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Correcting Posture (Body and Foot) in Karate: Influence of Propriofoot Concept on Posture in Children Under 12 Years of Age

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Abstract
Background. Correct posture, both body and foot, is essential in *karate* for maintaining balance, generating power, and preventing injury. Despite its importance, correcting improper posture remains challenge, particularly in children under 12 years of age who are still undergoing physical development. This age group requires more time and structured guidance to master correct posture.
Problem and aim. Interventions aimed at improving posture in *karate*, especially for children under 12, represent a significant area of research. However, to the best of the authors' knowledge, notable gaps persist in the literature within the Slovak context. Therefore, the aim of this study was to experimentally validate the impact of the *Propriofoot Concept* on posture improvement in young *karate* practitioners under the age of 12.
Material and methods. A 10-week intervention program (*Propriofoot Concept*) was conducted from September 2 to November 8, 2024, with sessions held three times per week, each lasting 10 minutes. The program targeted 8 children (50%) under 12 years of age in the experimental group (mean age: 10.40 ± 0.60 years; weight: 38.20 ± 2.40 kg; height: 138.60 ± 2.40 cm). The control group also consisted of 8 children (50%) under 12 years of age (mean age: 10.80 ± 0.80 years; weight: 36.40 ± 2.20 kg; height: 136.20 ± 2.40 cm), who did not receive any experimental stimulus. Posture evaluation was performed using a standardized method, Klein and Thomas's, refined by Mayer and Srdecny's Index Method. Assessments were conducted before (Week 1, September 2) and after

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(Week 10, November 8, 2024) the intervention. The impact of the program was statistically evaluated using the Wilcoxon Rank-Sum Test, Wilcoxon Signed-Rank Test, and Pearson's r.
Results. The 10-week intervention program significantly improved posture in the experimental group (n = 8, 50%), with results showing statistically significant improvements ($p < 0.01$; $p < 0.05$). In contrast, no significant changes were observed in the control group (n = 8; $p > 0.05$).
Conclusions. The absence of significant improvements in the control group highlights the importance of structured intervention programs in correcting posture among young *karate* athletes. These findings emphasize the need for targeted interventions that support motor learning, posture correction, and motivation, particularly for children under 12 years of age engaged in *karate* training.

Introduction

Traditional martial art – *karate*, requires precise control of body movements, balance, and posture to execute techniques effectively. Correct posture is crucial for injury prevention, athletic performance, and motor development in children. Existing research indicates that training in martial arts, including *karate*, positively influences postural control, coordination, and balance, particularly in children under 12 years of age [Cynarski *et al.* 2014; Witte *et al.* 2017]. Despite these benefits, incorrect postural habits formed during early childhood may lead to musculoskeletal disorders (*MSDs*), negatively affecting long-term athletic performance and overall health.

Children's musculoskeletal systems undergo continuous development, adapting to changes in motor coordination, neuromuscular balance, and muscular control. These developmental transitions significantly influence their ability to maintain balance and perform complex movements required in sports such as *karate* [Arslan *et al.* 2024].

Karate training involves intricate movements that challenge and enhance neuromuscular balance. Particular emphasis is placed on stances, especially *zenkutsu-dachi* (front stance) and *kokutsu-dachi* (back stance), which require balance, coordination, and correct body alignment [Mustafa *et al.* 2022]. Martial arts training, especially *karate*, has been shown to improve balance, proprioception, and dynamic postural control, thereby reducing postural deviations and fostering neuromuscular stability [Truszczynska *et al.* 2015]. Practicing *kata* (*kihon*) enhances motor coordination and neuromuscular adaptations that contribute to improved posture [Arslan *et al.* 2024].

The biomechanics of *karate* depend on proper weight distribution, correct foot placement, and core stability [Paillard, Noe 2006]. *Karate* stances (*zenkutsu-dachi*, *kokutsu-dachi*, *kiba-dachi*) require precise foot positioning; when misaligned, these positions can compromise body mechanics and increase stress on the joints [Perrot *et al.* 1998]. Children under the age of 12, due to ongoing skeletal development, may struggle to maintain correct posture, often leading to excessive pronation or supination [Gorgy *et al.* 2008]. Proper posture in *karate* enhances force transmission and striking effectiveness [Hrysomallis 2011]. Conversely, incorrect foot arch alignment disrupts the kinetic chain, affecting kick performance [Gauchard *et al.* 2017], as well as agility and reaction time [Paillard, 2019]. Without timely interventions, early postural imbalances may persist, increasing the risk of injuries [Gawel, Zwierzchowska 2024].

