Fig. 4).

Figures are also used to help us understand each of these results.

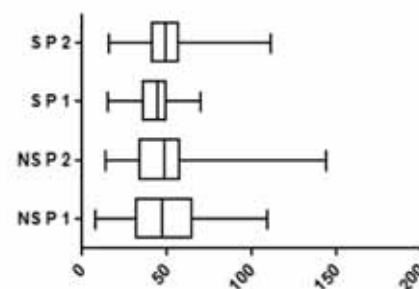


Fig. 1 – Protein intake.

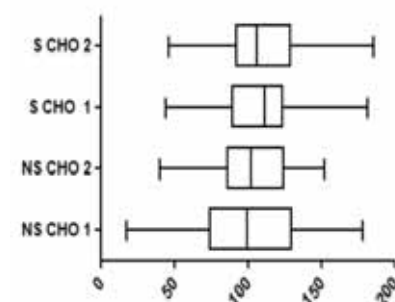


Fig. 2 – Carbohydrate intake.

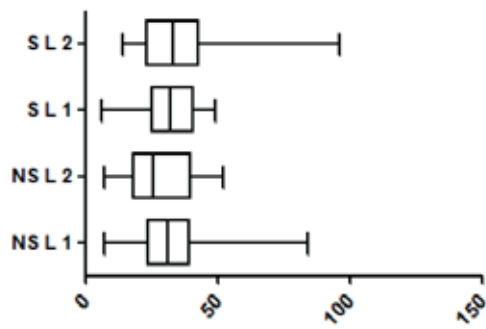


Fig. 3 – Lipid intake.

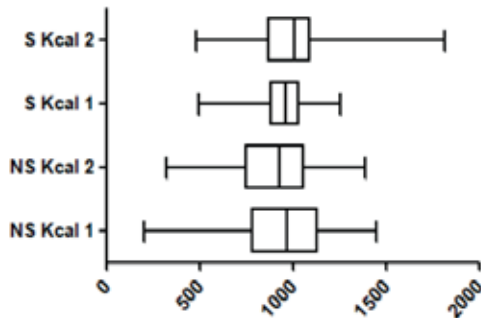


Fig. 4 – Caloric intake.

More than 80% of children who took part on both days said they still ate a lot of meat. There were no statistically significant differences ( $p = 0.274$ ,  $r = 0.11$ , CI 95%:  $-0.26-0.44$ ).

Vitamin D and fish oil were the most popular dietary supplements, with 61.7% and 50% of the time, respectively. Magnesium and iron were used much less often, with 14.7% and 8.8% of the time, respectively. The differences were statistically significant ( $p = 0.008$ ).

The study found that children who cannot digest lactose (NS) ate and got their macronutrients in a different way than the group (S). During the 48-hour period, the S group ate a lot fewer plant-based meals and in fruit intake was 5.66% ( $p=0.032$ ,  $r=-0.36$ , CI=95%,  $-0.62$  and  $-0.03$ ). This could mean that kids who don't have to follow a certain diet have different tastes in food and are likely to eat an unbalanced diet.

Both groups ate a lot of baked foods (71.7%) and meat (60%) which shows that they need more refined carbs. When we compare the number of macronutrients and calories, there are differences between the two groups. The (NS) group ate fewer calories overall, but they ate more plant fats and carbs to make up for it. The kids in the (S) group eat more free sugars and saturated fats.

Children who were intolerant had lower Z scores and eat an average of 1350 calories per day. Kids who weren't intolerant had higher Z scores and eat 1550 calories a day, but they all ate the same amount of protein (1.1g/kg/day).

The data in Table I show that both lactose-intolerant children, and those without it, received information mainly from family doctors. In the group without intolerance, friends and social networks are the main sources of information, but for children with intolerance,

medical sources are the most important, and the influence of family or friends is minimal. Neither group received enough help from nutritionists or scientific studies.

Table I  
Nutritional Information Sources.

