TITLE OF THE DOCTORAL THESIS

ACUTE IMPACT OF A SIMULATED WKF KARATE BOUT ON THE INTER-LIMB ASYMMETRY PROFILE OF SELECTED KINETIC VARIABLES IN POLISH NATIONAL TEAM ATHLETES

ABSTRACT

Theoretical background: The physical and physiological profile of elite World Karate Federation (WKF) athletes remains insufficiently characterized. Biomechanical analyses of karate combat indicate that most technical actions rely on explosive movements, such as punches and kicks, whose effectiveness is largely determined by muscular strength and, critically, the rate of force development (RFD). Given the limited time available to execute a strike, athletes are often unable to reach maximal force, highlighting the primary importance of RFD in karate performance. Although upper-limb techniques are typically faster, evidence suggests that lower limbs (LL) play a fundamental role in generating effective actions. Karate-specific stances and techniques are inherently lateralized, with athletes typically adopting a preferred side. In such positions, the dominant lower limb (DLL) supports approximately 70% of body mass during punching actions. Consequently, long-term exposure to asymmetrical biomechanical loading may promote inter-limb asymmetries. These asymmetries may induce compensatory mechanisms, alter locomotor biomechanics, and potentially increase the risk of non-contact injuries. Furthermore, the asymmetric nature of karate combat may influence the RFD profile of the LL, thereby affecting the athlete's ability to generate rapid acceleration during striking. Despite these considerations, empirical evidence examining the effects of a karate bout on inter-limb asymmetry remains limited. Therefore, there is a need to (a) better define the physical and physiological profile of elite WKF athletes and (b) evaluate inter-limb asymmetry in selected kinetic variables, including their acute responses to a karate bout. Such analysis may help identify neuromuscular fatigue thresholds and optimal time points for force generation, thereby contributing to the optimization of RFD characteristics. Additionally, it may clarify whether variables such as peak vertical force (PVF) and RFD are associated with competitive success and whether a certain degree of asymmetry is functionally advantageous. Assessing asymmetry across age groups may also provide insight into injury risk, particularly when asymmetry exceeds 15%, thereby informing preventive strategies, what may contribute to maintain long-term health of karate athletes.

Aims and hypotheses of the study: The doctoral thesis includes two interrelated research stages. STAGE I aimed to conduct a systematic qualitative synthesis of recent literature to identify key physical and physiological determinants of elite karate performance across disciplines (*kata and kumite*). Additionally, the study sought to determine the most relevant motor abilities and commonly used assessment protocols. It was hypothesized that muscular strength and power are primary determinants of elite performance, regardless of specialization. STAGE II aimed to extend these findings through experimental investigation of elite kumite athletes across age categories (U16, U18, Senior), focusing on inter-limb asymmetry in kinetic variables (PVF and RFD) and the acute effects of a simulated karate bout (SKB). It was hypothesized that: (i) elite athletes exhibit inter-limb asymmetry influenced by limb dominance; (ii) the DLL demonstrates greater PVF, with asymmetry increasing with age; (iii) the non-dominant lower limb (NDLL) exhibits higher RFD values, with peak RFD occurring within 150 ms; (iv) SKB enhances PVF and RFD; and (v) successful athletes display greater bout-induced changes in asymmetry.

Research methodology: Two methodological approaches were applied: a systematic review conducted according to PRISMA guidelines (STAGE I) and a randomized crossover experimental design (STAGE II). The literature search (2012–2024) included PubMed, EBSCO, and Scopus databases. In STAGE II, 61 athletes from the Polish National Karate Team participated. The experimental condition (EXP) involved a simulated karate bout (2–3 minutes, depending on age), while treadmill walking at 4 km/h served as the control condition (CTRL). Kinetic variables of the LL were assessed using the isometric mid-thigh pull (IMTP) test performed on a force plate to determine PVF and RFD.

Main research outcomes and conclusions: Muscular strength and power, particularly of the lower limbs, are key determinants of performance in WKF karate. Elite kumite athletes demonstrate inter-limb asymmetry in PVF and RFD; however, the acute impact of a simulated bout on asymmetry was not consistently observed. The SKB induced acute increases in PVF (U16, U18) and RFD (U18, Senior), likely reflecting post-activation performance enhancement. Contrary to initial assumptions, the DLL was not consistently associated with higher PVF, while the NDLL tended to produce higher peak RFD values, with age-related variability. Across all age groups, peak RFD was typically achieved within 150 ms. Competitive success may be associated with greater asymmetry changes in strength profiles. Although this may also correspond to an elevated risk of non-contact injury in senior athletes.

Key words: martial arts, physical profile, physiological profile, muscular strength, sports training, IMTS test, isometric strength, sports injuries, RFD, muscle power