Structured intervention programs, integrating proprioceptive training, neuromuscular balance, and motor learning within Physical Education and sports settings, have demonstrated promising results [Bendikova *et al.* 2020; Grus *et al.* 2021; Rozim *et al.* 2022; Mandzakova, Slovakova 2023; Bendikova *et al.* 2024]. Combinations of corrective exercises, foot positioning, and movement-based training show effectiveness in addressing postural deviations in *karate* practitioners [Benis *et al.* 2016; Drzal-Grabiec, Truszczynska 2014]. These programs should be tailored to the developmental needs of young athletes, ensuring the acquisition of fundamental movement skills while minimizing the risk of postural imbalances [Gauchard *et al.* 2017].

Interventions focused on improving posture in *karate*, particularly among children under 12 years of age, represent an important area of research. However, significant gaps remain in the literature, especially in the Slovak context (to the best of the authors' knowledge). Therefore, the aim of this study was to experimentally validate the impact of the *Propriofoot Concept* on posture improvement in *karate* practitioners under the age of 12.

Material and methods

The 10-week intervention program (*Propriofoot Concept*) was designed to improve posture in 8 children (50%) under 12 years of age, comprising the experimental group (mean age: 10.40 ± 0.60 years; weight: 38.20 ± 2.40 kg; height: 138.60 ± 2.40 cm). An additional 8 children (50%), who did not receive any experimental stimulus, formed the control group (mean age: 10.80 ± 0.80 years; weight: 36.40 ± 2.20 kg; height: 136.20 ± 2.40 cm). All participants were recruited from the "*Centrum mládeže karate*" in Banská Bystrica. Table 1 presents the anthropometric characteristics of the full sample of 16 children under 12 years of age (100%), including training experience (in years) and foot length (in centimetres). The participants formed a convenience sample, selected using purposive sampling criteria based on age and gender [Marko *et al.* 2023]. At Week 1 (September 2, 2024), the children were randomly assigned to either the experimental or control group to ensure balanced allocation. The entire evaluation of the 10-week intervention and its impact on posture in children under 12 was conducted in accordance with ethical principles outlined in the Declaration of Helsinki (1964), including its later amendments and comparable ethical standards [Harriss *et al.* 2020]. Ethical approval was granted by the Artistic and Pedagogical Council of the Faculty of Performing Arts, Academy of Arts in Banská Bystrica (Decision dated December 2, 2024). Written informed consent was obtained from the legal guardians of all participating children.

Table 1. Anthropometric data of 16 (100%) children under 12 years of age

Anthropometric data	Experimental group (50%, 8n)	Control group (50%, 8n)
Age (years)	10.40 ± 0.60	10.80 ± 0.80
Weight (kg)	38.20 ± 2.40	36.40 ± 2.20
Height (cm)	138.60 ± 2.40	136.20 ± 2.40
Body mass index (kg/m^2)	19.80 ± 0.80	19.50 ± 0.60
Length of practice (years)	4.0 ± 1.50	4.0 ± 2.0
Length of foot (cm)	24.20 ± 1.80	24.40 ± 1.20

% - percentage; n- number; kg - kilogram; cm - centimeter; kg/m2 - kilogram per square meter.