Source of information	S group	NS group
Family doctor	45.28%	52.94%
Social media/ friends	43.40%	35.29%
Nutritionist	16.98%	29.41%
Scientific studies	3.77%	5.88%
Internet (general)	37.74%	41.17%

## Discussion

For children with lactose intolerance, maintaining an appropriate intake of calcium and vitamin D is a serious nutritional concern. If they don't take supplements, about 68% of children with lactose intolerance get less calcium and vitamin D. This study from 2024 is just one of many that have shown that kids who can't digest lactose don't get enough calcium and vitamin D, because they don't eat dairy, which is an important source of nutrition. Calcium and vitamin D are important for building and keep bone mass. Dairy products help keep bones from breaking and becoming osteoporosis. Because of this, it's very important to eat a balanced diet that includes foods that are high in calcium and vitamin D (Port Luis et al., 2024).

To maintain a healthy immune system, it is advised to ensure sufficient levels of vitamin D through supplements, or moderate sun exposure. Just 17.07% of the lactose-intolerant youngsters in the study group took probiotics, according to Winzenberg et al. (2018). This is true, even though research suggests that probiotics can help reduce discomfort associated with digestion.

These results imply that more medical education and the improvement of therapeutic approaches for treating lactose intolerance in children are required (Yadav et al. 2022).

Only 17.07% of the children with lactose intolerance in the study population utilized probiotics, despite research showing that they are effective in reducing related digestive problems. As mentioned above, this is another indicator that shows how crucial medical advice is in treating lactose intolerance in children (Yadav et al.2022). The NS group exhibits a significant imbalance in supplement use, with low probiotic and magnesium usage. This, along with a diet that is already low in nutrients and not well balanced, could mean that kids with lactose intolerance don't get the nutrients they need. Probiotics help microbiota by putting good bacteria in the digestive system. They help the body make mucus, which protects the lining of the intestines and keeps important proteins from breaking down. Probiotics also help keep the immune system and inflammatory diseases. A lot of studies have shown that they might help with gut problems (Olvera-Rosales et al., 2021; Banerjee et al., 2018; Yadav et al., 2022). Probiotics are used to help with several health problems, including lactose intolerance, to get their gut microbiota back in balance. Moreover, prebiotics enhance immunological and digestive health, and promote the growth of good bacteria, which is how

Table II

Comparative anthropometric parameters and nutritional intake in children with (NS) and without food intolerances (S).

Parameter	Our study (2024-2025)	Flammarion et al. (2011)
Mean age(years)	9.2±3.1	4.7±2.5
Weight for age z score(ns)	-0.4±0.9	0.1
Weight for age z score(s)	0.2±0.8	0.6
Height for age z score(ns)	-0.3±1.0	0.2
Height for age z score(s)	0.5±0.7	0.8
Average caloric intake(ns)	1350 kcal/day	Similar control group
Average caloric intake (s)	1550 kcal/day	Similar to the allergy group
Average protein intake	1.1g/kg/day(both groups)	Similar between groups
Calcium intake	Below the daily recommended intake in 68% of children with intolerances	Similar between groups

probiotics work (Mazziotta et al., 2023)

The evaluation of energy intake and dietary composition received particular attention during the nutritional supplementation analysis, because these factors offer a more comprehensive picture of the overall nutritional status and the possible risks of an unbalanced diet, particularly for children with dietary restrictions. The lactose-intolerant group (S) accounted for most of the participants, with just 16% falling within the optimum range of daily calorie demands (plus or minus 10%). Only 6% of the children who took part said they ate more calories than they should have. This distribution shows that children in general tend not to get enough food, especially toddlers who can't digest lactose (NS). This conclusion is even stronger because there is a strong negative link ( $p < 0.01$ ,  $r = -0.55$ ). This could mean that there is a higher risk of long term nutritional deficiencies. For instance, a 9-year-old in the NS group only ate 950 calories a day, which is much less than the 1600 calories (95% CI: 1520-1680) that experts think they need. A child in the S group of the same age, on the other hand, ate 1500 calories which is within the recommended age. These differences show that the diets of kids with lactose intolerance are less stable and more likely to change.

