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THE INFLUENCE OF KYOKUSHIN KARATE TRAINING ON THE LOWER LIMB MUSCLE GROUPS STRENGTH SYMMETRY AS A FACTOR OF CONTACTLESS INJURIES

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Abstract

Introduction. Kyokushin karate is a full-contact style of karate. In addition to typical injuries resulting from opponent strikes during fights, non-contact injuries of the lower limbs also occur. The most common of these include injuries to the upper ankle joint and the knee. One of the causes of such injuries is the performance of motor tasks in an asymmetrical manner, with a clear preference for the dominant side of the body. Based on these observations, the aim of the study was to examine the relationship between asymmetries in strength and power and the occurrence of non-contact lower limb injuries. ***Material and Methods.*** The study involved 28 participants (4 females and 24 males) aged 23.39 ± 3.89 years, including 15 (2 females and 13 males) practicing Kyokushin karate and 13 (2 females and 11 males) with no experience in combat sports. None of the participants had a history of hip, knee, or upper ankle joint injuries. Passive and active range of motion measurements were conducted for the hip, knee, and upper ankle joints. Isometric strength testing was performed for the flexors and extensors of the knee and upper ankle joints. Reactive strength index (RSI) was assessed using a force plate. ***Results.*** Kyokushin karate practitioners exhibited high symmetry in the assessed strength and power parameters. In the control group, knee flexor strength significantly differed between the dominant and non-dominant limbs ($p = 0.029$). Additionally, karate practitioners demonstrated significantly higher RSI values compared to the control group ($p = 0.048$). ***Conclusions.*** Kyokushin karate training contributes to symmetrical development of lower limb strength and power. The observed symmetry in these parameters cannot be considered a direct cause of non-contact lower limb injuries in this population.

Key words: kyokushin karate, RSI, muscular strength, injury, lower limb

Introduction

Kyokushin karate is one of the karate styles in which competitive bouts are conducted in a full-contact format. Despite considerable similarities with traditional forms of karate, Kyokushin, due to the specific nature of its motor tasks, is more comparable to taekwondo or kickboxing [1, 2].

In Kyokushin karate, there are no regularly maintained injury reports; therefore, reference must be made to other combat sports. Research on injury profiles typically divides injuries into contact and non-contact categories [3, 4]. In Olympic karate and taekwondo, contact injuries are the most prevalent [3, 4]. Among non-contact injuries, upper ankle joint injuries dominate [3, 5], with nearly half involving ligament damage, and 75% of such ligament injuries affecting the non-dominant lower limb [5].

The most severe injuries reported in Olympic karate were knee joint injuries [6]. The authors of the study emphasized the role of asymmetry in lower limb muscle strength and insufficient postural stability as risk factors for sustaining injuries [5, 7]. Additionally, significant asymmetry was observed in the strength of identical muscle groups between the dominant and non-dominant lower limbs, as well as between antagonistic muscle groups within the same limb [7]. There is a lack of research on lower limb muscular strength in adult Kyokushin karate athletes. Given the similarities in training and competition processes, it is reasonable to assume that lower limb strength asymmetry may also be present in Kyokushin athletes, as is observed in taekwondo practitioners, potentially contributing to injury risk.

Kyokushin karate involves numerous actions that utilize the stretch-shortening cycle. Athletes engage in plyometric exercises during motor preparation. The Reactive Strength Index (RSI) is used to measure reactive strength and assess muscular power in plyometric efforts [8]. RSI is also applied in many sports unrelated to combat disciplines as an indicator of rehabilitation progress and return to full physical functionality [9, 10, 11]. However, no studies have investigated the use of RSI in injury prevention among karate athletes.

Considering the limited literature on indicators that may help identify non-contact injuries in Kyokushin karate, the aim of this study was to examine the relationship between asymmetries in strength and power and the occurrence of non-contact lower limb injuries, as well as the extent of asymmetry in these parameters. This study could serve as a starting point for further research in this area, as well as for discussions concerning potential preventive measures for Kyokushin karate athletes.