The evaluation of the 10-week intervention program in children under 12 years of age followed a true experimental design [Armour, Macdonald 2012], conducted three times per week (Monday, Wednesday, Friday) for 10 minutes per session over a 10-week period. The experimental group (n = 8; 50%) received the intervention, referred to as the *"Propriofoot Concept"*, which specifically targeted a defined postural state (S). The control group (n = 8; 50%) received no experimental stimulus and continued training under the regular supervision of *karate* coaches. The duration of the intervention (Δt = 10 weeks) was consistent for both groups, with postural assessments conducted in Week 1 and Week 10. The control group functioned as a baseline comparator for the experimental program. Initially defined as a causal, independent, and experimental design, the 10-week intervention was later interpreted as impact-driven, dependent, and experimental due to the nature of outcomes observed over Δt [Azor *et al.* 2024]. The experimental group underwent the intervention under the direct guidance of the authors, who introduced and explained the principles of the *Propriofoot Concept*. This concept served as a balance-training tool with both preventive and therapeutic purposes, implemented during the cool-down phase of regular *karate* training. It consisted of 20 progressive exercises, ordered from the simplest (1) to the most challenging (20), with a strong emphasis on mastery of each step [Baicry, Paris 2025]. The correct execution of all 20 exercises, particularly in terms of fixation and starting positions, was considered the independent variable, serving as the experimental and dependent stimulus [Azor *et al.* 2024]. The *Propriofoot Concept* uses four distinct balance plates (square-shaped, 10 x 10 cm), each differing in color, structure, and degree of instability [Bendikova *et al.* 2024]. The green plate, incorporating two parallel cylinders located on either side of its base, is considered secure. The yellow and blue plates are moderately unstable, with cylinder arrangements positioned centrally, causing instability in two directions. The red plate is the most unstable version, featuring hemispherical structures, produces instability in all directions, serving as the most advanced challenge (see Figure 1) [Springrova 2018; Baicry, Paris 2025].

Fig. 1 Propriofoot Concept [Baicry, Paris 2025]

The experimental group completed the 10-week intervention program under the direct supervision of the authors, who thoroughly documented the program's progress and any arising issues [Azor *et al.* 2024]. Participants were instructed to report any musculoskeletal discomfort or pain, while the authors actively monitored for signs of fatigue, trembling, or loss of motor control. A social group setting was chosen as the method of delivery due to its cost-effectiveness and its relevance in community-based interventions [Gottschalk *et al.* 2022]. Standardized postural assessments were conducted before and after the 10-week intervention using Klein and Thomas's method, refined by Mayer and Srdecny's Index Method.

Klein and Thomas's method, as refined by Mayer, evaluates five body segments: 1. Head and neck; 2. Shape of chest; 3. Abdomen and pelvis; 4. Curvature of spine; 5. Shoulders and scapulas. Each segment is assessed using numeric values ranging from 1 to 4, based on postural quality. The cumulative postural score categorizes posture as follows: 1. Correct posture: ≤ 5 points; 2. Good posture: 6-10 points; 3. Poor posture: 11-15 points; 4. Incorrect posture: 16–20 points. This method has proven to be practical and easily applicable in school settings, making it a valuable tool for Physical Education and posture evaluation [Bendikova *et al.* 2020; Marko *et al.* 2023; Azor *et al.* 2024]. In addition, a non-invasive diagnostic tool, the *Podo4Foot Cam* (RGB) with MultiReha® software, was used to analyze foot posture, particularly the medial longitudinal arch (Figure 2). The Srdecny's Index Method evaluates the arch by calculating the index (i), based on the formula: $i = w/l*10$, where w = width of the footprint (at the arch) and l = length of the footprint. If $i \leq 1.7$, the arch is classified as normal. If $i > 1.7$, it indicates a flattened (flat) longitudinal arch on the inner side of the sole [Srdecny 1982].

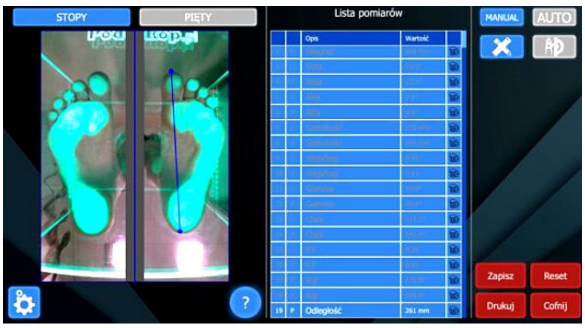

Fig. 2 MultiReha® - Diagnostic software [https://multireha.com]

