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ORIGINAL ARTICLE

# Acceleration time, peak torque and time to peak torque in elite karate athletes

*Le temps d'accélération, le pic de force et le temps pour le pic de force chez les athlètes d'élite en karaté*

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## KEYWORDS

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Muscle strength;  
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Knee;  
Elbow

## Summary

**Aim.** – To assess the bilateral differences in peak torque normalized by the body mass (PT/BM), acceleration time (AcT) and time to peak torque of the knee and elbow muscles of elite karate athletes, in order to identify risk factors for injury.

**Methods.** – Seven male elite karate competitive athletes were evaluated in an isokinetic dynamometer at 60°/s and 360°/s.

**Results.** – No bilateral difference was found in any of the variables on the knee flexion and extension assessment ( $P > 0.05$ ). The elbow assessment revealed higher values of PT/BM in elbow flexion ( $P = 0.02$ ) and a smaller AcT in elbow extension ( $P = 0.01$ ) at the 60°/s speed on the dominant limb when compared to the non-dominant limb. At the 360°/s speed, the non-dominant elbow presented a smaller AcT in elbow extension when compared to the dominant limb ( $P = 0.05$ ). Moreover, the data regarding the flexor/extensor ratio on both joints revealed values that have been related to an increased risk of joint injury in young athletes.

**Conclusion.** – Our results indicate that the functional demands of regular competitive karate training are not necessarily bilateral strength differences induced-factors in male karate elite athletes, especially considering that similar bilateral differences were found previously in healthy non-athletes. However, the competitive regular training of this martial art could produce agonist-antagonist muscle asymmetries that could predispose these athletes to injuries in the elbow and knee joints.

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**MOTS CLÉS**

Arts martiaux ;  
Force musculaire ;  
Lésions sportives ;  
Genou ;  
Coude

**Résumé**

*Objectifs.* – Évaluer chez les athlètes d'élite en karaté, les différences du pic de force normalisé par le poids corporel (PF/PC) des muscles extenseurs-fléchisseurs de la jambe et du coude, de l'accélération angulaire de ces muscles (TAc), et de leur temps de contraction, entre les membres gauches et droits. Cette étude se propose d'identifier des facteurs de risque d'accidents liés aux réponses à l'entraînement.

*Méthodes.* – Sept athlètes d'élite de karaté du sexe masculin ont été évalués sur un dynamomètre isocinétique, en utilisant les vitesses angulaires de 60°/s et 360°/s.

*Résultats.* – On n'a pas pu trouver de différences bilatérales, pour aucune des variables étudiées en extension ou en flexion du genou ( $p > 0,05$ ). L'évaluation fonctionnelle des muscles du coude permet de montrer que les muscles fléchisseurs du membre dominant ont des valeurs de PF/PC supérieures au côté opposé, alors que les muscles extenseurs ont un TAc plus bas du côté dominant à la vitesse de 60°/s ( $p = 0,01$ ) par rapport au membre non dominant. À la vitesse de 360°/s, le coude non dominant présente des valeurs inférieures de TAc pour les extenseurs par rapport au membre dominant ( $p = 0,05$ ). Les valeurs du rapport fléchisseur/extenseur pour les deux articulations suggèrent un risque potentiel accru de lésions chez ces jeunes athlètes.

*Conclusion.* – Les résultats indiquent que les exigences fonctionnelles de l'entraînement pour la compétition n'induisent pas nécessairement des différences bilatérales chez les athlètes d'élite en karaté, d'autant que des différences similaires ont été trouvées dans d'autres études chez des sujets non athlètes. Toutefois, l'entraînement régulier en karaté peut produire des asymétries entre les muscles agonistes et antagonistes qui pourraient prédisposer ces athlètes à des lésions des muscles mobilisateurs du genou et du coude.

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**1. Introduction**

Asymmetries between dominant and non-dominant limbs have been related to an increased risk of injury in athletes [1,2]. Imbalances between the agonist-antagonist muscles of the knee and elbow have also been linked to a greater susceptibility to injury in these joints [2–4]. Elite athletes may develop significant muscular asymmetries in response to daily high demand sports training, and the specificity of the sport gestures may lead to muscle imbalances that could predispose these athletes to injuries [5–7]. Therefore, the assessment of the muscular function of elite athletes is relevant in order to identify muscle imbalances and establish injury prevention programs.

The isokinetic dynamometer has been widely utilized to assess the muscle performance of athletes [2–4,6–15] in order to identify specific adaptations related to sports practice and important muscle imbalances that could be related to injury predisposition. In isokinetic testing, the peak torque variable is considered the "gold standard" measurement [16,17] and, therefore, it is an important parameter to be assessed, especially in the athletic population. However, it has been stated that strength measurements do not reflect muscle performance characteristics comprehensively and muscle balance considerations should not be limited to analysis of strength parameters [18]. Parameters such as acceleration time and time to peak torque have been established in the literature as muscle recruitment variables that provide valuable information regarding neuromuscular readiness to produce maximal contractions [17,19,20]. The ability to produce torque quickly is an important skill in most athletic endeavors and the assessment of muscle recruitment patterns in athletes may provide better indications of the functional performance than the evaluation of peak torque alone [17]. Through a more comprehensive isokinetic

assessment, muscle recruitment issues may be identified and neuromuscular control interventions may be implemented for injury prevention or in the rehabilitation of injured athletes.

Karate is currently considered one of the most widely practiced system of Japanese martial arts in the world [21]. Its practice requires high technical skill accompanied by a great ability to perform strikes and kicks as fast as possible [15,22,23] and the practitioners are continuously challenged in performing very complex actions with precision and high velocity to adequately execute effective attack and defense techniques in combat [15,24]. Therefore, the musculature involved in these actions needs to be quickly recruited in maximal effort, which highlights the importance of assessing isokinetic parameters such as acceleration time, peak torque and time to peak torque in this population. Rehabilitation specialists should also be aware that karate athletes spend a great deal of time training in positions that could place significant amount of stress on joints such as the hips, ankles and especially the knees [11,22]. Thus, a better understanding of the muscle performance of these athletes may be of great usefulness in injury rehabilitation and prevention centers.

Muscle imbalances around the knee joint have been studied in several populations and it has been proposed that decreased hamstrings relative to quadriceps strength is implicated as a potential mechanism for lower extremity injuries [2,3,8,12,13,25]. Deficits in relative hamstrings strength and recruitment may contribute to increased anterior cruciate ligament (ACL) injury risk in athletes, considering that hamstrings activation can decrease the load on the passive restraints of the knee [26], increase the knee joint compression force, and stabilize the knee from external varus/valgus loads [27].

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