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Karate Training and Postural Health: A Study on Spinal Deviations among Young Karate Practitioners from Northeastern Romania

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Abstract: *The aim of this pilot study was to investigate spinal health among young karate practitioners from northeastern Romania, focusing on thoracic kyphosis, lumbar lordosis, trunk rotation, and postural deviations of the shoulders and pelvis. Utilizing a cross-sectional design and scientifically validated methods, the study identified potential postural asymmetries. The analysis showed that, while significant structural deformities were not present, several deviations appeared as non-structural scoliotic attitudes, characterized by minor trunk rotations and asymmetries in the shoulders and pelvis, which indicate a thoracolumbar scoliotic posture in the majority of cases. These results suggest that a corrective exercise plan is necessary to effectively address these subtle deviations. We propose the integration of a customized karate exercise program aimed at optimizing postural control and preventing the progression of asymmetries, thereby promoting spinal health among youth. The implications of this study underscore the importance of continuous monitoring of young athletes and suggest directions for future research focusing on the long-term effects of martial arts training on postural alignment.*

Keywords: *karate practitioners, spinal health, scoliotic posture, postural deviations, scoliotic attitudes.*

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Introduction

Spinal deviations among children and adolescents are becoming increasingly common, influenced by factors such as modern lifestyles, poor posture and insufficient physical activity. Adolescence represents a critical period for musculoskeletal development, and prolonged exposure to risk factors can lead to spinal deformities such as hyperlordosis, hyperkyphosis, or scoliosis. These deviations affect not only physical health but also psychological well-being and overall quality of life.

Physical activity is essential for both the prevention and correction of these conditions. Traditional karate, with its complex and dynamic movements, has the potential to improve posture and stabilize the spine. Karate training involves rotational, stabilization, and balancing movements that strengthen the trunk musculature, thereby enhancing postural alignment (Brzęk et al., 2022). However, the impact of karate practice on spine remains insufficiently studied, and the existing research findings are mixed.

Research suggests that controlled karate movements can help prevent and correct postural deviations (Drzał-Grabiec & Truszczyńska, 2014). However, empirical evidence supporting these benefits, especially among young practitioners, remains limited. Furthermore, improper execution of karate techniques may contribute to postural imbalances rather than correcting them (Hosseinzadeh et al., 2019). This highlights the need for further investigation into the biomechanical effects of karate on spinal alignment.

This study aims to assess spinal deviations in both the sagittal and frontal planes among young karate practitioners from northeastern Romania, aged 11 to 18 years. Specifically, it examines thoracic kyphosis and lumbar lordosis angles, trunk rotation, and postural deviations of the shoulders and pelvis. Additionally, it investigates potential gender-based differences in postural alignment. We hypothesize that the repetitive movement involved in karate training may have beneficial effects on spinal posture, contributing to improved alignment and balance. The findings of this research could provide valuable insights for optimizing training protocols in martial arts postural education programs.

Material and method

This study employed a descriptive, cross-sectional design to evaluate spinal deviations among young karate practitioners from northeastern Romania. The research protocol adhered to ethical standards outlined in the

"Declaration of Helsinki" and was approved by the "Research Ethics Committee of the Faculty of Physical Education and Sports" at "Alexandru Ioan Cuza University of Iaşi". All figures and tables in this article were created by the authors based on the collected data.

Participants

The sample consisted of 98 children and adolescents, aged 11 to 18 years (M = 13.73), recruited from karate clubs affiliated with the Romanian Traditional Karate Federation. Participants were selected from clubs located in Iaşi, Bacău, Piatra Neamţ, Bârlad, Galaţi, and Brăila. The sample included both male (68.4%, N=67) and female (31.6%, N=31) practitioners, with varying levels of training experience. The exclusion criteria included participation in training that was irregular and having less than one year of karate practice.

Data collection and instruments

Inclinometer: The angles of thoracic kyphosis and lumbar lordosis were measured using a Baseline Bubble Inclinometer (Fabrication Enterprises Inc., USA), a reliable tool validated in previous studies (Hunter et al., 2018) and we used the established protocol by Van Blommestein (2012) to calculate the curvature angles (Fig. 1). We used the formula for summing the angles between T1-2 and T12-L1 to record the thoracic kyphosis angle and summed the angles between T12-L1 and S1-2 to record the lumbar lordosis angle (Van Blommestein et al., 2012). Identifying these parameters required locating the spinous processes of the C7, T1, T2, T12, L1, L5, S1 and S2. Subjects were advised to remain as scantily dressed as possible, in underwear, to facilitate accurate palpation. The C7 was identified through palpation, as it is generally considered the most prominent process in the cervicothoracic region (Shin et al., 2011; Lumley, 2004; Palastanga et al., 2007). We palpated caudally from C7 and marked the T1 and T2 processes with a marker. To identify and mark the spinous processes of T12 and L1, we first located the L5 spinous process by palpating the first process cranial to the sacrum and then counted cranially to L1 and T12. The S1 and S2 were marked by counting caudally from L5.