Material and Methods

The study involved 28 participants. The experimental group consisted of 2 women aged 22 and 13 men aged between 20 and 34 years (mean age 23.27 ± 5.35 years, body mass 77.43 ± 10.42

kg, body height 176.9 ± 7.73 cm). All participants were Kyokushin karate athletes who had competed at least at the level of the Polish Senior Championships or the Polish U21 Championships. Until the day of the examination, the participants had no history of joint injuries – other than contusions – affecting the hip, knee, or ankle joints. This allows for the exclusion of potential pathological changes in these joints as a confounding factor in the measurement results. The control group comprised 2 women aged 23 and 11 men aged between 23 and 25 years (mean age 23.54 ± 0.78 years, body mass 81.25 ± 15.34 kg, height 178.04 ± 8.0 cm). These individuals had no experience in Kyokushin karate or any other combat sports. None of the control participants had previously sustained injuries to the hip, knee, or ankle joints. The control group and the study group were compared in terms of lower limb strength and power asymmetry. All participants provided written, informed consent to participate in the study. The study protocol received a positive opinion from the Senate Research Ethics Committee of the Józef Piłsudski University of Physical Education in Warsaw, under decision number SKE 01-30/2024.

Anthropometric Measurements

After providing informed consent, each participant underwent anthropometric measurements and identified their dominant lower limb. Body mass was measured to the nearest 0.1 kg using a BSM170 medical scale. Body height was measured to the nearest 0.1 cm using a BSM170 digital stadiometer. Waist and lower limb circumferences were assessed with a precision of 0.5 cm using a standard measuring tape. Waist circumference was measured midway between the highest point of the iliac crest and the lowest point of the rib cage arch [12]. The following lower limb circumferences were recorded: thigh 1, thigh 2, shank 1, and shank 2 [13]. Measurements were taken first on the dominant lower limb, followed by the non-dominant one.

Range of Motion Measurements

Measurements of both active and passive ranges of motion were performed for the following joints: hip (flexion and extension), knee (flexion and extension), and upper ankle (dorsiflexion and plantarflexion). Measurements were taken for both lower limbs using the EasyAngle digital goniometer. Hip flexion was assessed in the supine position. The goniometer was attached with an elastic strap to the lateral surface of the thigh, 10 cm above the base of the patella. Once aligned parallel to the floor, the goniometer was calibrated. Upon signal, the participant performed active hip flexion. After reaching the active range of motion, the examiner applied additional force to obtain the passive range. Hip extension was measured in the prone position, using the same goniometer placement and method as described above for flexion. Knee flexion was assessed in the prone position, with the feet extending beyond the edge of the examination table. The goniometer was attached with an elastic strap to the mid-length of the shank, on its lateral surface. After aligning the goniometer parallel to the floor, the device was zeroed. Upon signal, the participant actively flexed the knee, followed by the examiner continuing the movement to determine the passive range. Knee extension range was measured using the same methodology but with the participant in the supine position. Upper ankle dorsiflexion and plantarflexion were evaluated in the prone position, with the feet extended beyond the examination table. For both measurements, the goniometer was aligned along the long axis of the fifth metatarsal bone. The feet were placed in a neutral position. Upon signal, the participant performed either dorsiflexion or plantarflexion. The procedure for the upper ankle joint followed the same methodology as previously described.

Lowe Limb Power Assessment

Following the stabilometric platform assessment, each participant performed a standardized warm-up. After the warm-up, testing was conducted on a dynamometric platform manufactured by JB Zb. Staniak. Three types of jumps were performed on the force platform: countermovement jump (CMJ), bilateral drop jump (DJ), and single-leg drop jump for the left and right lower limbs [14]. The CMJ was executed at the center of the dynamometric platform [10, 15]. The drop jumps were performed from a 30 cm box positioned 40 cm from the center of the platform [15]. Each jump type was performed twice, and the better result was used for analysis. Based on the collected data, the Reactive Strength Index (RSI) from DJ was calculated. All data were recorded using the MVJ6v0 software.

Muscle Strength Assessment

To evaluate maximal muscle strength, torque measurements of the lower limb muscle groups were conducted. The assessed groups were responsible for knee joint flexion and extension, as well as upper ankle joint dorsiflexion and plantarflexion. The testing was performed under static conditions. Each muscle group was tested three times, with each trial lasting 3 seconds. During each attempt, participants performed a maximal voluntary isometric contraction (MVC). Knee flexor and extensor strength was assessed in a seated position [16]. In the starting position, the hip and knee joints were both flexed at 90 degrees [16]. Assessment of dorsiflexor and plantarflexor strength of the upper ankle joint was also performed in a seated position [17], with the hip, knee, and upper ankle joints all positioned at 90 degrees [17]. Torque measurements were conducted using dedicated testing stations equipped with dynamometers (JBA Zb. Staniak).