The 10-week intervention program and its impact were evaluated using the Wilcoxon Rank-Sum Test (for independent samples), the Wilcoxon Signed-Rank Test (for dependent samples), and Pearson's correlation coefficient (r), with statistical analyses performed using IBM SPSS Modeler [Azor *et al.* 2024]. To determine significant differences between two independent samples, namely the experimental and control groups, the Wilcoxon Rank-Sum Test was applied, with the level of significance set at $p < 0.01$ and $p < 0.05$ [Nahm 2016]. For evaluating significant differences within dependent samples, i.e., comparisons between Week 1 and Week 10 measurements within each group, the Wilcoxon Signed-Rank Test was used, also with significance levels set at $p < 0.01$ and $p < 0.05$. To assess the linear correlation between two sets of data, Pearson's correlation coefficient (r) was employed [Schober *et al.* 2018]. In addition, descriptive statistics, specifically the arithmetic mean ($\bar{x}$) and percentage (%), were used to summarize and describe the demographic and anthropometric characteristics of the participants (children under 12 years of age).

Results

Table 2 presents the statistically significant differences in posture between two dependent samples, using Klein and Thomas's method, refined by Mayer, to evaluate the impact of the 10-week intervention program on five specific postural parameters in the experimental group (n = 8; 50%) and control group (n = 8; 50%). In the experimental group, significant improvements were observed in four out of the five assessed parameters over the 10-week period. The arithmetic mean ($\bar{x}$) for head and neck alignment decreased from 2.62 to 1.50 ($Z = 2.46$, $p < 0.05$, $r = 0.62$), while the mean score for abdomen and pelvis decreased from 2.86 to 1.62 ($Z = 2.64$, $p < 0.01$, $r = 0.66$). The curvature of spine showed improvement, with the mean score dropping from 2.48 to 1.48 ($Z = 2.82$, $p < 0.01$, $r = 0.70$). Similarly, shoulders and scapulas improved, with scores decreasing from 2.20 to 1.26 ($Z = 2.44$, $p < 0.05$, $r = 0.62$). The only parameter that did not demonstrate a statistically significant change was the shape of chest, which decreased slightly from 1.76 to 1.62 ($Z = 1.00$, $p > 0.05$, $r = 0.26$). However, the overall postural score ($\bar{x}$) showed a significant improvement, dropping from 11.72 to 7.48 ($Z = 2.56$, $p < 0.01$, $r = 0.64$), indicating a notable enhancement in total posture quality following the intervention. In contrast, the control group exhibited no statistically significant changes in any of the evaluated parameters over the same period ($p > 0.05$), highlighting the effectiveness of intervention in improving posture among children under 12 years of age.

Table 2. Differences of posture between 2 dependent samples

Klein and Thomas's method, as refined by Mayer			
Experimental group			
Parameters/ Test; Week	**Pre-; 1**	**Post-; 10**	**Wilcoxon S-R Test**
Head and neck ($\bar{x}$)	2.62	1.50	Z = 2.46, p < 0.05, r = 0.62*
Shape of chest ($\bar{x}$)	1.76	1.62	Z = 1.00, p > 0.05, r = 0.26
Abdomen and pelvis ($\bar{x}$)	2.86	1.62	Z = 2.64, p < 0.01, r = 0.66**
Curvature of spine ($\bar{x}$)	2.48	1.48	Z = 2.82, p < 0.01, r = 0.70**
Shoulders and scapulas ($\bar{x}$)	2.20	1.26	Z = 2.44, p < 0.05, r = 0.62*
Postural score ($\bar{x}$)	11.72	7.48	Z = 2.56, p < 0.01, r = 0.64**
Control group			
Parameters/ Test; Week	**Pre-; 1**	**Post-; 10**	**Wilcoxon S-R Test**
Head and neck ($\bar{x}$)	2.60	2.60	n/a
Shape of chest ($\bar{x}$)	2.60	2.60	n/a
Abdomen and pelvis ($\bar{x}$)	2.82	2.82	n/a
Curvature of spine ($\bar{x}$)	2.66	2.66	n/a
Shoulders and scapulas ($\bar{x}$)	2.50	2.50	n/a
Postural score ($\bar{x}$)	13.20	13.20	n/a

Pre- - Pre-test; **Post-** - Post-test; **S-R** - Signed-Rank; **Z** - Z-score, **p** - P-value; **r** - Pearson's correlation coefficient; * - Significance (α) = 0.05; ** - Significance (α) = 0.01; $\bar{x}$ - Arithmetic mean; **n/a** - No answer.