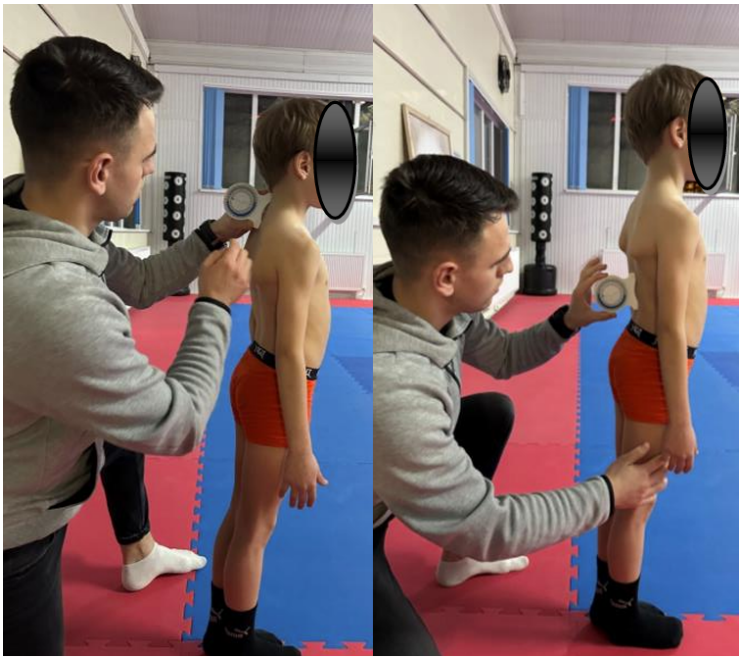


Fig. 1 – Measuring the thoracic kyphosis and lumbar lordosis angles with inclinometer.
Source: Created by the authors.

Scoliometer: To assess postural deviations of the spine in the frontal plane, the angle of trunk rotation was measured during the Adams test. The Adams test involves the subject bending forward at the trunk from a standing position. Instructions were given to ensure that, during flexion, the subject relaxed their head and kept their hands reaching toward the floor with palms pressed together. The angle of trunk rotation was measured using the scoliometer "Gima Professional Medical Products, Gima 119 S.p.A., Gessate, Milan, Italy". The scoliometer was positioned with its center aligned over the spinous processes of the upper thoracic vertebrae, and the maximum angle detected was recorded progressively down to the lumbar vertebrae (Fig. 2) This instrument has been shown to be both reliable and user-friendly for detecting the degree of trunk rotation, with studies showing that the scoliometer provides valid data suitable for use in medical offices and research contexts (Coelho et al., 2013; Dobosiewicz, 2006; Scaturro et al., 2020).

To analyze shoulder and pelvic symmetry, the "Posture Screen Mobile" postural screening software was used. This professional postural analysis software is available as an application that can be installed on a tablet or smartphone. It has been proven to be a reliable and user-friendly tool for identifying specific postural parameters, with studies indicating that

Posture Screen Mobile provides valid data suitable for use in specialized clinics and academic research (Neufeld et al., 2020; Iacob et al., 2020; Türkmen et al., 2023; Akyurek et al., 2022; Santos et al., 2021). After scanning the subject from the posterior view, the software identifies the following anatomical landmarks: earlobes, C7 vertebra, scapulohumeral joint points, subaxillary points, T4, T8, T12, and L3 vertebrae, posterior superior iliac spines, and the center of the Achilles tendons. Using these anatomical landmarks, we focused on shoulder and pelvic markers to identify asymmetries in the scapulohumeral and pelvic girdles (Fig. 2)



Fig. 2 – Measuring trunk rotation angle with scoliometer & scanning from posterior with "Posture Screen Mobile" Software. Source: Created by the authors.

Procedure

All measurements were conducted in a controlled environment, ensuring participants were dressed in minimal clothing to facilitate accurate anatomical landmark identification. Participants were instructed to stand in a relaxed, upright posture while measurements were taken. The data collection process involved three main steps: identifying and marking anatomical landmarks, performing inclinometer and scoliometer assessments, and capturing postural images using the PSM software. The data were collected by a licensed physiotherapist, ensuring a consistent and accurate assessment process. The data analysis was performed using the "IBM SPSS Statistics 20". Statistical tests were selected based on the type of data and the purpose of the analysis.

Ethical considerations

Consent was obtained from all participants as well as their parents or legal guardians. The study complied with all ethical standards, ensuring participant confidentiality and the right to withdraw at any point.

Findings

General overview

This section presents the results of the spinal assessments performed on young karate practitioners. The analysis focuses on thoracic kyphosis (CT), lumbar lordosis (LL), angle of trunk rotation (ATR) and asymmetries on scapulohumeral and pelvis girdles. The results indicate that most practitioners fall within the normal range for spinal curvature and alignment but some deviations in frontal plane was found.

