Abstract

Purpose. To investigate changes in blood lactate concentration after the 100 m dash in elite male sprinters.

Basic procedures. Nine male sprinters who had their personal best in I to M (Master) sport class. Lactate Scout was used to assess blood lactate concentration.

Main findings. Before the warm-up, the average blood lactate concentration was 1.40 ± 0.24, in the 1st min 9.38 ± 2.18 mmol*l–1. In the 5th min 10.11 ± 0.99 mmol*l–1 and in the 10th min 9.51 ± 1.23 mmol*l–1.

Conclusions. The recovery process pattern is different for male and female sprinters. Blood lactate concentration should not be measured directly after performance or after the 10th-11th min.

Keywords: sprint, 100 m, short-term efforts, lactate, physiology, athletics, sports, restitution.

Introduction

Speed is the most important motor element determining the results of the 100-meter dash. The level of strength, endurance, precision of movement and hybrid abilities such as: speed-endurance or speed-strength cause minimal (extremely important) differences between top-class sprinters. ATP is the primary source of energy during muscle work. During a sprinting effort, the amount of ATP increases even as much as 1000 times relative to the level of restitution [1] and its resources in the muscles already become depleted during the 2 seconds into the run [2]. Re-synthesis of ATP initiates a creatine kinase reaction immediately after the start of the effort [3]. A small amount of ATP is produced as a result of the adenylate kinase reaction occurring in the cytoplasm [4]. Another source of ATP re-synthesis is also anaerobic glycolysis activating immediately after the start of an effort [1]. Participation of oxygen changes in the 100 m sprint is minor because the energy required to complete the 100 m dash in a time of about 10 seconds is estimated (in men) as 50% of phosphocreatine and 50% of anaerobic glycolysis [5]. It is worth noting that phosphogenic changes are the main source of energy for maximum 8 seconds of the effort [6]. Obtaining a time less than 8 seconds in a 100-meter dash is not
possible, therefore a sprinter uses anaerobic glycolysis during the final stage of the run. Changing the source of ATP re-synthesis for the duration of the sprint is reflected in the following phases: 1) start acceleration; 2) phase of running at maximum speed; 3) phase of lowering maximum running speed [7]. Also worth highlighting is that the final result is affected by external factors such as wind speed and direction, temperature, humidity and hardness of treadmill surface [8].

Based on the times of the sprinters measured at 20-meter check-points, it may be noticed that none of them maintain the speed in the last 20 meters of the 100 m dash [8]. The lactate concentrations in the blood (LA) after the 100 m dash in world-class sprinters equal 13.2 mmol*l–1 [9]. The only scientific statement in the available academic literature in which LA was investigated during the 100 m dash in sprinters throughout a competition is the experiment during the championship [10].

After completion of the sprinting effort, the following may be observed: enhanced re-synthesis of ATP resources, phosphocreatine in the muscles, lactate metabolism, and other processes occurring within the whole body, actuated by the activated neurohormonal factors during exercise [4]. Re-synthesis of phosphocreatine distributed during the effort takes place very quickly after its completion (4-6 minutes) [11]. After short, intense physical activity, leading to a significant reduction in creatine phosphate resources, an increase in the rate of aerobic processes, glycolysis activation and lactate production occur [4]. The aim of the study was to analyze the process of changes in blood lactate concentration following the 100-meter dash during the Track and Field Premier League finals in top Polish sprinters.

**Material and methods**

The study involved nine of the top national sprinters (mean age 23.78 ± 3.70 years, body height 177.67 ± 5.68 cm and mass 73.78 ± 4.89 kg). Their personal bests were in I to Master sports classes. Training experience averaged 8.44 ± 3.47. Seven of the participants were members of the national PZLA (Polish Association of Track and Field Athletes).

The experiment was carried out during the most important track and field competition of the season. The class of the competition was M, which is the highest possible. The fastest sprinters in Poland were evaluated in the series. The competitors were informed about the purpose and method of research. The participants agreed to take part in the measurements. Weather conditions were read by the local weather station. The air temperature was 16.6°C, atmospheric pressure 990.6 hPa and relative humidity 57%. Wind speed was 1.1 m/s which means acceptable (equal to or less than 2 m/s).

To determine the concentration of lactate in the blood, SensLab Lactate Scout instruments with a range of 0.5-25 mmol*l–1 and the method of measurement based on the enzymatic-amperometric determination of capillary blood lactate were used. Measurements were carried out: before the warm-up, immediately after the sprint (within 1 min. of restitution), 5 and 10 min after the end of the effort.

**Statistics**

To determine the significance of differences in the level of blood lactate, RMANOVA Repeated Measures Analysis of Variance was used in between particular measurements. Statistically significant results were further analyzed with the method of simple contrast. The results are presented as arithmetic mean and standard deviation. The level of p ≤ 0.05 was considered statistically significant.

**Results**

The conducted experiment showed the dynamics of changes in blood lactate concentrations occurring before and after the 100 m dash in sprinters representing the highest level of athletic competition. The values of the analyzed blood lactate concentrations and the results of the sprint in individual athletes are shown in Table 1.

