











# Blood Lactate Decreased by Foam Rolling Post-Quarter Marathon

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## Abstract

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**BACKGROUND:** New training methods, increased volume, the prolonged duration could induce the delayed onset of muscle soreness (DOMS), and it is associated with blood lactate (BL). Foam roller (FR) is known as a tool for active recovery.

**AIM:** The study's purposes are to assess the effect of the Quarter Marathon (QM) and Foam Roller (FR) on blood lactate (BL).

**METHODS:** This is a pilot study with a quasi-repeated-measures design. Ten trained young males were voluntarily signed up using the purposive sampling technique. The Accutrend-Plus by Roche was used to measure BL. Blood lactate was measured 6 times. Combination FR protocols from the Master of Muscle and Casall were used. Repeated-measures ANOVA test was used to analyze the changes in BL.

**RESULTS:** Blood lactate significantly increased  $4.90 \pm 3.0$  (mmol/L) post-QM as  $p < 0.05$ , pre-test  $2.23 \pm 0.8$  (mmol/L) compared to post-running  $7.1 \pm 2.6$  (mmol/L). It was decreased after foam rolling activity  $4.33 \pm 0.7$  (mmol/L), and  $3.06 \pm 0.5$  (mmol/L) at 120 min post-running, then returned to normal after 24 h post-QM  $2.44 \pm 0.5$  (mmol/L).

**CONCLUSION:** Foam rolling potentially decreased BL after QM.

## Introduction

Delayed onset of muscle soreness is a normal physiological response from exercise, and a damaged skeletal muscle membrane triggers to inflammatory response. DOMS occurs at 24 h post-training, and it will take about five up to seven days to recover [1]. Muscle trauma during DOMS can be evaluated using an instrument called visual analog scale (VAS) [2]. Meanwhile, increased blood lactate production occurs when the body is performing an aerobic exercise and prolonged the duration of the exercise. Blood lactate concentration is related to fatigue. However, blood lactate also will be increased when the body at DOMS condition [3]. A previous study stated that blood lactate also can be used as a biomarker to evaluate DOMS [4].

Studies provide several therapies to overcome perceived a painful feeling during DOMS and how to accelerate the recovery process, there are the following: thermal therapy [5], compression [6] massage [7],

acupuncture [8], drugs including non-steroidal anti-inflammatory drugs [9], branched-chain amino acids [10], stretching [11], and foam rolling [12], [13]. Hence, a study comparison conducted by Malanga showed that foam rolling is considered more effective compared to massage. Foam rolling is one of independent therapy technique for skeletal muscle that be perform before (warming up) or after (cooling down) physical training [14].

Blood lactate production occurs all the time; it is a normal consequence (1.3 mmol/L) from an aerobic metabolism (glycolysis) that our body performed [15]. Take note that even during long duration physical activity; glycogen will always be used as the spare energy sources. It leads to onset of blood lactate accumulation (OBLA) also known as lactate threshold, which can be marked when it levels reach to  $\geq 4$  mmol/L [16], [17]. The combination of muscle blood flow and increased blood lactate concentration is a reflection of muscle metabolism, and it is strong message of muscle fatigue to brain [18]. Fatigue is a complex emotion that is

influenced by factors such as motivation and drive, other emotions such as anger and fear, and memory of the previous activities. Fatigue is unique to each person and is essentially an illusion [19], [20].

Based on the elucidation above, we assume that foam rolling has positive effects to lowering blood lactate concentration (mmol/L) in DOMS post-quarter marathon. The objectives of this study are: (1) To assess the effect of the quarter marathon on blood lactate (2) to assess the effect of foam rolling on blood lactate.

## Methods

This is a pilot study with a quasi-experiment one group repeated-measures design [21]. The independent variable in this study is a foam roller, while the dependent variable is blood lactate (mmol/L) as an indicator of fatigue [2], [22].