Nutritional information is essential for understanding and properly managing lactose intolerance. In the study, 65.85% of parents and kids who can't handle lactose (NS) said they get dietary advice from their family doctor. However, only 17.07% of parents and children indicated they visit a nutritionist who is most able to handle nutritional inadequacies associated with restricted diets. It was also observed that some families used the internet as a source of information (48.78%), hence they are more likely to come across distorted, or false information online. A lot of research shows that dietitians are very important for helping kids with lactose intolerance. A 2016 study showed that trained dietitians need to give children personalized diets to help them grow and avoid bad effects (Collins et al. 2016).

Another group of researchers who published a study in 2016 also found that diets that are too limited, can make children more likely to have nutritional deficiencies which can slow down growth. In these circumstances, the involvement of a nutritionist becomes essential to achieve

an appropriate diet adaptation, either through diversifying plant sources or through strategic supplementation (Giovannini et al., 2016).

Moreover, to manage food intolerances effectively, an integrated approach is necessary, where nutritionists, allergists, pediatricians, and even psychologists work together. The dietitian not only makes sure the family eats well, but they also teach them and offer emotional support, as they deal with daily challenges of having to follow a strict diet. As a consequence, nutritionists should be involved in the care process from the start and play an active role in this journey. This could greatly lower the chances of problems and help the child grow normally, even if they can't eat well. Table II highlights that children with food intolerances have lower Z scores for weight and height relative to age, even though caloric and protein intake is similar between children with and without food intolerances. This indicates that children with food intolerances may have compromised nutritional status, even if they receive an adequate intake of food. Malabsorption can be one of the many causes associated with food intolerances.

Both studies emphasize how important it is to closely monitor the growth and development of children with food intolerances. It also emphasizes that frequent nutritional assessments are necessary to prevent deficiencies and ensure healthy development (Flammarion et al. 2011).

A multicentric prospective intervention study examined the nutritional status of children with food allergies aged between 6 and 36 months who received dietary counseling. In this research, 91 children with food allergies were observed, and 66 children without allergies were considered the control group. Children with lactose intolerance started with lower energy and protein intakes, as well as more frequent growth deficits. 21% of these children had a weight/length ration below -2 SD, compared to 3% of healthy children ( $p < 0.001$ ). After six months of nutritional counseling, the energy intake and anthropometric parameters significantly increased. These findings highlight the importance of personalized dietary interventions in preventing malnutrition and supporting the normal development of children with food allergies (Berni Canani et al. 2016).

According to previous information, we find that

children with food intolerances have a lower caloric and protein intake than the control group. The analysis of food diaries showed similar differences in carbohydrate and lipid intake. This underscores the importance of continuous monitoring and personalized nutritional counseling to ensure that children on restrictive diets receive an optimal intake of macronutrients.

Limitations: One of the main limitations of this study is the small sample size, which may affect the generalization of the results. Additionally, the data were based on self-reporting, which carries the risk of subjective errors. In the future, we plan to expand the study to a larger and more diverse sample to obtain more relevant and representative results.

## Conclusions

1. Both groups have a caloric intake below the recommended requirement. Due to their much lower daily caloric intake, children with lactose intolerance showed this pattern more clearly, increasing their risk of long-term nutritional deficits.

2. Both groups of children present an unbalanced intake of macronutrients, particularly with frequent deficiencies in lipids and proteins. An excessive consumption of meat and bakery products was also observed, compared to the consumption of fruits and vegetables, which is lower in both groups.

3. The differences observed between children with lactose intolerance and those without indicate that the NS group exhibits a more unstable dietary profile with tendencies towards nutritional imbalance, reflected both by the increased variability in caloric intake and by the frequent energy deficit and imbalance in supplement usage. Effective management of lactose intolerance requires not only the avoidance of lactose, but also ensuring an adequate intake of essential nutrients (especially calcium and vitamin D).

## Conflict of interest

The authors declare no conflicts of interest.

## Acknowledgment

The first author's bachelor's thesis includes some of the paper's preliminary findings.

