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Application of Sport Science in Kyokushin Karate

Austėja Navickaitė and Gavin Thomas review the demands of kyokushin karate, recommend a battery of fitness tests, and provide training recommendations for sport scientists and coaches working with kyokushin karatekas.

Introduction

Karate is a popular combat sport, practiced across 202 nations with 42038 clubs registered (SPORTDATA, 2022). Kyokushin karate originated from Okinawa where it was founded by Masutatsu Oyama in the 20th century. When reviewing the demands of kyokushin karate, it is important to define the two disciplines: kumite and kata. Kumite is a fight between two opponents, whereas kata is a sequence of movements performed by the karateka alone. As kyokushin karate is a full contact combat sport, the main criteria that kumite performance is judged on is the damage that the karateka has caused to their opponent. Therefore, kyokushin karate is often considered to be the hardest and the most aggressive style of karate. A kumite fight lasts up to 3 minutes. If the judges and referee cannot decide on a clear winner, an extension of 2 minutes can be granted 3 times. Like most martial art competitions, kumite contestants are divided into five weight categories, for both males and females. The European guidelines for these weight categories are as follows: lightweight ($M = <65\text{kg}$; $F = <50\text{kg}$), middleweight ($M = <75\text{kg}$; $F = <65\text{kg}$), light heavyweight ($M = <85\text{kg}$; $F = <60\text{kg}$), heavyweight ($M = <95\text{kg}$; $F = <65\text{kg}$), super heavyweight ($M = \geq 95\text{kg}$; $F = \geq 65\text{kg}$) and open weight. Within this article we review the demands of kyokushin karate, recommend a battery of fitness tests and provide training recommendations for sport scientists and coaches working with kyokushin karatekas.

Demands of kyokushin karate

Physiology

Due to the length of a kumite fight (9 minutes maximum) the aerobic energy system is the predominant one, followed by the anaerobic lactic system which fuels combinations of explosive punches and kicks. The anaerobic lactic energy system has the lowest contribution during a fight but becomes key during

prolonged attacks involving frequent strikes. It should be noted, the distribution of energy systems used during a fight will largely vary depending on the tactics employed and possible changes in the length of a fight due to knockouts or match extensions. Nevertheless, a kumite match is often executed using high intensity intervals. In kata, the distribution of energy system contribution is similar. Aerobic metabolism is still the predominant one, however its contribution is significantly lower than in kumite. Whereas the anaerobic lactic metabolism has significantly higher contribution in kata. Anaerobic lactic metabolism still has the lowest contribution (Doria *et al.*, 2009). These differences may be due to the time frame of kata being less (approximately 1 minute) and including explosive combinations of varying speed. Further research is needed to confirm energy contribution between the two disciplines.

Regardless of the discipline, aerobic capacity is essential to prevent fatigue during training, during the breaks between bouts of activity within a competition and to improve the recovery process between competitions. $\dot{V}O_{2\text{max}}$ values for elite male karatekas have been found to range from 47.8 ± 4.4 to 59 ± 6.6 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ whereas $\dot{V}O_{2\text{max}}$ values for elite female karatekas have been reported to be slightly lower at 42.9 ± 1.6 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ (Chaabène *et al.*, 2012). When evaluating the anaerobic abilities, explosive power is an integral component for karatekas. Using the Brazilian Karate National Team, Roschel *et al.* (2009) confirmed this by comparing different power values in 'winners' and 'losers' from kumite matches. Power generated at 30% 1RM was found to be very valuable as 'winners' produced 11% and 23% significantly more power in the squat and bench press, respectively (Roschel *et al.*, 2009). Successful karatekas will often be more powerful using lighter loads, this makes sense, as striking in karate involves no external load.

Movement analysis

Movement analysis focuses on punches and kicks as they are the factors that contribute to points being awarded. A common kick is mawashi geri (see figure 1) which can be executed in under 1.3 seconds with a peak impact force of approximately $14 \text{ N} \cdot \text{kg}^{-1}$ by an advanced karateka. This kick, also known as the roundhouse kick, involves many muscles including biceps femoris, quadriceps femoris and all the knee flexors (artorius, semitendinosus, gracilis, popliteus, gluteus maximus, gastrocnemius). Another common kick in kyokushin karate is nae geri which can be executed in approximately 1 second with a peak impact force of approximately $60 \text{ N} \cdot \text{kg}^{-1}$. Regarding punches, Dinu & Louis (2020) using boxers found the uppercut has the highest maximal punching force $44 \text{ N} \cdot \text{kg}^{-1}$, followed by the cross ($42.9 \text{ N} \cdot \text{kg}^{-1}$) and the hook ($40.7 \text{ N} \cdot \text{kg}^{-1}$). However, the hook has the highest maximal punching velocity ($11.2 \pm 2 \text{ m} \cdot \text{s}^{-1}$) compared to the uppercut ($10.2 \pm 1.8 \text{ m} \cdot \text{s}^{-1}$) and the cross ($8.1 \pm 2.1 \text{ m} \cdot \text{s}^{-1}$). Proximal-to-distal generation of force, starting with pelvis rotation ensures maximal impact force during execution of punches. Flexion and extension of the elbow play a significant role during the cross and the jab, whereas the uppercut and the hook are more dependent on the contribution of the shoulder. Regardless of the strike used, maximum force is needed at the distal end of a kinetic chain to ensure higher impact and more damage to the opponent. This can be achieved through a higher degree of acceleration.



