Project Marcialonga Science 2015

Dr. Pellegrini Barbara

The Marcialonga Science idea was an initiative of CeRiSM, research centre of Verona University, located in Rovereto (Trentino, Italy). The centre is interested in testing and evaluating cross-country skiing for many years, in addition to dealing with other individual outdoor sports, with international networks as well as appreciations. The general aim of the project Marcialonga Science was to further deepen the knowledge about cross-country skiing trough scientific investigations and experimentations performed in conjunction with Marcialonga appointments. Indeed, this international race host many athletes, from recreational to top level, thus providing an ideal scenario to investigate different aspects related to this sport.

For Marcialonga Science 2015, CeRiSM conducted an important investigation that involved 25 high-level cross-country skiers, thanks to the precious support of Marcialonga Committee, Fiamme Gialle military Group and Ski Stadium of Lago di Tesero (Trentino, Italy). The athletes were involved in four different tests. The first one was conducted the month before the race on a snowy ring track at the Ski Stadium of Lago di Tesero. It allowed the researchers to evaluate the involvement of different muscle compartments during double poling at increasing velocities, in addition to provide to the athletes useful indications for training intensities. Another part of the experimentation permitted to evaluate muscle fatigue after the race. Moreover, the researchers could monitor different interesting parameters during the race, through innovative smartwatches.

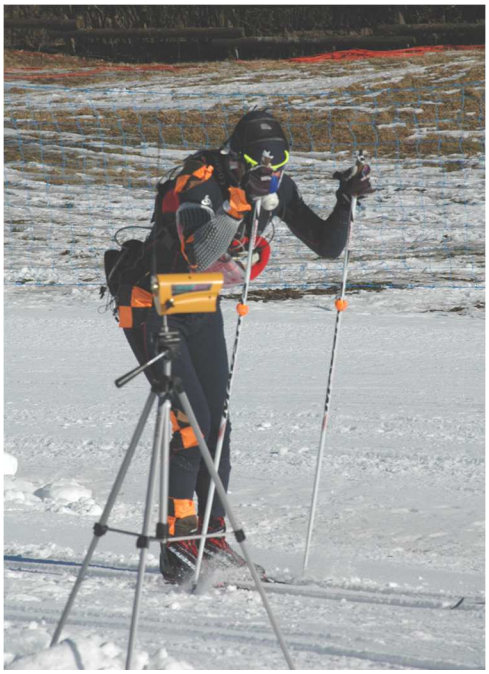
Marcialonga Science was renewed in 2016 with a different form: a questionnaire about training methodologies was filled out by about 1600 athletes of different performance levels. The results are now in processing.

Electromyographic and kinematic analysis of on-snow double poling

Dr. Zoppirolli Chiara

The aim of the study was to analyze muscle activation and cycle timing of on-snow double poling, at increasing velocities.