Detailed findings

The mean thoracic kyphosis angle was 37.63° (95% CI: 35.99° – 39.26°), falling within the normal range of 20°–50° for healthy adolescents. Similarly, the mean lumbar lordosis angle was 26.59° (95% CI: 24.91° – 28.26°), which aligns with the normal range of 25°–48°. The mean trunk rotation angle was 1.53° (95% CI: 1.17° – 1.89°), remaining well below the 5° threshold associated with postural complications. These findings confirm that all measured parameters are within expected values for healthy adolescents. Descriptive statistics of the study variables are presented in Table 1.

Table 1. Descriptive Statistics and Confidence Intervals for Spinal Curvature and Trunk Rotation. Source: Created by the authors.

Parameter	Mean/SD (°)	95% Confidence Interval (°)	Normal Range (°)
Thoracic Kyphosis	37.63 / 8.16	35.99 – 39.26	20 – 50
Lumbar Lordosis	26.59 / 8.36	24.91 – 28.26	25 – 48
Trunk Rotation	1.53 / 1.81	1.17 – 1.89	≤ 5

The presence of scoliotic attitudes was analyzed by evaluating angles of trunk rotation (ATR) within the 0–5° range and examining anatomical landmarks identified using the Posture Screen Mobile (PSM) software. This tool scanned the scapulohumeral girdle, represented by the acromioclavicular joints, and the line connecting the posterior superior iliac

spines (PSIS) to identify asymmetries in the scapulohumeral and pelvis girdles. These asymmetries are closely related to spinal deficiencies in the frontal plane.

The analysis revealed that 61.2% of participants exhibited scapulohumeral girdle asymmetries, with an average inclination angle of 1.42°, suggesting scoliotic tendencies in more than half of the study subjects. Additionally, 76.53% of participants showed pelvic asymmetries, with an average inclination of 2.14°, indicating scoliotic postures in approximately two-thirds of the karate practitioners (Fig. 3). These results underscore the importance of monitoring postural deviations to prevent progression into structural deformities.

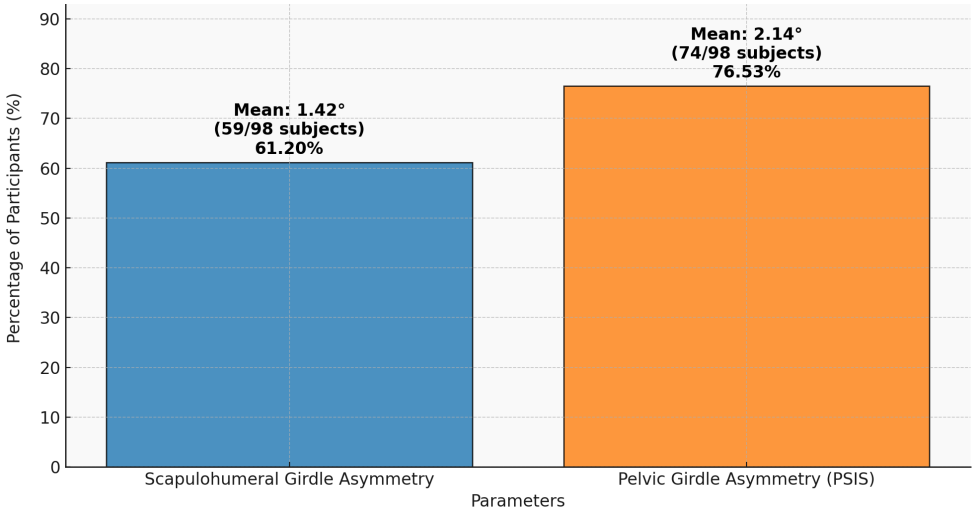


Fig. 3 – Postural asymmetries in karate practitioners of the study. Source: Created by the authors.

Following the identification of shoulder and pelvic asymmetries, participants were classified into four categories of scoliotic attitudes: Thoraco-Lumbar Scoliotic Attitude (TLSA), Lumbar Scoliotic Attitude (LSA), Thoracic Scoliotic Attitude (TSA), and 'S' Scoliotic Attitude (SSA). Additionally, a small percentage of participants showed no postural asymmetries (Fig. 4).

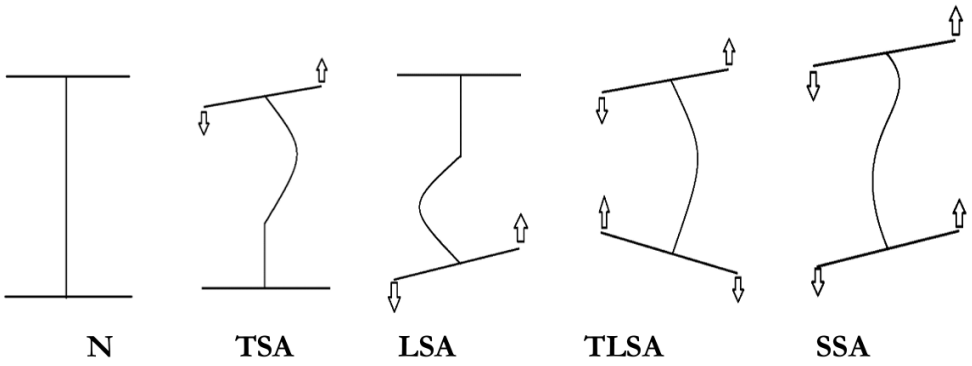


Fig. 4 - Classification of Scoliotic Attitudes Based on Shoulder and Pelvic Asymmetries - *N=Normal; TLSA=Thoraco-Lumbar Scoliotic Attitude; LSA=Lumbar Scoliotic Attitude; TSA=Thoracic Scoliotic Attitude; SSA=S Scoliotic Attitude.* Source: Created by the authors.