Figure 1. The mawashi geri is a common kick in kyokushin karate.

Table 1: Battery of fitness tests for karatekas and supporting comments

Vertical Jump	Measure of lower-body power.
Single Arm Medicine Ball throw	A 2kg medicine ball thrown on both sides, conducted in the relevant stance that mimics the open kinetic chain of the punching action is recommended.
Reactive Strength Index (RSI)	Is recommended to indicate stretch-shortening cycle ability, RSI is determined by height jumped/ground contact time.
1 RM Squat and Bench Press	Used to evaluate lower and upper body maximum strength.
15s Continuous Jump Test	A more appropriate anaerobic capacity measure for karatekas than the Wingate test due to jump ability and the stretch-shortening cycle being important performance factors.
Karate-Specific Aerobic Test	A valid and reliable means of measuring aerobic fitness. Karatekas complete a set sequence of roundhouse kicks and straight punches on a suspended heavy bag. Using a Karate-Specific Aerobic Test instead of the more common treadmill or cycle ergometer. $\dot{V}O_{2\text{max}}$ test will allow higher ecological validity.

Injury analysis

Generally, in karate the most common types of acute injuries are contusions, bruises, and abrasions followed by bleeding, hematomas, and epistaxis. In kyokushin karate contusions are experienced by most fighters during competitions. As high impact kicks are received to the head during kumite competitions, this can result in head and neck injuries, such as concussions. Joint injuries, muscle and fascia damage and torsions are also common injuries that are experienced during kumite competitions. These usually occur at the limbs. In a full contact combat sport, it is impossible to completely avoid injuries such as contusions, bruises, or bleeding. However, common strains, sprains and even dislocations of the lower extremity (knees and ankles), can be prevented or at least minimized by strengthening the surrounding muscles, tendons, and ligaments.

Fitness tests

Based on the demands of kyokushin karate a battery of tests has been suggested. Sport scientists and coaches are encouraged to conduct the tests in the order described in Table 1 as this will help to mitigate against the negative effects of accumulated fatigue as the karateka progresses through the testing battery.

Training recommendations

When considering periodisation for karatekas' training, multi-targeted block periodisation is recommended, as this allows preparation for multiple events and the development of multiple qualities (e.g., aerobic fitness, strength, power, and acceleration). Since the aerobic energy system is likely to be the predominant energy system during a fight, it is suggested that aerobic training is prescribed concurrently with resistance training.

High Intensity Interval Training (HIIT)

HIIT is recommended to develop aerobic fitness while minimizing the concurrent effects of combining aerobic and resistance training. Sparring-based HIIT sessions are recommended to allow sport specific adaptations without a large diminishing effect on resistance adaptations. An example HIIT sessions may consist of 4 – 6, 30 second all-out intervals with 3-to-4-minute rest.

Resistance training

Resistance training should focus on the development of power, strength, and acceleration, as these qualities contribute to achieving maximal impact when executing strikes – essential for kyokushin karatekas. It is recommended that strength development would be targeted initially with the aim of enhancing the potential to improve power output in the subsequent training phase. As a wide variety of unilateral movements are performed in kumite matches unilateral strength development is recommended to increase the sport-performance carryover. Example exercises include lunge variations, split squats, and single leg exercises such as single leg Romanian deadlifts and single-arm landmine presses.

For power development, we recommend using Olympic weightlifting derivatives, resistance bands (chains), and plyometric training. Olympic weightlifting derivatives allow acceleration and high velocity throughout the entire movement which is highly beneficial for karatekas as it relates to punching acceleration and impact force. Example exercises include jump shrug, power clean from hang and split jerk. Applying resistance bands or chains to traditional resistance exercises (e.g., Squat and bench press) mimics the increase in resistance during a strike upon collision. Therefore, using bands or chains in power development sessions allows sport specific adaptations needed for karatekas. Plyometric training enhances the stretch-shortening cycle which transfers to the kicking and punching actions in karate. Example exercises include box jumps, drop jumps, scissor lunges, single arm—medicine ball throws and push up claps.

Additional considerations

Considering the high impact forces when receiving a kick to the head, neck strengthening exercises, such as isometric band holds, may be beneficial to help prevent concussions – although further research confirming this is needed. Kicks may also be improved through flexibility training, especially for the lower body. To improve flexibility, proprioceptive neuromuscular facilitation at the end of training sessions is recommended. ■

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