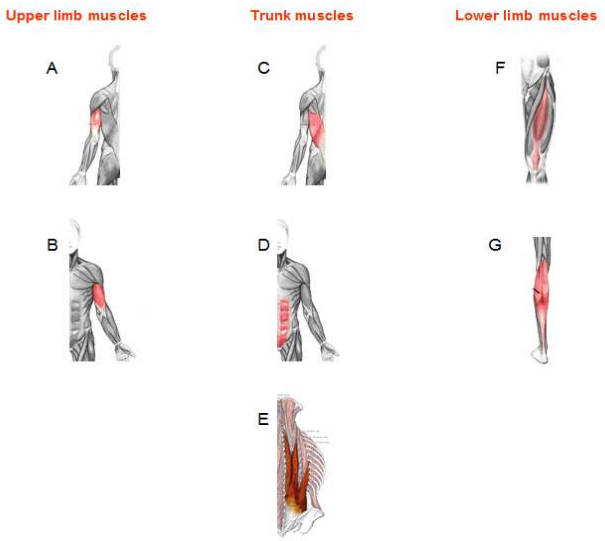
Figure 1



The data of 11 well-trained cross-country skiers have been analyzed. Each skiers was prepared before the experimental protocol. A wrist watch, with a tri-axial accelerometer incorporated, was worn by the athletes; it permitted to recognize the beginning and the end of each poling phase. Furthermore, the electromyographical activity of 7 muscles (triceps brachii, biceps brachii, latissimus dorsi, rectus abdominis, erector spinae , rectus femoris and gastrocnemius medials) was monitored by skin electrodes positioned in correspondence to the muscles of interest. The athletes skied on a snowy track of about 200 m, with the double poling technique only. An audio-pace system allowed the skiers to maintain constant and pre-determined velocities (15, 16.5, 18, 19.5, 21 km/h). Each trial lasted about 3 min. Finally, the skiers were asked to ski at a constant maximal velocity that could be sustained for about 3 min. A system of photocells permitted to measure and control the real velocities performed by the athletes.

The data demonstrated that the frequency of the movement was progressively increased while the poling time reduced, when increasing the double poling velocities. Triceps (Fig. 2 A) and biceps brachii (Fig. 2 B) activations were always high, independently from double poling velocity. On the other hand, latissimus dorsi (Fig. 2 C), rectus abdominis (Fig. 2 D), erectos spinae (Fig. 2 E), rectus femoris (Fig. 2 F) and gastrocnemius medialis (Fig. 2 G) showed an increasing activation.

Figure 2



Conclusions: the muscular involvement of trunk and lower limbs increases across velocities, while upper limb muscles are always very much involved during double poling, independently from velocity. Thus, larger-sized and more oxygen extracting muscles are recruited to face higher exercise intensities. Double poling technique changes accordingly to double poling velocity, making double poling a whole-body exercise at high velocities. This technical strategy allow the skier to limit cardio-vascular work and rate of effort perception at increasing velocities, as well as to improve poling force exertion at each poling cycle.

Race analysis: velocities and techniques recorded during the competition

Dr. Lorenzo Bortolan

The aim of the study was to determine the techniques used by the skiers along the race track. To this purpose, three different stages were thought: an analysis of the motion characteristics related to the different classic techniques of cross-country skiing with the creation of a discriminating algorithm, the data acquisition during the competition and the analysis of the results.

Step 1: During January 2015, a huge quantity of data were recorded for dozens of cross-country skiers who volunteered for the study, at the Ski stadium of Lago di Tesero. The skiers were asked to ski with pre-determined techniques or to training freely choosing their preferred technique. The aim of this step was to match the data acquired with the respective techniques executed, to create an algorithm that could automatically discriminate the different techniques.

Step 2: Immediately before the race, the skiers could wear a wrist-watch that was able to acquire acceleration and GPS signals, as well as heart rate.

Step 3: The data acquired during Step 2 were elaborated with the algorithm developed during Step 1, and combined with the exact position of the skiers during the race. Also heart rate could be analyzed synchronously. The integration of these parameters allowed to understand that for the athletes who finished the race within three hours, the 93% of the track was completed using the double poling technique, 5% using the diagonal stride, while only 2% with the double poling with a kick. These data confirmed that elevated use of double poling during long-distance cross-country skiing races.

Effects of fatigue in upper and lower limbs

Dr. Gennaro Boccia

For the neuromuscular part of the study, 19 subjects were involved. The test were performed a week before the race and immediately after, at the Ski Stadium of Lago di Tesero and in a lab prepared near the finish line, respectively. Maximum force and rate of force development (rapid force) of upper and lower limbs were measured during the neuromuscular test. Moreover, a discrimination between the central or peripheral origin of muscle impairment was possible through muscle stimulation.

The results of this study demonstrated that the fatigue induced by such a type of competition created a grater loss of rapid force in upper (-26%) than in lower (-11%) limbs. On the other hand, fatigue created a grater loss of maximum force in lower (-13%) than in upper (-6%) limbs. Muscle stimulation confirmed that muscle fatigue was elevated in upper limbs.

These type of measurements are important to improve the knowledge about the physiological effects of cross-country skiing and to give useful information to trainers. Indeed, the knowledge of the neuromuscular impairments after a long distance race permits to plan the training sessions more accurately.