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# A BRIEF REVIEW: NEUROMUSCULAR FUNCTIONS OF COMBAT SPORTS DURING DIFFERENT TYPES OF JUMPS

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**Abstract:**
The aim of this research is to study the effect of different jumping types on vertical jumps, between athletes of different combat sports and non-athletes. The jump types investigated were squat jump (SJ), countermovement jump (CMJ) and drop jump (DJ), where in the latter case we distinguished two different height distances (20 cm and 40 cm). The neuromuscular activation of the athletes shows better neuromuscular coordination and greater maturation than non-athletes. Although vertical jumping ability is not consistent with the technique of a combat sports athlete, however, it can be a powerful reference factor at the level of athletes when combined with individual power indices.

**Keywords:** jumping types, combat sports, neuromuscular function

## 1. Introduction

In international scientific literature there are relatively few studies and researches on the power of the lower limbs and the use of jumping tests for diagnosis as well as the extraction of safe conclusions about the improvement of vertical jumping (plyometric training) in individuals participating in combat sports (CS) such as karate and kickboxing (K/KB) (Doria et al., 2009). These CS require high-level technical skills, motion control both in static and dynamic situations, ability to accurately execute actions and movements (hits and kicks), execution moves that are both powerful and explosive (Sørensen, Zacho, Simonsen, Dyhre-Poulsen, & Klausen, 1996; Zehr E. p., Sale D. G, & Dowling J. J, 1997).

The power is defined as the ability to achieve the highest possible strength values in the unit of time (<250 mm / sec). In particular, according to Enoka (2003) the

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power is divided into: a) the explosive force; b) the starting force; and c) the reactive force (Enoka et al., 2003).

Blazevich (2012) report that reactive force is the ability to use accumulated elastic energy and activate the muscles more through the proprioceptive receptors (muscular spindle and tendon organs Golgi) during the stretch-shortening cycle (SSC) (Blazevich, 2012). The forms of movement observed in a SSC are characterized as reactive and the generated force reactive force or reaction force. The starting force or initial force is the ability to develop as much force as possible (vertical growth) immediately after the start of the movement (contraction), approximately in the first 15-20 msec. Explosive force is the ability to develop as rapidly as possible very high force values, that is, a vertical force development is realized. It is defined exclusively in the time of maximum force increase (Kraemer, Deschenes, & Fleck, 1988; Kraemer W. J, Fleck S. J, & Evans W. J, 1996).

Explosive force is one of the most important and significant physical abilities, and along with the speed of movement, which varies from athlete to athlete, it is responsible for both aggressive and defensive movements especially in CS. Speed, strength and relationship between them (power) is a feature of adapting long-term training to experienced karate athletes (Zaggelidis & Lazaridis, 2013; Zehr, Sale, & Dowling, 1997).

## 2. Power in combat sports

In most CS, a set of factors is required to achieve the best possible result, such as technique, aerobic and anaerobic ability, strength, speed and power. None of these characteristics affects performance individually in CS (Chaabene, Hachana, Franchini, Mkaouer, & Chamari, 2012). In addition, CS are based on the balance between power and maximum oxygen uptake ($VO_{2max}$) capacity to maximize their performance (Machado, Osório, Silva, & Magini, 2010). Power as already mentioned is an important factor in an athlete's physical condition and contributes to improved performance and derived from the combination of strength and speed of the athlete (Reiser, Maines, Eisenmann, & Wilkinson, 2002; Roschel et al., 2009). Muscular power (MP) and anaerobic ability are essential for athletes who have punches and kicks to perform as soon quickly as possible with the ultimate goal of gaining points or even put their opponent "knock out" specifically to K/KB (Thomas, G. N., Hong, A. W., Tomlinson, B., Lau, E., Lam, C. W., Sanderson, J. E., & Woo, 2005). In these sports the high explosion and power in lower limbs is necessary at jump kicks, standing kicks and airborne kicks (Elsawy, 2010; Roschel et al., 2009) as they play an important role in the performance of the athlete (Roschel et al., 2009). Power tests between national and international karate athletes differ in terms of maximum power (Koropanovski et al., 2011). The maximum explosive power is an important element for most athletic performances and is also decisive in performance of CS (Cronin & Crewther, 2004). For this reason, the maximum

explosive force of the lower limbs is often referred by means of the vertical jump (Lazaridis et al., 2013; Zaggelidis, Lazaridis, Malkogiorgos, & Mavrovouniotis, 2012).