During restitution, blood lactate concentration equalled 1.34 ± 0.16 mmol*l–1, however, immediately after the 100 m dash (during the 1st minute of restitution) the level significantly increased to 9.36 ± 2.33 mmol*l–1 (Figure 1) compared to the level during restitution (p ≤ 0.05).

During the 5th min, there was an insignificant increase in the measurement of lactate concentration 10.10 ± 1.05 mmol/l (Figure 1) in comparison to the measurement taken during the 1st min, however, the difference in relation to the value before the effort evolved at a significantly higher level (p ≤ 0.05).

In 10th min, a decrease tendency (9.66 ± 1.22 mmol*l–1) in the level of lactate concentration compared to the measurement taken during the 5th min was noticed (Figure 1). However, a significant difference between the 10th min of restitution and the resting state before the warm-up (p ≤ 0.05) was found.

The athletes competing in unfavourable sprinting conditions (air temperature 16.6°C) achieved the average value of 10.67 ± 0.10 s during the 100 m dash.

The highest concentration of lactate (in 1st min of restitution 11.6 mmol*l–1) was noted in the sprinter who won the race (10.53 sec).
Blood lactate concentrations in the top Polish sprinters during the 100-meter dash

Table 1. Results in males during 100 m dash

<table>
<thead>
<tr>
<th>#</th>
<th>Lactate concentration [mmol*l−1]</th>
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<th>Personal best [s]</th>
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<td>Restitution</td>
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Discussion

The presented study is the world’s first experiment monitoring the changes in lactate concentration during a championship competition with the participation of top Polish sprinters.

The maximum value of lactate concentration in the 5th min (10.10 mmol*l−1) at the end of the effort is justified by the current observations indicating the so called delay resulting from the accumulation of lactic acid in the muscle after the completion of short-term intense exercise [13]. What is interesting in our experiment is the high concentration of LA in all three measurements after the sprint. After efforts lasting up to several seconds, intensification of glycolysis and oxidation can often be greater than during the exercise. Lactate produced in muscle cells during an effort (or immediately after its completion) diffuses into the blood. In most cases, the diffusion rate is slower than the production rate of the compound, thus in the first minutes following the effort (after intensive efforts up to 10 minutes), the concentration of LA increases. The reversion of LA to the values

Fig. 1. Changes in lactate concentrations in sprinters during 100 m dash
achieved during restitution after intense efforts usually occurs within the first hour following the effort [4]. The time is dependent on the intensity and type of exercise and resting time interval [14].

Lack of literature containing studies on high-class sprinters tested during championship competitions does not allow to analyze the recorded changes in lactate concentration during the 1st, 5th and 10th min of restitution after beginning the 100 m dash in sprinters during competitions at the highest level.

It seems that the process of changes in lactate concentration in an individual sprint is related to the particular characteristics of motor skills and an athlete’s level of concentration in an individual sprint is related to the participation at the highest level.

Conclusions

The following conclusions were drawn on the basis of the achieved results:

- Changes in lactate concentration during the 1st and 5th min after the sprint are an important physiological observation which can be used in planning the duration of restitution intervals in sprinting training.

- High lactate concentrations during the 10th min following the sprint indicates that this break is too short for the body to completely regenerate.

Practical application

The process of changes in lactate concentrations during the 1st, 5th and 10th min following the completion of the 100 m dash marks a new direction in the research on post-exercise restitution in sprinters. The recorded study results can provide a reference point for programming training sessions to shape strength-speed, particularly planning the intensity, restitution interval duration and the number of repetitions for individual competitors.

The high concentration of lactate during the 10th min of restitution indicates strong engagement of anaerobic glycolysis (heavy use of muscle glycogen) requiring excellent speed-endurance from the sprinter, which is crucial in the second part of the 100 m dash. The course of the tested restitution clearly indicates that taking on an additional effort (e.g. running the 100 m dash once more) even 10 min after completing the first sprint, the runner is still tired and not regenerated — which is proven by the high level of lactate concentration in the blood. In this case, re-application of an effort at maximum intensity is extremely risky because it can lead to muscle injury, such as: stretching or tearing muscle groups dominant in this kind of effort (in a sprinter: the biceps or quadriceps).

It is often the case that a sprinter takes part in other disciplines (e.g. long jump), while the restitution period between starts is only a few minutes long which is not a sufficient amount of time. The consequence of such an action may be a myocardial injury which excludes a participant from weeks or months of training and the next starts.

It should be emphasized that the determination of lactate concentration is a precise indicator in controlling training loads in short efforts as such, e.g. heart rate is not very credible because the effort is too short for the heart muscle to reach its maximal or sub-maximal values.

References

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Corresponding author:
Kamil Kobiałka
limak@o2.pl
Department of Athletes Motor Skills,
University School of Physical Education, Wroclaw
Al. Ignacego Jana Paderewskiego 35, 51-612 Wroclaw