Table 3 illustrates the differences in the longitudinal arches of inner sides of the soles between two dependent samples, using Srdecny's Index Method to evaluate the impact of 10-week intervention program in both the experimental and control groups. In the experimental group, significant improvements were observed in the medial longitudinal arch over the intervention period (Δt). The arithmetic mean ($\bar{x}$) for the right foot decreased from 1.86 to 1.68 ($Z = 2.62$, $p < 0.05$, $r = 0.44$), while the left foot decreased from 1.78 to 1.62 ($Z = 2.52$, $p < 0.05$, $r = 0.42$), indicating a normalization of foot arch structure. In contrast, the control group showed no statistically significant changes in the longitudinal arches of either foot over the same period ($p > 0.05$), suggesting that improvements in the experimental group were attributable to the applied intervention.

Table 3. Differences of arches of foot between 2 dependent samples

Srdecny's Index Method			
Experimental group			
Parameters/ Test; Week	**Pre-; 1**	**Post-; 10**	**Wilcoxon S-R Test**
Arches of foot – Right (x̄)	1.86	1.68	Z = 2.62, p < 0.05, r = 0.44*
Arches of foot – Left (x̄)	1.78	1.62	Z = 2.52, p < 0.05, r = 0.42*
Control group			
Parameters/ Test; Week	**Pre-; 1**	**Post-; 10**	**Wilcoxon S-R Test**
Arches of foot – Right (x̄)	1.82	1.82	n/a
Arches of foot – Left (x̄)	1.80	1.80	n/a

Pre- - Pre-test; **Post-** - Post-test; **S-R** - Signed-Rank; **Z** - Z-score, **p** - P-value; **r** - Pearson's correlation coefficient; * - Significance (α) = 0.05; **x̄** - Arithmetic mean; **n/a** - No answer.

Table 4. Differences of posture between 2 independent samples

Klein and Thomas's method, as refined by Mayer			
Pre-; Week 1			
Parameters	**Experimental group**	**Control group**	**Wilcoxon R-S Test**
Head and neck (x̄)	2.62	2.60	Z = -1.12, p > 0.05, r = -0.28
Shape of chest (x̄)	1.76	2.60	Z = -2.46, p < 0.05, r = -0.62*
Abdomen and pelvis (x̄)	2.86	2.82	Z = -0.42, p > 0.05, r = -0.08
Curvature of spine (x̄)	2.48	2.66	Z = -0.82, p > 0.05, r = -0.14
Shoulders and scapulas (x̄)	2.20	2.50	Z = -0.36, p > 0.05, r = -0.08
Postural score (x̄)	11.72	13.20	Z = -0.32, p > 0.05, r = -0.06
Post-; Week 10			
Parameters	**Experimental group**	**Control group**	**Wilcoxon R-S Test**
Head and neck (x̄)	1.50	2.60	Z = -1.58 p > 0.05, r = -0.40
Shape of chest (x̄)	1.62	2.60	Z = -1.42, p > 0.05, r = -0.36
Abdomen and pelvis (x̄)	1.62	2.82	Z = -3.02 p < 0.01, r = -0.80**
Curvature of spine (x̄)	1.48	2.66	Z = -2.80 p < 0.01, r = -0.70**
Shoulders and scapulas (x̄)	1.26	2.50	Z = -2.54 p < 0.05, r = -0.64*
Postural score (x̄)	7.48	13.20	Z = -3.12 p < 0.01, r = -0.82**

Pre- - Pre-test; **Post-** - Post-test; **R-S** – Rank-Sum; **Z** - Z-score, **p** - P-value; **r** - Pearson's correlation coefficient; * - Significance (α) = 0.05; ** - Significance (α) = 0.01; **x̄** - Arithmetic mean.