The analysis revealed the following proportions: 33.7% of participants (33 individuals) exhibit thoraco-lumbar scoliotic attitudes (TLSA), characterized by combined asymmetries in the shoulders and pelvis; 29.6% (29 individuals) present lumbar scoliotic attitudes (LSA), with pelvic asymmetries and symmetrical shoulders; 15.3% (15 individuals) show thoracic scoliotic attitudes (TSA), involving asymmetries only in the shoulders; 13.3% (13 individuals) display 'S' scoliotic attitudes (SSA), where asymmetries occur on the same side at both the shoulders and pelvis. Only 8.2% (8 individuals) showed no postural asymmetries (Fig. 5)

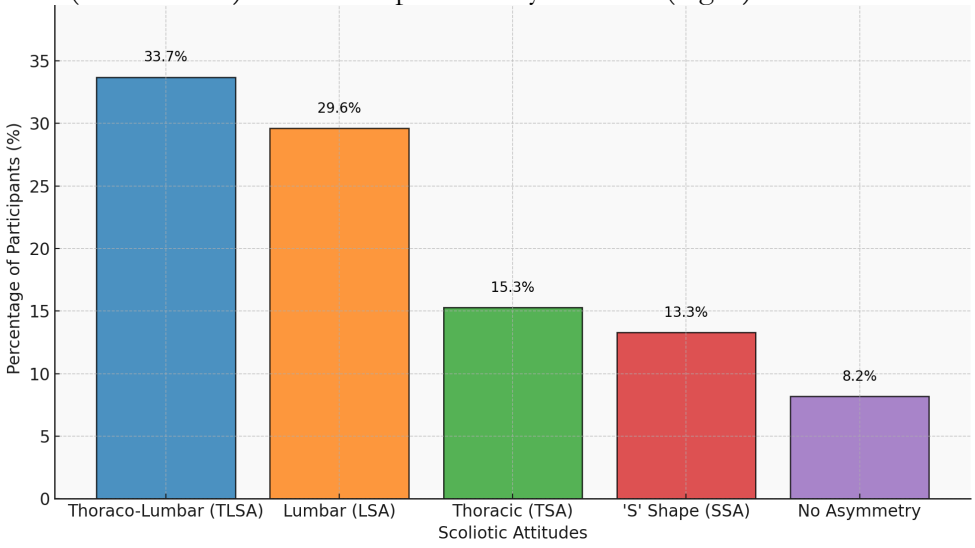


Fig. 5 – Distribution of scoliotic attitudes among practitioners. Source: Created by the authors.

A Mann-Whitney U test was conducted to evaluate differences in trunk rotation angles (ATR), scapulohumeral and pelvis girdles inclination between male and female participants. The test revealed that there was no statistically significant difference between genders on ATR ($p = 0.905$) and scapulohumeral girdle angles ($p = 0.814$). The A Mann-Whitney U test performed to analyze differences in pelvic asymmetry between genders showed that there was a statistically significant difference ($p < 0.05$) with a mean inclination of 1.56° for females and 2.41° for males (Fig. 6). These results highlight potential gender-specific biomechanical factors affecting pelvic alignment on karate practitioners.