It is very important that the performance in CS depends more on the muscular strength of the lower limbs than on the upper limbs, since the decisive movements in these sports depend on the explosive muscular force in the upper limbs and mainly at the lower limbs (Faraji, H., Nikookheslat, S. D., Fatollahi, S., & Alizadeh, 2016). It has been found by various studies that there are differences in performance between high and low level CS athletes, which refer to maximum strength, lower leg strength, vertical jump and maximum speed, while simultaneously emphasize that the needed improvement of speed and explosives in order to improve the performance (Nikookheslat S. D, Faraji H, Fatollahi S, & Alizadeh M, 2016; Roschel et al., 2009).

To improve CS performance, fast and explosive movements on kicks and punches are required (Pozo, Bastien, & Dierick, 2011; Roschel et al., 2009). Other research has shown that speed is the main factor determining the performance of karate athletes, and the explosive strength of the lower limbs is also useful for predicting karate performance (Blazevich, 2012; Simonović, Bubanj, Projović, Kozomara, & Bubanj, 2011).

**2.1 Plyometric training and vertical jumps**

Improved vertical jump is achieved through different types of training such as weight training, electro-stimulation and plyometric training (Imamura, Yoshimura, Uchida, Nishimura, & Nakazawa, 1998). It is worth noting that the plyometric training leads to the greatest improvement in the jumping ability (Markovic, Vuk, & Jaric, 2011). The adaptations that occur to this type of training referred both to the nervous (Kyrdltiinen & Komi, 1995) and the musculo-tendons system (Foure, Nordez, & Cornu, 2012).

This type of training mainly uses jumping exercises (plyometrics), which are the main training tool for improving the explosive force, while at the same time improving the neuromuscular coordination but also the three forms of the force (starting, reactive and explosive force) (Willoughby, Stout, & Wilborn, 2007). Factors that affect the intensity of this type of exercise are the type of jump, the height of drop, the contact time and body weight of the trainee (Arampatzis A, Stafilidis S, Morey-Klapsing G, & Brüggemann G. P, 2004; Lazaridis et al., 2013).

According to the Bosco (1985) research, a 20-40 cm DJ induce a power improvement, while the 40-60 cm DJ induce improves of the explosive power at the concentrate and eccentric phase of the jump and in the performance of the vertical jump (Bosco, 1985). The same author reports that the vertical jump should be accompanied by a high take-off speed (Bosco, 1985). Also, Papadopoulos (2014) reported that the CS athletes present statistical differences in all jumps (SJ, CMJ, $DJ_{20cm}$ & $DJ_{40cm}$) in relation to non-athletes. Athletes induced shorter contact time, higher vertical ground reaction forces and better evaluation of SSC in all phases of the examined jumps (Papadopoulos N. K., 2014).

## 3. Discussion

In recent years, the field of training given special meaning to the plyometric exercises because of their structure and the similarities they present in relation to the sport specific skills in most sports and especially in K/KB (Margaritopoulos, S., Theodorou, A., Methenitis, S., Zaras, N., Donti, O., & Tsolakis, 2015). Miarka et al. (2011) using three different protocols that included strength exercises, plyometric exercises, and a combination of both showed that the plyometric exercises as well as the combination of plyometric exercises and strength exercises had the best effect on the performance of the participants (Miarka, B., Del Vecchio, F. B., & Franchini, 2011).

## 4. Conclusion

In conclusion, plyometric exercises (like DJ) are a precious and indispensable tool of the coaching process for most sports today that require the development of high power like CS and especially the K/KB. The vertical jumps can be an instrument for both K/KB athletes and their coaches to improve their training programs through biomechanical benefits and neuromuscular functions.

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