Table 4 presents the differences in posture between two independent samples, using Klein and Thomas's method, refined by Mayer, to evaluate the impact of the 10-week intervention program across five postural parameters in the experimental group compared to the control group. At the beginning of program (Week 1), there were no statistically significant differences in four of the five assessed postural parameters between the two groups ($p > 0.05$). However, a notable exception was found in the shape of chest, where a difference of 0.84 in the mean score was statistically significant ($Z = -2.46$, $p < 0.05$, $r = -0.62$), favoring the experimental group. The difference in overall postural score at Week 1 between the groups was 1.48, which was not statistically significant ($Z = -0.32$, $p > 0.05$, $r = -0.06$). After ten weeks of intervention (Week 10), significant improvements were observed in the experimental group compared to the control group. Statistically significant differences were found in three parameters: shoulders and scapulas ($Z = -2.54$, $p < 0.05$, $r = -0.64$), curvature of spine ($Z = -2.80$, $p < 0.01$, $r = -0.70$), and abdomen and pelvis ($Z = -3.02$, $p < 0.01$, $r = -0.80$). However, differences in head and neck ($Z = -1.58$, $p > 0.05$, $r = -0.40$) and shape of chest ($Z = -1.42$, $p > 0.05$, $r = -0.36$) remained statistically insignificant. The overall postural score difference between the experimental and control groups at Week 10 was 5.72, which was statistically significant ($Z = -3.12$, $p < 0.01$, $r = -0.82$), again favoring the experimental group.

Table 5. Differences of arches of foot between 2 independent samples

Srdecny's Index Method			
Pre-; Week 1			
Parameters	**Experimental group**	**Control group**	**Wilcoxon R-S Test**
Arches of foot – Right (x̄)	1.86	1.82	Z = -0.84, p > 0.05, r = -0.20
Arches of foot – Left (x̄)	1.78	1.80	Z = -1.36, p > 0.05, r = -0.34
Post-; Week 10			
Parameters	**Experimental group**	**Control group**	**Wilcoxon R-S Test**
Arches of foot – Right (x̄)	1.68	1.82	Z = -2.16, p < 0.05, r = -0.54*
Arches of foot – Left (x̄)	1.62	1.80	Z = -3.36, p < 0.01, r = -0.84**

Pre- - Pre-test; **Post-** - Post-test; **S-R** - Signed-Rank; **Z** - Z-score, **p** - P-value; **r** - Pearson's correlation coefficient; * - Significance (α) = 0.05; ** - Significance (α) = 0.01; **x̄** - Arithmetic mean.

The analysis of differences in the longitudinal arches of the inner side of soles between the experimental and control groups was conducted using Srdecny's Index Method. At Week 1, there were no statistically significant differences in the arch measurements between the two groups ($p > 0.05$), indicating comparable baseline conditions. However, by Week 10, significant improvements were observed in the experimental group compared to the control group. The analysis showed statistically significant differences in the medial longitudinal arch of both feet. For the right foot, the result was significant ($Z = -2.16$, $p < 0.05$, $r = -0.54$), and for the left foot, the difference was even more pronounced ($Z = -3.36$, $p < 0.01$, $r = -0.84$), both in favor of the experimental group.

Discussion

Posture plays an important role in maintaining musculoskeletal health, influencing movement efficiency, balance, and injury prevention. This study investigated the impact of 10-week intervention program - *Propriofoot Concept*, on five parameters of posture and longitudinal arch of inner sole in children under 12 years of age practicing *karate*. Standardized methodologies were used to assess outcomes. The findings revealed notable improvements in the experimental group (n = 8; 50%), while no statistically significant changes were observed in the control group (n = 8; 50%, $p > 0.05$). These results align with a growing body of literature supporting targeted interventions to enhance postural alignment and foot biomechanics [Kanasova 2015; Bendikova *et al.* 2020; Grus *et al.* 2021; Rozim *et al.* 2022; Mandzakova, Slovakova 2023; Marko *et al.* 2023; Azor *et al.* 2024; Bendikova *et al.* 2024; Slovakova, Mandzakova 2024].