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# Impact of food allergies on perceived stress and fatigue syndrome in children

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## Abstract

*Background.* The prevalence of food allergies and intolerances is steadily increasing, especially among children, and this represents a risk factor for both their physical health and emotional well-being.

*Aims.* The aim of this study was to analyze the relationship between food hypersensitivity and the level of perceived stress, as well as the presence of fatigue syndrome in diagnosed children.

*Methods.* The study was conducted over a 6-month period on a sample of 138 children diagnosed with food allergies or intolerances. Data collection was carried out through an online questionnaire completed by parents, which included anthropometric parameters, living environment, aspects related to food hypersensitivity, and relevant questions to calculate the perceived stress level score and fatigue syndrome, taken from previously validated questionnaires on the topic.

*Results.* A positive association was found between body weight and perceived stress level. Additionally, engaging in physical activities such as dancing and outdoor walks significantly reduced children’s stress levels. A link was identified between perceived stress, behavioral changes, and high scores for fatigue syndrome.

*Conclusions.* Children diagnosed with food hypersensitivity are at increased risk of perceived stress and chronic fatigue syndrome. Emotional support and engagement in physical activity are extremely important for an improved quality of life.

**Keywords:** food allergies, food hypersensitivity, food intolerances, perceived stress, fatigue syndrome.

## Introduction

The cases of food allergies and anaphylaxis are continually increasing, representing a significant public health issue. A marked rise in the prevalence of food allergies has been observed in recent years, particularly in developed countries. In Europe, the prevalence is 6%-8% among children aged 1 year, declining towards the end of childhood to reach 3%-4%. The European Academy of Allergy and Clinical Immunology estimates that more than half of Europeans will be diagnosed with at least one allergy within approximately 15 years (Escarrer-Jaume et al., 2021).

In Romania, the overall prevalence of food allergy among school-age children is 8.89%, with lower prevalence in children of 6 to 10 years of age (Pop et al., 2025).

Among the main food allergens, a higher prevalence among institutionalized children was observed for milk or milk derivatives (36.5%), different types of nuts (12.7%), chicken eggs (9.5%). Sesame allergy seems to be on the rise, while a lower prevalence was observed for cereals, fish, seafood and soy. An increased prevalence of

strawberry allergy has been reported. Noteworthy, a cross-reaction with pollen allergy is suspected, as the season coincides, however, many parents believe that children’s hives are caused by food ingestion rather than a reaction to pollen exposure (Pop et al., 2025).

Improved characterization and recognition of allergy symptoms have led to more accurate diagnosis of patients. Proper case history, skin and serological tests are the main tools used by allergists. Current diagnostic methods allow us to know the degree of sensitisation of children, cross-reactivity, and to recommend the adequate exclusion diet for each patient (Escarrer-Jaume et al., 2021).

Food allergy is a complex pathology, characterized by immunological adverse reactions following exposure to food allergens (Rizzi & Gangemi, 2024). Unlike food allergies, the term “food intolerance” is used to define a range of adverse reactions to different foods, which do not involve the immune system. Clinical manifestations can affect several organs and systems, but the most common are the gastrointestinal symptoms such as pain, abdominal distension, flatulence and diarrhoea (Colella & Parisi,

*Received:* 2025, June 2; *Accepted for publication:* 2025, June 7

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<https://doi.org/10.26659/pm3.2025.26.2.95>

2023).

The most common food implicated in food intolerance and allergy is cow's milk, especially in young children (Manuyakorn & Tanpowpong, 2019). Allergy to cow's milk protein is an immunological reaction to one or more proteins present in the milk, particularly affecting infants and young children, with clinical manifestations ranging from gastrointestinal symptoms to anaphylactic reactions (Solano & Mendez, 2025). Treatment involves the complete exclusion of milk protein and their replacement with age-appropriate formula (Sathya & Fenton, 2024). By contrast, lactose intolerance does not involve the immune system, but is the consequence of lactase deficiency. Diagnosis is based on the hydrogen breath test or lactose tolerance test. Treatment involves reducing lactose intake or supplementing the diet with lactase (Robles & Priefer, 2020).

