

9. Physical Preparation

Technique, strategy and state of mind are fundamental aspects of fighting. However, without good physical preparation, these factors may be ineffective. In karate (as in all combat sports), it is important to develop an athletic muscle mass that is capable of explosive moves and movements, all against a background of variable levels of endurance depending on the discipline and objective.

In this section we will analyse some physiological principles and concepts that are useful for physical preparation.

This section largely summarises two popular works: an anonymous text found on the web (<http://mapage.noos.fr/nicoach1/download/basesphysio.pdf>) and the guide *Muscle et fitness du HIIT*. Muscle & Fitness, 2010.

For anyone wishing to extend their understanding of the issues raised in this section, we recommend the books by J. Ferré and D. Reiss that you will find in the references.

9.1 Physiological Principles

9.1.1 Sources of Energy

Muscles use different sources of energy depending on the intensity and duration of an exercise.

At the cellular level, the energy source is adenosine triphosphate (ATP). ATP is a molecule consisting of adenine and ribose attached to three phosphate groups. Energies released when a phosphate group is detached from the ATP molecule:

ATP → ADP + Pi + Energy (ADP: adenosine diphosphate, Pi: phosphate).

ATP is present in the muscle in small quantities. As these reserves cannot maintain a contraction for more than three seconds, other sources of energy must recharge the ATP.

ATP cellular synthesis

1. The anaerobic pathway does not make use of oxygen (O₂). It is used for short, intense efforts.

a. For efforts of a few seconds at maximum intensity, ATP is renewed through the **creatine phosphate** (CP) cell reserve. This is an **anaerobic alactic** process. Beyond seven seconds, the muscles must use other resources.

b. For intense efforts of longer duration (30 seconds to two minutes), **glucose** produces the energy required for ATP

synthesis. This is **alactic anaerobic** process; i.e.it releases a significant amount of lactic acid (associated with muscle pain).

2. The aerobic pathway involves O_2 . It is used for long-lasting efforts and efforts of moderate intensity.

This system utilises the oxidation of **carbohydrates, lipids and proteins**. The presence of O_2 allows functioning of moderate intensity but for a long time. This path produces “residues” that have little influence on fatigue: **water** (H_2O) eliminated through sweating and **carbon dioxide** (CO_2) eliminated by expiration.

When the duration of the effort increases, the proportion of glucose used decreases in favour of lipids.

Capacity and Power

Capacity is the total amount of energy available.

Power is the maximum amount of energy used per unit of time.

Each energy path has capacity and power.

The energy pathways in summary:

- 1) Anaerobic alactic: creatine phosphate— in the muscle — without oxygen (O_2) — without producing lactic acid— Maximum capacity 20" —E.g. 60-100 m run.
- 2) Lactic anaerobic: glycolysis— No (or little) O_2 — Production of lactic acid— Capacity of 30 seconds to 2 minutes— E.g. 200-800 m run.
- 3) Aerobics: oxidising carbohydrates, lipids and proteins — With O_2 — H_2O and CO_2 produced— “Unlimited” capacity. E.g. 1500m-marathon

The three energy pathways are not involved in succession; they overlap gradually.

Intense, short-duration efforts are often used in karate, from a handful of seconds to several minutes. It is important, therefore, to prioritise working on and developing the anaerobic pathways. However, developing endurance and the aerobic pathway is useful if you want to make the most of a lesson of one or two hours or if you want to undertake one or more protracted fights.

Read more in the book "Karate: more than the move".

Various themes are discussed to understand and improve your practice:

- Breathing
- Adapting to exercise
- Oxygen debt
- Recovery times
- Adaptation to effort
- Aerobic and anaerobic thresholds
- Cardiovascular system
- Recovery and overcompensation
- Performance evaluation
- Field tests
- Training Planning.

9.3 HIIT

9.4.1 Introduction and definition

Traditional cardio-sessions are useful for improving endurance and burning fat. Intense and heavy weight-training programmes promote muscle mass.

HIIT (High Intensity Interval Training) consists of short but very intensive sequences (with any exercise* leading to a significant increase in heart rate) interspersed with recovery time or low-intensity work.

Basic HIIT example: after warming-up, run at 8 km/h for one minute, then accelerate to 16 km/h for another minute and drop back to 8 km/h and so on until you have done 8 repetitions of the same sequence, i.e. a total of 16 minutes of running.

() Examples: running, cycling, swimming, push-ups with jump squats, star jumps and any type of exercise that makes a large number of muscle groups work quickly and which is likely to raise the heart rate.*

This type of physical preparation takes into account the requirements of practitioners of combat sports fairly well. Furthermore, some of karate training drills may be similar to those of HIIT.

9.4.2 Principles of HIIT

During intense anaerobic training, lactate accumulates and oxygen debt is produced. This state is associated with a feeling of “burning” muscles caused by the H^+ released during ATP degradation. During the recovery phase, the cardiorespiratory system continues to work (the feeling of breathlessness) to supply the oxygen required to break down the lactate accumulated during the anaerobic exercise (oxygen debt).

This type of training forces the body to adapt by increasing its ability to use oxygen (VO_2 max) and the buffering systems, and by strengthening the cardio-respiratory muscles and enhancing the elimination of lactate (increased lactate threshold) whilst increasing speed and coordination. Even for high-level athletes, maximum intensity efforts can only be maintained for five to seven minutes (examples: five intervals with a maximum effort of

Sixty seconds or 15 intervals with 15 seconds at high intensity).

During this kind of effort, the body burns a maximum amount of sugars and generates oxygen debt. After the effort, the body, having exhausted its sugar reserves, will dip into its reserves of fat for several hours, which explains the fat burning.

Finally, the lactate produced during this kind of exercise seems to help boost the concentration of testosterone and growth hormones that aid recovery, muscle performance and growth.

9.4.3 Research examples

Tabata

In 1996, professor Tabata conducted a study on cycling with two groups of high-level athletes. The first group trained for an hour a day for six days out of seven at low intensity (70 % of VO₂ max). The second group trained for five minutes a day for six days out of seven with eight intervals of 20 seconds at high intensity (170 % of VO₂ max) followed by ten seconds of rest.

The study concluded that there was a significantly greater increase in the VO₂ max (endurance) in the HIIT group compared to the low intensity group. Furthermore, the HIIT group also improved its anaerobic capacity (power) in contrast to the low intensity group.

[Read more in the book "Karate: more than the move".](#)

Various themes on HIIT are discussed:

- Advantages
- Precautions
- The nutrition
- Practical Tips and tricks.
- Best intervals.