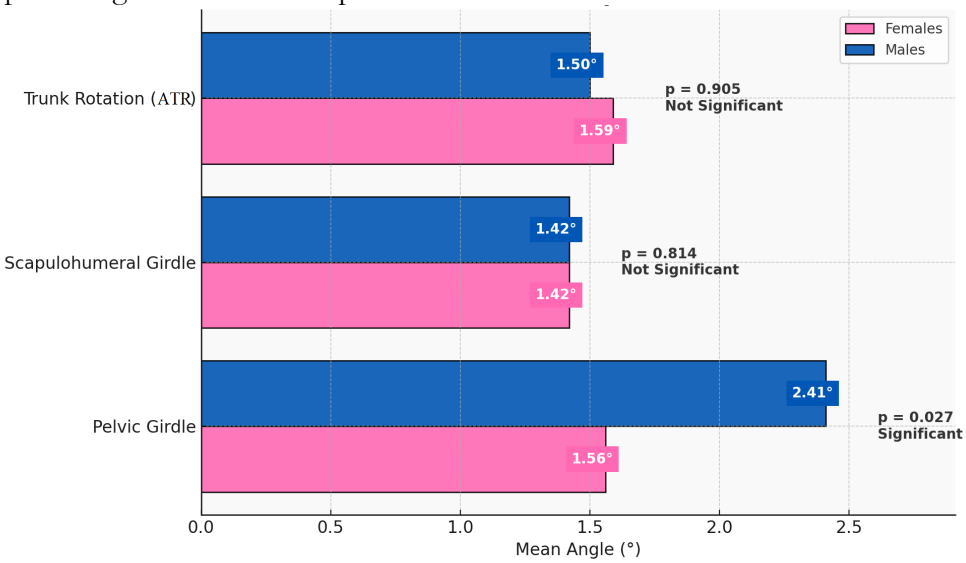


Fig. 6 – Gender Differences in Trunk rotation, Scapulohumeral and Pelvic Girdles angles. Source: Created by the authors.

Discussions

Postural deviations, particularly thoracic kyphosis and lumbar lordosis, have been extensively studied in pediatric and adolescent populations. Previous research reports wide variability in normal thoracic kyphosis values, ranging from 20º to 50º, with mean values between 27º and 38º (Takemitsu & Harada, 1977; Fon et al., 1980; Propst-Proctor & Bleck, 1983; Vedantam et al., 1998; Boseker et al., 2000; Shamsi et al., 2014). Lumbar lordosis has been reported with normal ranges between 25º and 48º

(Giglio & Volpon, 2007; Willner & Johnson, 1983). In this study, the mean thoracic kyphosis angle (37,63º) and lumbar lordosis (26,59º) remained within these normal ranges. These findings suggest that young karate practitioners do not exhibit sagittal plane spinal deficiencies. However, variability across studies may be attributed to differences in sample demographics, assessment methodologies and measurement tools. Understanding these differences is crucial for contextualizing the results of our study and comparing them with international standards.

If the trunk rotation angle (ATR) measured by the scoliometer exceeds 5º, it is correlated with a Cobb angle of at least 10º, leading to the diagnosis of spinal deficiencies in the frontal plane, specifically scoliosis (Coelho, 2013). Based on this criterion, the participants in our study do not present structural scoliosis. Despite this, postural asymmetries were prevalent, particularly in the scapular and pelvic girdles, which were assessed using the Posture Screen Mobile (PSM) system. Previous studies have established a strong correlation between shoulder and pelvic asymmetries and spinal deviations in the frontal plane (Kuklo et al., 2002; Zabjek et al., 2008; Maurice et al., 2011; Walker & Dickson, 1984; Pasha et al., 2014). Consistent with this literature, 91.2% of the study participants exhibited scoliotic postural attitudes (Fig. 7), reinforcing the necessity for targeted intervention strategies.

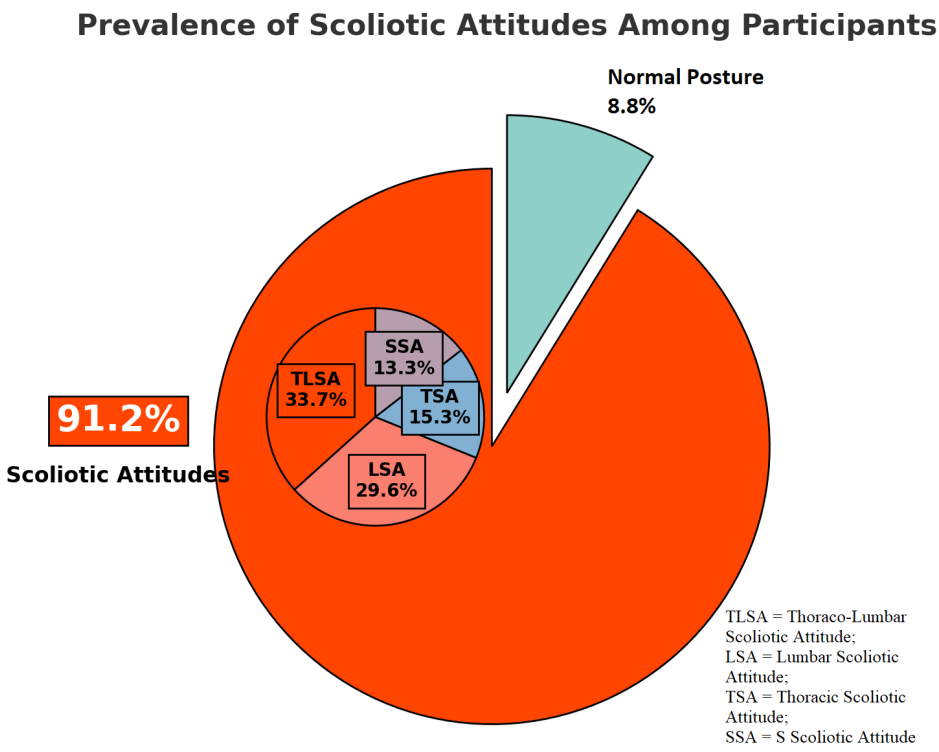


Fig. 7 – Prevalence of scoliotic attitudes among participants. Source: Created by the authors.