The presence of food hypersensitivity can be quite difficult for children or adolescents to manage, because it involves a lot of responsibility and vigilance to avoid the risk caused by the triggering foods. Living with food hypersensitivity is associated with increased anxiety, depression and lower quality of life (Tallentire et al., 2025).

It was shown that food allergies tend to limit the social and family activities. Many parents prevent the participation of their children to social events in order to minimize the risk of occurrence of an allergic reaction, thus increasing youth's anxiety levels. This excessive concern can also impair school attendance (Cummings et al., 2010).

The purpose of this study is to analyse the relationship between food allergies and intolerances and their impact on children's psyche, their quality of life and manifestations of physical and mental exhaustion.

## Material and methods

### a) Period and place of research

A 6-month observational study was carried out from 1 September 2024 to 3 March 2025.

The study was based on a questionnaire with 67 questions, addressed to parents of children diagnosed with food allergy or intolerance, sent online via social media, in groups set up by kindergarten, school and high-school staff, and data were analyzed within the territory of Romania.

### b) Subjects and groups

The study group consists of 138 children suffering from food allergies or intolerances.

Inclusion criteria: between 1 and 18 years of age,

presence of food hypersensitivity, and completion of the questionnaire in full. Exclusion criteria: other age (< 1 year; > 18 years), questionnaire not completed in full, presence of other pathologies.

All caregivers of the studied subjects agreed to have the subjects' data analyzed and to participate in the study.

### c) Applied tests

The analysis used information from the questionnaires completed by parents. These included the date of birth, anthropometric data of the children, such as weight, height and weight-for-height development in the last 6-12 months. The development of the subjects was analyzed using percentiles and interpreted on the PediTools website (Chou et al., 2020). The questionnaire also included information related to the existing allergies or intolerances such as: the foods to which the child is allergic or intolerant, the severity of the allergy or intolerance manifestations, and the type of diet followed. It also contained questions to determine the level of perceived stress and fatigue syndrome, retrieved from 2 specific validated questionnaires, Perceived Stress Questionnaire (Shahid et al., 2011), Chronic Fatigue Symptom - Mitchell Medical Group (Michielsen et al., 2003).

### d) Statistical process

Data were statistically analyzed using the GraphPad Prism 6.0 software. Minimum and maximum values, means or medians and standard deviations were used as descriptive statistical measures. Spearman r test and D'Agostino & Pearson omnibus normality test were applied for the statistical analysis. A 95% confidence interval (95% CI) was used.

## Results

The study included a total number of 138 children, of whom 50 (36.23%) were diagnosed with food allergies, 46 (33.33%) with food intolerances, and the rest (30.43%) with both pathologies.

The anthropometric characteristics and scores obtained for the perceived stress and fatigue syndrome are presented in Table I.

A review of the statistics showed that there is a positive relationship between the child's weight and the perceived stress score, a greater weight of the child being associated with an increased stress level. ( $r = 0.2155$ ; 95% CI = 0.04520 to 0.3737;  $p = 0.0111$ ). The same correlation was found between height (cm) of the child and their stress level. ( $r = 0.1816$ ; 95% CI = 0.009944 to 0.3429;  $p =$

**Table I**  
Anthropometric data and score of perceived stress and chronic fatigue syndrome.

Parameters	Min	Median	Max	p value	CV%
Weight (kg)	9	24	99	< 0.0001	64.03%
Height (cm)	75	127	186	0.0194	22.31%
Weight-for-age percentile	0	44	100	< 0.0001	71.69%
Height-for-age percentile	0	56	100	< 0.0001	69.07%
BMI-for-age	0	33.5	100	< 0.0001	83.34%
PSQ score	54	65	98	< 0.0001	14.43%
Chronic fatigue score	16	22	45	< 0.0001	29.90%

0.033). In contrast, no association was found between the height-for-age percentile and the perceived stress score, neither between the weight-for-age percentile and the increased perceived stress levels.

There was an association between physical activity, such as dancing and outdoor walking and a lower index of perceived stress as shown in Table II.

**Table II**

Correlation between physical activity and perceived stress score.