Statistical Analysis

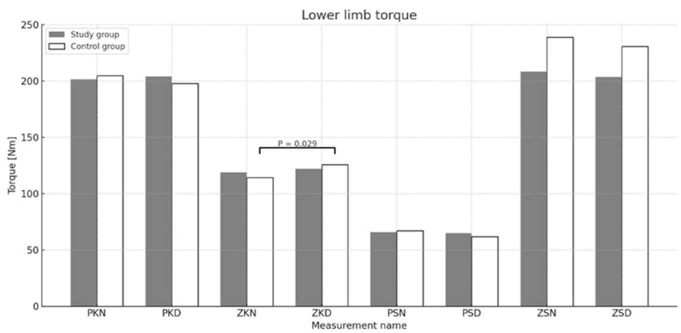
The normality of distribution for the examined variables was assessed using the Shapiro-Wilk test. To compare means, repeated measures ANOVA and Student's t-test were applied. In cases where the variable did not follow a normal distribution, the Mann-Whitney U test was used. Statistical significance was set at $p < 0.05$.

Results

No statistically significant differences were observed in the range of motion measurements for any of the assessed joints between the experimental and control groups. The most notable differences were found in the following movements: active dorsiflexion of the dominant lower limb's upper ankle joint (ZSCD), passive plantarflexion (WSPN), and active plantarflexion (WSCN) of the same limb. For ZSCD, the experimental group recorded a mean value of 43.2 ± 3.76 degrees, while the control group achieved 39.3 ± 9.28 degrees ($p = 0.148$). During WSPN, the experimental group reached 27.60 ± 6.27 degrees, and the control group reached 24.7 ± 3.38 degrees ($p = 0.147$). In WSCN, the experimental group achieved 24.3 ± 0.14 degrees, compared to 21.5 ± 3.02 degrees in the control group ($p = 0.136$).

In the control group, the knee flexors of the dominant lower limb were significantly stronger ($p = 0.029$) than those of the non-dominant limb.

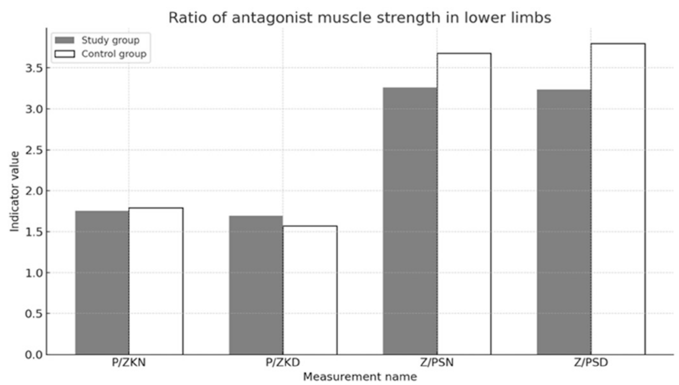
The ratio of knee extensors to flexors and upper ankle flexors to extensors did not differ significantly between the expe-



Z – flexors; P – extensors; K – knee joint; S – ankle joint; N – non-dominant lower limb; D – dominant lower limb; ⌐¬ – comparison of two parameters.

Fig. 1. Lower Limb Muscle Torque Values

rimental and control groups (Fig. 2). Statistical analysis also revealed no significant differences between the dominant and non-dominant limbs within either group.



Z – flexors; P – extensors; K – knee joint; S – ankle joint; N – non-dominant lower limb; D – dominant lower limb.

Fig. 2. Ratio of Antagonistic Muscle Group Strength

Table 1. RSI Values

Measurement Type	Study Group		Control Group		p-value
	Mean	± SD	Mean	± SD	
CMJ	1.870	0.346	1.551	0.467	0.048
DROP	2.275	0.706	1.883	0.585	0.086
DROP N	1.177	0.335	0.994	0.267	0.127
DROP D	1.185	0.354	1.002	0.265	0.138

CMJ – countermovement jump; DROP – bilateral drop jump; DROP N – single-leg drop jump for the non-dominant lower limb; DROP D – single-leg drop jump for the dominant lower limb.