Population in this study is trained young males in Semarang City. Purposive technique sampling was used to obtain the samples ( $n = 10$ ) with inclusion criteria: Voluntary willing to follow all the procedure in this study, 17–25 years old, non-smoker, not under medication, and never used foam roller before the treatment. On the other hand, the exclusion criteria: re-sign as the volunteer and not willing to do, professional athlete, based on the medical history-having cardiovascular problem, having a pulmonary problem, having contradiction related with muscle-ligament injuries, back pain, and fractures  $<2$  years.

All the voluntary subjects were asked to avoid any physical exercise at least 7 days before Long-Distance Running (10 km) day but still allowed to do the daily activity as usual. We did not force them to consider the turnaround time, but subjects were asked to focus at the finish line, meanwhile, some of the research assistant were place at some points to encourage subjects. About 70–80% of maximum heart rate were determined as the range of intensity, Xiaomi Mi Band 3 were used to track their intensity during running. Running was performed outdoor on the jogging track of Sumurboto public sports facility, Tembalang, Jatingaleh District, Semarang City.

Foam Roller is a self-therapy tool which considered able to help lighten up fatigue and soreness in the muscle also able to increase muscle flexible and performance [23]. High density foam roller material was chosen, given to the gluteus muscle group for 45 s of rolling, and 15 s of rest 3 times, the total duration for two legs is 6 min. The presented foam rolling technique is a combination technique from Master of Muscle and Casall [24], [25]. Both techniques are easy to follow and available in a form of video as well as brochure. Furthermore, the combination technique was expected

to found a better result. Foam rolling given 2 min post cooling down from quarter marathon.

Blood Lactate measurement was using the Quick Reference Guide from Accutrend Plus by Roche was followed to measure blood lactate (mmol/L). Using second milking fresh capillary blood, blood lactate was measured for 6 times. Before running, two minutes post running, 30 min post running and foam rolling, 60 min, 120 min, and 24 h post running.

The Research Protocols has been approved by the institutional health research ethics commission, Universitas Negeri Semarang (Number Letter: 120/KEPK/EC/2020). Informed consent has been obtained from all individuals included in this study. There are three steps in this study: (1) Preparation, checking the venue, instruments, data collectors, professional laboratory assistant, subjects, then delivering instructions to all subjects on what should do and do not during the data collection as well as how to give quarter marathon (10 km Running). In addition, subjects were asked not to do any physical exercise for seven days before the day of long-distance running 10 km. (2) Implementation, repetition of all the procedures, ensuring that all subjects were not dehydrated, then data collection for pre-data: Blood lactate measurement (BLM). Followed by warming up straight to quarter marathon running 10 km, 2 min cooling down, directly followed by second BLM, then foam rolling treatment for 6 min, third BLM at 30 min post 10 km, fourth BLM at 60 min, fifth BLM at 120 min, and 24 h for the last BLM. (3) Closing, after treatment and data collection, the next step was data analysis and presentation which then followed by interpretation data, discussion, and conclusion.

Normality and homogeneity were performed as prerequisite tests. To evaluate the effect of long-distance running (10 km) toward changes in blood lactate and the effect of foam rolling toward changes in blood lactate, the Repeated Measures ANOVA Test was chosen with a significant value of  $p < 0.05$ . It was used to evaluate the data changes every time on an interval basis. IBM SPSS *Statistic* 26 was used to perform all the data analysis.

## Results

Characteristic data of subjects are showed that their average age is  $19 \pm 1$  years old, height  $166.8 \pm 5.6$  (cm), weight  $64 \pm 6.7$  (kg), and normal body mass index  $23 \pm 2.5$  ( $\text{kg}/\text{m}^2$ ). Detailed data are shown in Table 1.