The high prevalence of thoraco-lumbar asymmetries among participants underscores the importance of tailored corrective exercise programs. Such interventions should focus on shoulder and pelvic realignment to minimize scoliotic tendencies. Early detection and intervention are crucial in preventing these postural imbalances from developing into structural deformities. Future training programs should integrate corrective exercises aimed at improving spinal symmetry and reducing musculoskeletal imbalances.

Additionally, gender differences in pelvic inclination were identified, with male participants showing a higher mean inclination (2.41º) compared to female participants (1.56º), a statistically significant difference ($p = 0.027$). Although some studies have reported no significant gender-based differences in frontal plane posture (Bibrowicz et al., 2022), our findings suggest that gender-specific factors should be considered when developing corrective interventions for postural asymmetries.

A possible explanation for this difference could be that male practitioners tend to use their dominant side more forcefully when executing

lower limb strikes, which may contribute to increased pelvic asymmetry over time. Although no studies directly compare the number of kicks executed by male and female karate practitioners, several pieces of research suggest differences in fighting style and technique utilization. A broader review of the physiological characteristics of karate athletes highlights that male competitors exhibit greater explosive muscle power, which plays a crucial role in kicking performance (Chaabene et al., 2012). This physiological advantage may contribute to a higher frequency of lower-limb strikes among male karate practitioners. Additionally, a study on young Malaysian karate athletes found that male competitors were more effective in offensive actions than females (Azmi et al., 2020). While these studies do not provide a direct comparison of kicking frequency between genders, they suggest that male athletes may favor kicks more frequently due to physiological advantages and a more aggressive fighting style. This factor should be considered when assessing gender-specific postural asymmetries and designing corrective training programs tailored to karate practitioners.

Our study partially supports the hypothesis that karate training influences spinal posture positively. While no structural deformities were identified, most participants exhibited scoliotic postural tendencies. This aligns with previous research indicating that karate training promotes bilateral muscle development and balanced postural alignment (Kotrljanovic et al., 2016; Trajković et al., 2016). Furthermore, targeted stretching exercises incorporated into martial arts training have been shown to prevent and correct idiopathic scoliosis (Karski & Karski, 2023). These findings highlight the potential of karate as a training method for maintaining spinal health, provided that exercises are executed with proper technique.

This study has certain limitations that should be addressed in future research. The sample was limited to young karate practitioners from northeastern Romania, which may restrict the generalizability of the findings to broader populations. Additionally, the study design was cross-sectional, preventing an analysis of long-term postural adaptations resulting from karate practice. Future longitudinal studies should investigate whether prolonged karate training leads to sustained postural improvements or if certain asymmetries persist over time. Moreover, an experimental intervention study incorporating a structured corrective exercise program alongside karate training could provide valuable insights into the effectiveness of targeted postural correction strategies.

Our findings emphasize the importance of monitoring postural alignment in young karate practitioners. While karate training appears to support spinal stability, specific attention must be given to correcting shoulder and

pelvic asymmetries to prevent long-term postural imbalances. Future research should focus on refining intervention programs that integrate martial arts techniques into postural correction strategies, potentially benefiting not only athletes but also individuals undergoing rehabilitation for postural deviations.

Conclusions

The findings of this study confirm that young karate practitioners do not exhibit structural spinal deformities. Thoracic kyphosis and lumbar lordosis values were within the normal range for healthy adolescents, and trunk rotation remained well below the threshold for scoliosis.

However, despite the absence of structural spinal deficiencies, postural asymmetries were prevalent, with 91.2% of participants exhibiting scoliotic postural attitudes, particularly in the scapulohumeral and pelvic girdles. These asymmetries, if left unaddressed, could contribute to musculoskeletal imbalances over time, highlighting the need for continuous postural monitoring.

A significant gender difference in pelvic inclination in the sagittal plane was identified, with male participants displaying greater asymmetry. This aspect should be considered in future intervention plans to develop targeted corrective strategies that optimize postural alignment.

To mitigate these asymmetries, integrating corrective exercises into karate training may be beneficial for enhancing postural stability and preventing long-term imbalances. Future research should focus on assessing the long-term effects of karate on spinal alignment and evaluating structured intervention programs designed to address postural deviations.