Physical activity	r value	95% CI	p value
Dance	-0.259	-0.4126 to -0.09110	0.0022
Walks	0.1846	0.01300 to 0.3456	0.0302
Football	0.05902	-0.1141 to 0.2287	0.4917
Tennis	0.01737	-0.1551 to 0.1888	0.8397
Swimming	-0.1317	-0.2969 to 0.04125	0.1237

Food allergy to nuts, legumes, fish and fruits was found to be positively associated with a higher perceived stress score, as shown in Table III.

**Table III**

Correlation between food allergens and PSQ index.

Allergens	r value	95% CI	p value
Nuts	0.2473	0.07866 to 0.4022	0.0035
Legumes	0.2193	0.04919 to 0.3771	0.0097
Fish	0.1911	0.01981 to 0.3516	0.0247
Fruits	0.1855	0.01393 to 0.3464	0.0294
Soy	0.1189	-0.05421 to 0.2850	0.1649
Egg	0.1486	-0.02404 to 0.3126	0.082

Symptoms of hypersensitivity such as itching, anaphylactic shock and respiratory distress were associated with increased perceived stress scores, as shown in Table IV.

**Table IV**

Association between manifestations of food hypersensitivity and perceived stress levels.

Manifestations of hypersensitivity	r value	95% CI	p value
Itching	0.2233	0.05333 to 0.3806	0.0085
Anaphylactic shock	0.1981	0.02707 to 0.3579	0.0198
Difficulty breathing	0.2655	0.09800 to 0.4184	0.0016
Gastric disorders	0.1499	-0.02271 to 0.3138	0.0794
Rash	0.1902	0.01886 to 0.3507	0.0254
Diarrhoea	0.1395	-0.03328 to 0.3042	0.1027
Headache	-0.03362	-0.2044 to 0.1392	0.6955

The statistics show a positive link between perceived stress and child's aggressive behavior, changes in eating behavior, difficulty concentrating, as shown in Table V.

**Table V**

Behavioral changes in the context of food allergy and stress levels.

Behavioural changes	r value	95% CI	p value
Aggressive behavior	0.2704	0.1032 to 0.4228	0.0013
Difficulty concentrating	0.4161	0.2629 to 0.5488	< 0.0001
Changes in eating behavior	-0.2447	-0.3998 to -0.07585	0.0038
Impulsivity	0.09297	-0.08030 to 0.2608	0.2781

It has been shown that the feeling of isolation experienced by the child is correlated with the fatigue syndrome. The presence of food sensitivity is also associated with an increased chronic fatigue syndrome score. Table VI also shows the association between the perceived stress levels and the fatigue scores. Statistics show that higher stress levels lead to higher fatigue syndrome scores.

**Table VI**

Manifestations of the chronic fatigue syndrome.

	r value	95% CI	p value
Feeling isolated	0.2787	0.1120 to 0.4300	0.0009
Energy level	-0.3896	-0.5263 to -0.2333	< 0.0001
Food sensitivity	0.4957	0.3538 to 0.6152	< 0.0001
Perceived stress	0.504	0.3635 to 0.6221	< 0.0001

## Discussion

A review of data regarding the overall condition of children with food hypersensitivity indicates a strong link between food allergies and heightened perceived stress levels. This connection can be attributed to the psychological burden of food allergy management, as well as the anxiety stemming from potential exposure to food allergens and the resulting allergic symptoms. A study published in the journal *Allergy* demonstrated that food allergies significantly affect daily activities and quality of life, contributing to psychological issues like anxiety and depression, which adversely impact both the child and their family (Cummings et al., 2010).

The study highlights a significant correlation between a child's weight and their perceived stress levels, indicating that increased weight is linked to higher stress. This relationship may be attributed to social pressures stemming from excess weight or exclusion from peer groups. Additionally, other scientific literature suggests that stress leads to unhealthy eating habits, obesity, and metabolic issues. A recent study revealed that prolonged psychological distress correlates with lower levels of satiety hormones and elevated hunger-inducing hormones like ghrelin and neuropeptide Y (Kuckuck et al., 2024).