Over the 10-week period, improvements were observed in four key posture parameters in the experimental group: head and neck ($\bar{x}$, 1.12), abdomen and pelvis ($\bar{x}$, 1.24), curvature of spine ($\bar{x}$, 1.00), and shoulders and scapulas ($\bar{x}$, 0.94). These improvements are consistent with existing research on the effects of core stabilization and balance training in postural correction [Ebrahimi *et al.* 2024; Gabriel *et al.* 2024]. Further support is found in studies highlighting the effectiveness of combined exercise and orthotic interventions for spinal alignment and postural control [Kirmizi *et al.* 2024]. However, the shape of chest showed minimal change ($\bar{x}$, 0.14) and was not statistically significant ($p > 0.05$), suggesting that chest posture may be less responsive to short-term intervention [Gabriel *et al.* 2024].

Additionally, the results demonstrated significant improvements in the longitudinal arches of inner soles in the experimental group. These findings support prior conclusions that interventions of at least 10 weeks improve foot arch function and stability [Jia *et al.* 2024]. Structured calisthenic exercises have been shown to increase medial arch height and enhance postural balance, particularly in individuals with flexible flatfoot, which reinforces the outcomes of this study [Ghorbani *et al.* 2025]. No changes were observed in the control group ($p > 0.05$), emphasizing the low probability of spontaneous postural improvement without intervention. This aligns with research on postural and proprioceptive adaptation, which found that programs lasting at least 10 weeks are essential to induce meaningful change [Mahmoudi *et al.* 2024].

Comparative analyses between dependent and independent samples revealed that no significant postural differences existed at baseline (Week 1). However, by Week 10, the experimental group showed statistically significant improvements, confirming the short-term effectiveness of the intervention. This is consistent with findings that short-foot exercises improve both postural stability and medial arch function [Kumar *et al.* 2024]. Similar conclusions were drawn that backward walking and posture correction exercises effectively enhance alignment by activating deep postural muscles [Mahmoudi *et al.* 2024]. Foot-targeted exercises significantly contribute to increased arch height and better postural balance [Gabriel *et al.* 2024].

In addition to the observed improvements in posture and medial arch structure, the use of Podo4Foot Cam (RGB) with MultiReha® software played an important role in providing objective and precise assessments of foot posture. The podoscan allowed for non-invasive evaluation of medial longitudinal arch using the Srdecny's Index Method, facilitating early detection of flatfoot tendencies and effectiveness of intervention in restoring normal arch function. Integrating advanced diagnostic tools such as podoscans enhances the accuracy of biomechanical assessments and supports tailored interventions for pediatric populations [Szczepanowska-Wolowiec *et al.* 2021; Azor *et al.* 2024]. This technology ensured consistency in data collection and offered visual feedback that could be beneficial for both researchers and practitioners in Physical Education and sports rehabilitation settings.

This study presents a well-structured experimental design for evaluating the effectiveness of the *Propriofoot Concept* in improving posture and foot structure among young *karate* practitioners. The positive outcomes observed in this study may be closely linked to the structured progression and graded instability of the *Propriofoot Concept*, which provide increasingly challenging proprioceptive stimuli to improve neuromuscular coordination and postural control. The color-coded plates, green, yellow, blue, and red, offered a scalable approach to balance training, with the red plate eliciting the highest level of postural engagement due to its multidirectional instability.

However, certain limitations should be acknowledged. The small sample size (n = 16), short intervention period, and absence of long-term follow-up constrain the generalizability of the findings. Although statistically significant improvements were observed in the experimental group, the limited sample size, drawn via convenience sampling, reduces statistical power and should prompt caution in broad interpretation [Azor *et al.* 2024]. Despite its limitations, the intervention demonstrated promising outcomes and may be a valuable tool for enhancing postural alignment and foot health in martial arts contexts. To confirm and expand upon these findings, future research should involve larger, more diverse populations and incorporate longitudinal follow-ups to evaluate the durability of postural changes. Further investigation is also warranted to optimize intervention strategies and explore broader applications in physical education, martial arts training, and injury prevention programs.