Acknowledgments

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References

Akyurek, E., Zengin Alpozgen, A., & Akgul, T. (2022). The preliminary results of physiotherapy scoliosis-specific exercises on spine joint position sense in

adolescent idiopathic scoliosis: A randomized controlled trial. *Prosthetics and orthotics international*, *46*(5), 510–517. https://doi.org/10.1097/PXR.0000000000000136

Azmi, A., Abd Malek, N. F., & J.F. Low. (2020). Tactical performance analysis of Malaysian youth karate exponents. *European Journal of Molecular & Clinical Medicine, 7*(02). https://scispace.com/pdf/tactical-performance-analysis-of-malaysian-youth-karate-gagl7u6mg0.pdf

Bibrowicz, K., Szurmik, T., Lipowicz, A., Walaszek, R., & Mitas, A. (2022). Tilt and mobility of the hip girdle in the sagittal and frontal planes in healthy subjects aged 19–30 years. *Journal of Back and Musculoskeletal Rehabilitation*, *35*(6), 1203-1210. https://doi.org/10.3233/BMR-200176

Boseker, E. H., Moe, J. H., Winter, R. B., & Koop, S. E. (2000). Determination of "normal" thoracic kyphosis: a roentgenographic study of 121 "normal" children. *Journal of Pediatric Orthopaedics*, *20*(6), 796-798. https://doi.org/10.1097/01241398-200011000-00019

Brzęk, A., Knapik, A., Brzęk, B., Niemiec, P., Przygodzki, P., Plinta, R., & Szyluk, K. (2022). Evaluation of posturometric parameters in children and youth who practice karate: Prospective cross-sectional study. *BioMed Research International*, *2022*(1), 5432743.https://doi.org/10.1155/2022/5432743

Chaabene, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. *Sports medicine*, *42*, 829-843. https://doi.org/10.1007/BF03262297

Coelho, D. M., Bonagamba, G. H., & Oliveira, A. S. (2013). Scoliometer measurements of patients with idiopathic scoliosis. *Brazilian journal of physical therapy*, *17*, 179-184. https://doi.org/10.1590/S1413-35552012005000081

Dobosiewicz, K. (2006). Non-specific back pain in children and adolescents–neurophysiological, biomechanical and psychosocial factors. *Neurologia Dziecięca*, *15*(30), 51-7. https://neurologia-dziecieca.pl/neurologia_30-51-58.pdf

Drzal-Grabiec, J., & Truszczyńska, A. (2014). Evaluation of selected postural parameters in children who practice Kyokushin karate. *Biomedical Human Kinetics*, *6*(1), 69-73. https://doi.org/10.2478/bhk-2014-0013

Fon, G. T., Pitt, M. J., & Thies Jr, A. C. (1980). Thoracic kyphosis: range in normal subjects. *American Journal of Roentgenology*, *134*(5), 979-983. https://doi.org/10.2214/ajr.134.5.979

Giglio, C. A., & Volpon, J. B. (2007). Development and evaluation of thoracic kyphosis and lumbar lordosis during growth. *Journal of Children's Orthopaedics*, *1*(3), 187-193. https://doi.org/10.1007/s11832-007-0033-5

Hosseinzadeh, B., Zandi, S., Baban, K. (2019). Common postures and sport injuries in elite karate athletes. *Journal for Research in Sport Rehabilitation*, *7*(13), 111-123. https://doi.org/10.22084/rsr.2019.19156.1455

Hunter, D. J., Rivett, D. A., McKiernan, S., Weerasekara, I., & Snodgrass, S. J. (2018). Is the inclinometer a valid measure of thoracic kyphosis? A cross-sectional study. *Brazilian journal of physical therapy*, *22*(4), 310-317. https://doi.org/10.1016/j.bjpt.2018.02.005

Iacob, S. M., PhD, Chisnoiu, A. M., PhD, Lascu, L. M., PhD, Berar, A. M., PhD, Studnicska, D., MD, & Fluerasu, M. I., PhD (2020). Is PostureScreen® Mobile app an accurate tool for dentists to evaluate the correlation between malocclusion and posture?. *Cranio: The Journal of Craniomandibular practice*, *38*(4), 233–239. https://doi.org/10.1080/08869634.2018.1512197

Karski, T., & Karski, J. (2023). Karate, Taekwondo, Aikido, Kung Fu, Yoga and Other far eastern forms of activities: best method of treatment of locomotor's system deformities especially of the so-called idiopathic scoliosis. *Research Highlights in Disease and Health Research* (Vol. 2, pp. 41–57). https://doi.org/10.9734/bpi/rhdhr/v2/18231D

Kotrljanovic, A., Atanasov, D., Veljovic, D., & Drid, P. (2016). An isokinetic profile in senior female and male karate athletes national team level. *Archives of Budo Science of Martial Arts and Extreme Sports*, *12*(1), 203-2010. https://smaes.archbudo.com/view/abstract/id/11420

Kuklo, T. R., Lenke, L. G., Graham, E. J., Won, D. S., Sweet, F. A., Blanke, K. M., & Bridwell, K. H. (2002). Correlation of radiographic, clinical, and patient assessment of shoulder balance following fusion versus nonfusion of the proximal thoracic curve in adolescent idiopathic scoliosis. *Spine*, *27*(18),2013-2020. https://journals.lww.com/spinejournal/abstract/2002/09150/correlation_of_radiographic,_clinical,_and_patient.9.aspx

Lumley, J. S. (2004). Palpation anatomy. *Athletic Therapy Today*, 45. https://doi.org/10.1123/att.9.3.44

Maurice, B., Jean-Marie, G., & Jean-Michel, T. (2011). Taking the shoulders and pelvis into account in the preoperative classification of idiopathic scoliosis in adolescents and young adults (a constructive critique of King's and Lenke's systems of classification). *European Spine Journal*, *20*, 1780-1787. https://doi.org/10.1007/s00586-011-1899-y

Neufeld, E. V., Seltzer, R. A., Sazzad, T., & Dolezal, B. A. (2020). A multidomain approach to assessing the convergent and concurrent validity of a mobile application when compared to conventional methods of determining body composition. *Sensors*, *20*(21), 6165. https://doi.org/10.3390/s20216165

Palastanga, N., Field, D., & Soames, R. (2007). *Anatomía y movimiento humano. Estructura y funcionamiento*. Editorial Paidotribo.