Additionally, physical activities, notably dancing, have been associated with reduced perceived stress levels. Prior research demonstrates that music-related activities can evoke positive emotions, enhance mood, and alleviate stress. (Grebosz-Haring et al., 2022).

Furthermore, there is a positive relationship between feelings of isolation and fatigue syndrome, suggesting that social isolation exacerbates fatigue. Our findings, together with existing knowledge, indicate that isolation negatively impacts children's mental and physical wellbeing. Engaging in activities and social interactions can help prevent depression, as literature shows that active social involvement, participation in diverse events, and regular interactions with friends are linked to a lower risk of depressive episodes (Chen et al., 2025).

Moreover, the presence of food sensitivity is related to a higher fatigue syndrome score, indicating that food sensitivity may contribute to increased fatigue due to the emotional energy children expend to manage these disorders. The literature suggests that immune responses

triggered by allergens significantly impact sleep quality. Those with allergies, such as hives or atopic dermatitis, report that nighttime itching worsens, disrupting their sleep. Patients suffering from hay fever experience breathing difficulties that delay sleep onset, fragment their sleep, and prevent restful nights (Sanders & Greenspan, 2020).

## Conclusions

1. Chronic stress associated with food allergies leads to physical and emotional exhaustion, manifested by excessive fatigue.

2. Physical activity, such as dancing, plays a significant role in how children diagnosed with allergies or food intolerances manage their emotions and reduce stress.

3. Food allergies lead to increased perceived stress levels, the main cause being the psychological impact of this disorder on children.

## Conflict of interest

The authors declare no conflicts of interest.

## Acknowledgment

The first author's bachelor's thesis includes some of the paper's preliminary findings.

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## **FOR THE ATTENTION OF CONTRIBUTORS**

### **The subject of the journal**

The journal has a multidisciplinary nature oriented toward biomedical, health, exercise, social sciences fields, applicable in activities of physical training and sport, so that the dealt subjects and the authors belong to several disciplines in these fields. The main rubrics are: “Original studies” and “Reviews”.

The Journal is aimed at adapting the profile of the journal to scientific contemporaneity in the field of medical and pharmaceutical sciences and interdisciplinary integration with health, physical activity and biopsychosocial rehabilitation.

The journal will have the same contents: editorials, original articles, review articles, case reports, recent publications, events. The journal is open for publication to all members of the national and international scientific community and offers the possibility to promote young people involved in research, along with top researchers in the above mentioned fields.

Regarding “Reviews” the main subjects that are presented are: oxidative stress in physical effort; mental training; psycho-neuroendocrinology of sport effort; physical culture in the practice of the family doctor; extreme sports and risks; emotional determinatives of performance; the recovery of patients with spinal column disorders; stress syndromes and psychosomatics; olympic education, legal aspects of sport; physical fitness/exercise in the elderly; psychomotricity disorders; high altitude sportive training; fitness; biomechanics of movements; EUROFIT tests and other evaluation methods of physical fitness; adverse reactions of physical fitness; sport endocrinology; depression in sportsmen/women; classical and genetic drug usage; Olympic Games etc.

Among articles devoted to original studies and researches we are particularly interested in the following: the methodology in physical education and sport; influence of some ions on effort capacity; psychological profiles of students regarding physical education; methodology in sport gymnastics; the selection of performance sportsmen.

Other articles approach particular subjects regarding different sports: swimming, rhythmic and artistic gymnastics, hand-ball, volleyball, basketball, athletics, ski, football, field and table tennis, wrestling, sumo.

The authors of the two rubrics are doctors, professors and educators, from universities and preuniversity education, trainers, scientific researchers etc.

Other rubrics of the journal are: the editorial, editorial news, reviews of the latest books in the field and others that are presented rarely (inventions and innovations, universitaria, preuniversitaria, forum, memories, competition calendar, portraits, scientific events).

We highlight the rubric “The memory of the photographic eye”, where photos, some very rare, of sportsmen in the past and present are presented.