Conclusions

The impact of the 10-week intervention program on posture in 8 children (50%) under 12 years of age practicing *karate* highlights the importance of musculoskeletal health in early athletic development. The program integrated a combination of 20 structured exercises, balance training, and corrective techniques, all aimed at enhancing postural awareness and control in martial arts performance. Such interventions are essential for minimizing the risk of *MSDs*, reducing asymmetrical loading, and improving biomechanical precision in karate practice. The observed differences in postural improvements emphasize the significance of early prevention and targeted correction in addressing postural imbalances and *MSDs* in young athletes. In contrast, the control group showed no significant changes ($p > 0.05$), reinforcing the necessity of structured intervention programs for effective postural correction. These findings also underscore the importance of integrating such interventions into training routines, not only to support physical development, but also to enhance motivation and engagement in *karate* among children under 12 years of age.

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Korygowanie postawy ciała i stóp w karate: wpływ koncepcji elektronicznej stopy Propriofoot na postawę ciała u dzieci poniżej 12 roku życia

Słowa kluczowe: korygowanie postawy ciała, program interwencyjny, sztuki walki, zdrowie układu mięśniowo-szkieletowego

Streszczenie

Tło. Prawidłowa postawa ciała i stóp jest niezbędna w karate do utrzymania równowagi, generowania siły i zapobiegania urazom. Pomimo swojego znaczenia, korygowanie nieprawidłowej postawy pozostaje wyzwaniem, szczególnie u dzieci poniżej 12 roku życia, które wciąż przechodzą rozwój fizyczny. Ta grupa wiekowa wymaga więcej czasu i ustrukturyzowanych wskazówek, aby opanować prawidłową postawę.

Problem i cel. Interwencje mające na celu poprawę postawy w karate, zwłaszcza u dzieci poniżej 12 roku życia, stanowią istotny obszar badań. Jednakże, zgodnie z najlepszą wiedzą autorów, w literaturze przedmiotu w kontekście słowackim utrzymują się znaczące luki. Dlatego celem tego badania było eksperymentalne zweryfikowanie wpływu koncepcji Propriofoot na poprawę postawy u młodych karateków w wieku poniżej 12 lat.

Materiał i metody. Przeprowadzono 10-tygodniowy program interwencyjny (Propriofoot Concept) od 2 września do 8 listopada 2024 r., z sesjami odbywającymi się trzy razy w tygodniu, z których każda trwała 10 minut. Program obejmował 8 dzieci (50%) w wieku poniżej 12 lat w grupie eksperymentalnej (średni wiek: 10,40 ± 0,60 lat; waga: 38,20 ± 2,40 kg; wzrost: 138,60 ± 2,40 cm). Grupa kontrolna składała się również z 8 dzieci (50%) w wieku poniżej 12 lat (średni wiek: 10,80 ± 0,80 lat; waga: 36,40 ± 2,20 kg; wzrost: 136,20 ± 2,40 cm), które nie otrzymały żadnego bodźca eksperymentalnego. Ocenę postawy ciała przeprowadzono przy użyciu standaryzowanej metody Kleina i Thomasa, udoskonalonej metodą wskaźnikową Mayera i Srdecny’ego. Oceny przeprowadzono przed (tydzień 1, 2 września) i po (tydzień 10, 8 listopada 2024 r.) interwencji. Wpływ programu oceniono statystycznie za pomocą testu sumy rang Wilcoxona, testu Wilcoxona ze znakiem rang i testu r Pearsona.

Wyniki. 10-tygodniowy program interwencyjny znacząco poprawił postawę ciała w grupie eksperymentalnej (n = 8, 50%), a wyniki wykazały statystycznie istotną poprawę ($p < 0,01$; $p < 0,05$). W przeciwieństwie do tego, nie zaobserwowano znaczących zmian w grupie kontrolnej ($n = 8$; $p > 0,05$).

Wnioski. Brak znaczącej poprawy w grupie kontrolnej podkreśla znaczenie ustrukturyzowanych programów interwencyjnych w korygowaniu postawy wśród młodych sportowców karate. Wyniki te podkreślają potrzebę ukierunkowanych interwencji, które wspierają uczenie się motoryczne, korekcję postawy i motywację, szczególnie u dzieci poniżej 12 roku życia zaangażowanych w trening karate.