Pasha, S., Aubin, C. E., Sangole, A. P., Labelle, H., Parent, S., & Mac-Thiong, J. M. (2014). Three-dimensional spinopelvic relative alignment in adolescent idiopathic scoliosis. *Spine*, *39*(7), 564-570. https://doi.org/10.1097/BRS.0000000000000193

Propst-Proctor, S. L., & Bleck, E. E. (1983). Radiographic determination of lordosis and kyphosis in normal and scoliotic children. *Journal of pediatric orthopedics*, *3*(3), 344-346. https://journals.lww.com/pedorthopaedics/abstract/1983/07000/radiographic_determination_of_lordosis_and.13.aspx

Santos, J. G. L., Montezuma, T., Perez, C. S., Sverzut, C. E., Trivellato, A. E., & Guirro, E. C. O. (2021). Body postural realignment in the first 2 months after orthognathic surgery. *American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics*, *159*(3), e281–e290. https://doi.org/10.1016/j.ajodo.2020.10.019

Scaturro, D., de Sire, A., Terrana, P., Costantino, C., Lauricella, L., Sannasardo, C. E., ... & Mauro, G. L. (2021). Adolescent idiopathic scoliosis screening: Could a school-based assessment protocol be useful for an early diagnosis?. *Journal of back and musculoskeletal rehabilitation*, *34*(2), 301-306. https://doi.org/10.3233/BMR-200215

Shamsi, M., Veisi, K., Karimi, L., Sarrafzadeh, J., & Najafi, F. (2014). Normal range of thoracic kyphosis in male school children. *International Scholarly Research Notices*, *2014*(1), 159465. https://doi.org/10.1155/2014/159465

Shin, S., Yoon, D. M., & Yoon, K. B. (2011). Identification of the correct cervical level by palpation of spinous processes. *Anesthesia & Analgesia*, *112*(5), 1232-1235. https://doi.org/10.1213/ANE.0b013e3182110f9f

Takemitsu, Y., & Harada, Y. (1977). Anteroposterior spinal curvature of normal growing children, *Journal of the Japanese Orthopaedic Association*, 51,795–801.

Trajković, N., Madić, D., Maksimović, N., Milošević, Z., Obradović, B., Dimitrova, N., & Drid, P. (2018) Evaluating injury risk in female karate athletes: bilateral and unilateral asymmetries of isokinetic strength. In *14th International Scientific Conference of Sport Kinetics 2018 "Movement in Human Life and Health"*, *Poreč, Croatia,* 133.

Türkmen, C., Köse, N., Bal, E., Bilgin, S., Çetin, H., Zengin, H. Y., ... & Mut, M. (2023). Effects of two exercise regimes on patients with Chiari malformation type 1: a randomized controlled trial. *Cerebellum 22*, 305–315. https://doi.org/10.1007/s12311-022-01397-1

Van Blommestein, A. S., MaCrae, S., Lewis, J. S., & Morrissey, M. C. (2012). Reliability of measuring thoracic kyphosis angle, lumbar lordosis angle and straight leg raise with an inclinometer. *Open Spine Journal*. https://doi.org/10.2174/1876532701204010010

Vedantam, R., Lenke, L. G., Keeney, J. A., & Bridwell, K. H. (1998). Comparison of standing sagittal spinal alignment in asymptomatic adolescents and adults. *Spine*, *23*(2), 211-215. https://journals.lww.com/spinejournal/abstract/1998/01150/comparison_of_standing_sagittal_spinal_alignment.12.aspx

Walker, A. P., & Dickson, R. (1984). School screening and pelvic tilt scoliosis. *The Lancet*, *324*(8395), 152-154. https://doi.org/10.1016/S0140-6736(84)91059-6

Willner, S., & Johnson, B. (1983). Thoracic kyphosis and lumbar lordosis during the growth period in children. *Acta Paediatrica*, *72*(6), 873-878. https://doi.org/10.1111/j.1651-2227.1983.tb09833.x

Zabjek, K. F., Leroux, M. A., Coillard, C., Prince, F., & Rivard, C. H. (2008). Postural characteristics of adolescents with idiopathic scoliosis. *Journal of Pediatric Orthopaedics*, *28*(2), 218-224. https://doi.org/10.1097/BPO.0b013e3181651bdc