Articles signed by authors from the Republic of Moldova regarding the organization of sport education, variability of the cardiac rhythm, the stages of effort adaptability and articles by some authors from France, Portugal, Canada must also be mentioned.

The main objective of the journal is highlighting the results of research activities as well as the permanent and actual dissemination of information for specialists in the field. The journal assumes an important role regarding the achievement of necessary scores of the teaching staff in the university and pre university education as well as of doctors in the medical network (by recognizing the journal by the Romanian College of Physicians), regarding didactic and professional promotion.

Another merit of the journal is the obligatory publication of the table of contents and an English summary for all articles. Frequently articles are published in extenso in a language with international circulation (English, French).

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**The images** (graphics, photos etc.) should be numbered consecutively in the text, with arabic numbers. They should be edited with SPSS or EXCEL programs, and sent as distinct files: „figure 1.tif”, „figure 2. jpg”, and at the editors demanding in original also. Every graphic should have a legend, written **under** the image.

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*Background, Aims.* Description of the importance of the study and explanation of premises and research objectives.

*Methods.* Include the following aspects of the study: Description of the basic category of the study: of orientation and applicative. Localization and the period of study. Description and size of groups, sex (gender), age and other socio-demographic variables should be given. Methods and instruments of investigation that are used.

*Results.* The descriptive and inferential statistical data (with specification of the used statistical tests): the differences between the initial and the final measurement, for the investigated parameters, the significance of correlation coefficients are necessary. The specification of the level of significance (the value p or the dimension of effect d) and the type of the used statistical test etc are obligatory.

*Conclusions.* Conclusions that have a direct link with the presented study should be given.

Orientation articles and case studies should have an unstructured summary (without respecting the structure of experimental articles) to a limit of 150 words.

### 3. Text

Original articles should include the following chapters which will not be identical with the summary titles: *Introduction* (General considerations), *Hypothesis*, *Materials and methods* (including ethical and statistical informations), *Results*, *Discussions* results, *Conclusions* and suggestions. The conclusions should be formulated briefly, without comments extracted from the research, and numbered. Other type of articles, as orientation articles, case studies, Editorials, do not have an obligatory format. Excessive abbreviations are not recommended. The first abbreviation in the text is represented first in extenso, having its abbreviation in parenthesis, and thereafter the short form should be used.

Authors must undertake the responsibility for the correctness of published materials.

### 4. References

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For articles from journals or other periodical publications the international Vancouver Reference Style should be used: the name of all authors as initials and the surname, the year of publication, the title of the article in its original language, the title of the journal in its international abbreviation (italic characters), number of volume, pages.

*Articles:* Pop M, Albu VR, Vişan D et al. Probleme de pedagogie în sport. *Educație Fizică și Sport* 2000; 25(4):2-8.

*Books:* Drăgan I (coord.). *Medicina sportivă*, Editura Medicală, 2002, Bucureşti, 2002, 272-275.

*Chapters from books:* Hăulică I, Bălţatu O. Fiziologia senescenţei. In: Hăulică I. (sub red.) *Fiziologia umană*, Ed. Medicală, Bucureşti, 1996, 931-947.

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Title of the journal: Health, Sports & Rehabilitation Medicine

pISSN: 2668-2303; eISSN: 2668-5132; ISSN-L: 2668-2303

Profile: a Journal of Study and interdisciplinary research

Editor: “Iuliu Hațieganu” University of Medicine and Pharmacy of Cluj-Napoca and The Romanian Medical Society of Physical Education and Sports in collaboration with the Cluj County School Inspectorate

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The level and attestation of the journal: a journal rated B+ by CNCSIS in the period 2007-2011 and certified by CMR since 2003

Journal indexed into International Data Bases (IDB): EBSCO, Academic Search Complete – USA; Index Copernicus, Journals Master List – Poland; DOAJ (Directory of Open Access Journals) – Sweden; CrossRef – Linnfield, MA(US)/Oxford (UK).

Year of first publication: 2000

Issue: quarterly

The table of contents, the summaries and the instructions for authors can be found on the internet page: <http://www.jhsrm.org>. Access to the table of contents and summaries (in .pdf format) is free.