Discussion

The aim of this study was to assess lower limb asymmetry in terms of muscular strength and power in Kyokushin karate athletes as potential contributors to non-contact injuries, and to consider physiotherapy as a preventive strategy. In the study of Kapinski et al., muscle torque, range of motion, stabilography and dynamic strength were shown as indicators of changes in the Achilles tendon morphology, which can lead to contactless injuries in athletes [18]. The primary observation from the conducted research is that Kyokushin karate athletes demonstrate a high degree of symmetry in the examined parameters.

The study was designed to determine whether these parameters significantly differ from those observed in a non-training population, and whether a significant difference exists between the dominant and non-dominant lower limbs among the athletes.

Lower limb muscle strength did not distinguish Kyokushin karate athletes from the non-training population (Fig. 1). However, unlike the control group, the karate practitioners exhibited symmetry in the strength of the knee flexors between the dominant and non-dominant limbs (Fig. 1). A study involving 17 taekwondo athletes with at least three years of competitive experience (control group aged 22.9 ± 4.0 years, study group aged 21.0 ± 0.8 years) indicated that athletes in this discipline demonstrated asymmetry in plantar flexor strength between the dominant and non-dominant lower limbs [7]. In isokinetic testing of maximal muscle strength, athletes practicing a style of karate other than Kyokushin achieved significantly lower peak torque in the dominant limb at angular velocities of 60 and 120°/s [19]. Similarly, in judo – which also involves side dominance – a study found lower peak torque values during knee extension of the non-dominant limb at 60°/s among judo athletes [20]. In contrast to these findings, Kyokushin karate athletes participating in the present study demonstrated symmetry in the strength of the tested lower limb muscle groups (Fig. 1).

Another observation from the conducted study was the absence of differences in the ratio of flexor to extensor strength in the upper ankle joint and extensor to flexor strength in the knee joint between the dominant and non-dominant limbs among the examined athletes. Studies on top-tier Polish football players demonstrated similar knee extensor-to-flexor strength ratios to those recorded in both the karate group and the control group, for both dominant and non-dominant limbs [21]. According to data presented by Korbolewska et al. [21], football players achieved knee extensor-to-flexor strength ratios ranging from approximately 1.5 to 1.7. Karate athletes in the present study demonstrated values close to 1.7, while the control group showed values between approximately 1.6 and 1.8 (Fig. 2). A study on overweight Japanese adults, both before and after weight normalization, indicated a flexor-to-extensor strength ratio for the upper ankle joint of approximately 3 (2.59 before weight reduction, 3.02 after) [22]. The results obtained by the karate athletes in the current study were very similar for both the dominant and non-dominant limbs (Fig. 2), while the control group significantly exceeded these normative values (Fig. 2).

Among the karate athletes, significantly higher RSI values were observed during the countermovement jump (CMJ) compared to the control group. This is likely due to the specific nature of Kyokushin karate, which frequently utilizes the stretch-shortening cycle. Furthermore, studies on female volleyball players – who also often rely on the stretch-shortening cycle – suggest that asymmetry in RSI values between limbs may constitute a risk factor for injury [23]. Additionally, the literature describes the RSI as a valuable tool for assessing return-to-sport readiness in athletes after ACL reconstruction [24], and it has been found to better reflect asymmetry between the injured and uninjured limb [14, 24]. In the present study, no significant differences were found between the dominant and non-dominant limbs in either group (Tab. 1). The high degree of RSI symmetry between the lower limbs may indicate a low risk of injury among Kyokushin karate athletes.

This study had several limitations that may have influenced the results. The control group consisted of students from the University of Physical Education. Although they had never practiced combat sports, the control group exhibited a level of physical fitness that exceeded the average for the general population. Another limitation was the small number of female participants. Only two female Kyokushin karate athletes, who met all inclusion criteria, agreed to participate in the study. Additionally, the measurement procedures may not have sufficiently replicated the conditions under which athletes perform motor tasks characteristic of their sport. As a result, it is not possible to analyse differences in outcomes between sexes. Athletes at the competitive level described in this study are subject to supplementary motor training, which affects the parameters being assessed, making it difficult to isolate the influence of karate training alone on the observed outcomes.

Conclusions

Kyokushin karate training contributes to the symmetrical development of lower limbs in terms of strength, power, and neuromuscular control. The observed symmetry in these parameters cannot be considered a direct cause of non-contact lower limb injuries in this group.

In this group of athletes, physiotherapy or supplementary training is not required to correct asymmetries in lower limb muscle strength and power.

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