The importance of anaerobic glycolysis and stiffness* in the sprints (60, 100 and 200 metres)

by Elio Locatelli

The author gives a detailed account of research carried out on 17 Italian athletes during the indoor and outdoor championships of 1994, with the object of assessing the importance of anaerobic glycolysis and muscle elasticity in the short sprint events. The data resulting from the research experiments was obtained through blood samples taken at intervals after each race.

Anthropometric details of each athlete are given together with performance results.

Firm conclusions are reached regarding the role played by anaerobic glycolysis in the 60 metres sprint, the relation between the phases of initial acceleration and of maintenance of speed, and the relation between the elastic strength of the locomotor muscles, anaerobic glycolysis and maintenance of speed.

Introduction

This research project was carried out in 1994 and was designed to study the importance of anaerobic glycolysis and muscle elasticity in the sprints (60, 100 and 200 metres), using as subjects top level athletes from the Italian national team.

17 athletes (13 men and 4 women) were tested during the 1994 Italian Championships, indoors for the 60 metres race and outdoors for the 100 metres and 200 metres (Figure 1). Their performances, equal to around 91-93% of the world record level for the men, and 89% for the women, were as follows:

- men
  - 60 metres = 6.78 ±0.05
  - 100 metres = 10.52±0.08
  - 200 metres = 21.12±0.15
- women
  - 100 metres = 11.71±0.15

The athletes gave their agreement for blood samples to be taken at the end of their races (after 2min, 4min and 6min in the 60 and 100 metres and after 3min, 5min, and 7min in the 200 metres).

The lactate was measured using the enzymatic method (LA 640 Kontron). The different methods of sampling, storage and analysis were corroborated by Geissant et al. (1985).

To estimate metabolic expenditure, we used the technique adopted by Lacour et al. (1990) for the definition of energy expenditure over the 400 and 800 metres (this technique takes into account the lactate produced and the utilisation of oxygen reserves and phosphocreatine).

The subjects' performances in the various races were measured using an electronic timekeeping system (F.I.C.). Times at intermediate speeds were obtained from video recordings of the trial sessions (Figure 2).

By using three 50 Hertz videocameras, arranged around the stand of the stadium and

* elastic strength, reactivity
Figure 1: Anthropometric characteristics and performances of the Italian athletes taking part in the research

Data marked by an asterisk show the distances analysed in this study; the other data correspond to the best performance achieved on the same day.

Activated by a "common lead", we were able to establish the average speeds (V) for each 5 metres of the first 60 metres in the 100 metres race, and between the 110 and 160m marks in the 200 metres.

2 Objectives

The objectives of this research were:

1) to demonstrate the importance of energy production by anaerobic glycolysis in top level athletes specialising in the 60, 100, and 200 metres;

2) to establish an association between energy production and the role of the elastic qualities of the muscle.

3 Stiffness values

These were measured using the Ergojump (Bosco et al. 1991). During the pre-race warm-up, the athletes performed a series of 5 successive

Figure 2: Arrangement of the video-cameras for the filming of the 100 metres race
vertical jumps on the conductance mat, keeping their legs almost straight, bouncing on the balls of their feet and using their arms to help.

This piece of equipment enabled us to establish the contact time and flight time for each jump, and then, from these parameters, to estimate energy expenditure during the impulse phase. The average result of the three best jumps was then used to give the maximum power expressed by the extensor muscles of the legs (using the simplified formula: \( P = h \times 2g/t \)), cf. Figures 3 and 4.

\[
\text{Stiffness} (W \times kg^{-1}) = 2g^2 t_{\text{flight}}^2 (8 t_{\text{contact}})^{-1}
\]

**Figure 3:** Formula to calculate the reactivity

### 4 Results

With regard to the relation between anaerobic glycolysis and performance, a relationship was found to exist between the average values of the athletes' peak lactate production and the average speed of each race.

We also found that the greater the race distance, the higher were the lactate values. For the 100 metres and the 200 metres, peak lactate production can be seen to increase with increases in running speed, while, in the 60 metres, running speed seems to be independent of lactate production.

To confirm these observations, we also used data from previous research (using the same measurement criteria) carried out during the national championships of Cameroon (Auier et al. 1994). Spearman's non-parametric test shows that there is a significant relation between the level of blood lactate and average speed (V) over the 200 metres (n=13, r=0.82, p<0.01), cf. Figure 5.

The percentage contribution of anaerobic glycolysis varies to the different sprint races (60, 100 and 200 metres). Figure 6 is showing the single percentages and illustrates visually the contribution made by each system in supplying the energy required in the different tests.

As the distance increases, an increase in the contribution made by the lactate (green) and aerobic (yellow) systems, and a reduction in the energy share provided by the phosphagens (ATP+CP) (red), can be noted; the total energy expended in each single run is shown on the right (expressed in KJ).

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**Figure 4:** Measured and calculated individual variables

The asterisk (*) indicates that this sprinter was injured in the last part of the 100 metres race and spontaneously lessened her pace. This performance should not be taken into consideration in relation to elastic strength or maximum lactate.
Running speeds were calculated using video-recordings, as noted above. The average speed over the last 40m of the 100m was then calculated from the difference between the timed result and the video-recording of the first 60m.

6 Conclusions and future steps

Our conclusions can be summarised in four main points:
1) Anaerobic glycolysis supplies a significant amount of energy over short sprint distances like the 60 metres, where we found, on average, 11 mmol/l of lactate.
2) In the sprints, initial acceleration and the maintenance of speed are derived from two different physical qualities:
a - acceleration: depending principally on the strength of the muscles involved;
b - maintenance of speed: depending principally on muscle stiffness.
3) The maintenance of speed is a function of stiffness (Figure 7).
4) Anaerobic glycolysis, during sprint races, is a function of stiffness. Athletes who do not have this capacity cannot reach and maintain high speeds.

7 Future steps
1) To confirm in a future study, using a larger group of subjects, the relations observed between stiffness and the maintenance of speed, and between stiffness and anaerobic glycolysis;
2) To carry out further studies, in the specific training context, on the effects of improvements in these parameters.
**Figure 7: Stiffness and running speed**

**Figure 8: Anaerobic glycolysis related to stiffness**

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