**Table 1: Subjects' characteristic**

Variables	Mean $\pm$ SD
Sex	Males ( $n = 10$ )
Age (year old)	$19 \pm 1$
Height (cm)	$166.8 \pm 5.6$
Weight (kg)	$64 \pm 6.7$
Body mass index ( $\text{kg}/\text{m}^2$ )	$23 \pm 2.5$

Blood lactate increased significantly by 4.87 mmol/L (218%) as  $p < 0.05$  at two minutes post quarter marathon. Pre-running blood lactate was  $2.23 \pm 0.8$  mmol/L, and after running  $7.1 \pm 2.6$  mmol/L. Remarkably, it decreased after foam rolling treatment (30 min post running) by 2.77 mmol/L (39%) from  $7.1 \pm 2.6$  mmol/L to  $4.33 \pm 0.7$  mmol/L, despite this reduction is still higher compared to baseline data. Although at 60 min ( $3.69 \pm 0.05$  mmol/L) and 120 min ( $3.06 \pm 0.5$  mmol/L) post running blood lactate seems decreased, but it was not significant ( $p > 0.05$ ). The day after running and application of foam rolling as a recovery, blood lactate was completely returned to its normal range, and it is not significantly different from the pre-test data. Detailed data are shown in Figure 1.

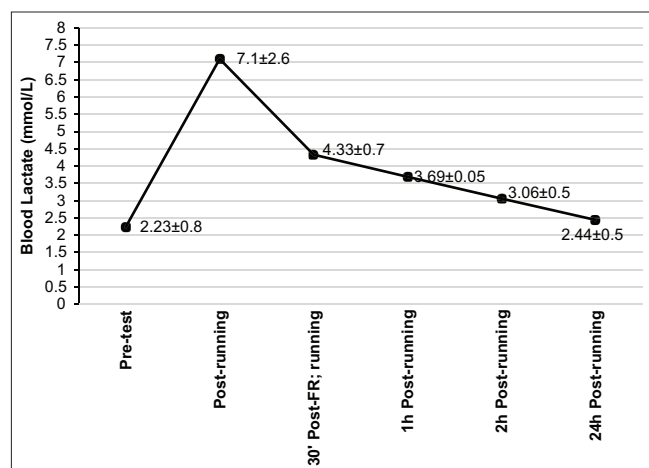


Figure 1: Changes in blood lactate (mmol/L) due to long-distance running 10 km and foam rolling treatment

## Discussion

The normal range of blood lactate is 2.0–3.0 mmol/L [26]. Increased blood lactate post quarter marathon (10 km) is in line with Gleeson's study, which stated that blood lactate will reach the peak at 2 min post workout [3]. The 218% increase can be a strong evidence that a quarter marathon is classified as a heavy physical activity for non-athlete individuals, and it cause a change in physiological response, as blood lactate is accumulated [4].

The rate of blood lactate clearance during active recovery after strenuous running depends on the intensity of the active recovery [27]. Active recovery is a recovery method in which an athlete engages in active movement (often the cardiovascular system) to increase blood flow and has been shown in previous studies to be the most effective form of recovery compared to passive ones. There are many recovery modalities that can be chosen as far as the personal reference such as massage therapy, whole-body vibration therapy, contrast water therapy, neuromuscular electrical stimulation therapy, compression garments, and pneumatic compression therapy [28], [29].

Blood lactate significantly decreased post foam rolling treatment. This phenomenon is also in line with a study conducted by Amico and Paolone, stating that foam rolling is able to suppress the spike of blood lactate post training session [30]. A study by Adamczyk *et al.* supporting the current data. They were comparing different foam rolling (smooth and grid) versus passive rest, stated that it has no different effects between foam rolling types but with passive recovery on the reduction of blood lactate [31]. The Cori cycle elucidated that to eliminate blood lactate from the bloodstream after workout take about 60 min, this process will be different in each individual and it can be faster with active recovery [30].

Lactic acid is transported to skeletal muscle through the plasma monocarboxylate transport (MCT) system and is used by muscles such as the heart and red muscle. It is also very important that the lactic acid produced to meet high energy requirements is removed from the muscles and metabolized by the liver or used as an energy substrate [32]. Decrease in lactate and blood sugar levels during the low-intensity exercise phase (active recovery) may indicate a well-trained athlete's ability to recover. Athletes involved in intermittent sports may need this recovery ability to perform well during competition [33].

The foam rolling technique that has been performed by subjects in this study might be different in the rolling speed, while a quarter marathon only focus on the mileage, not on the time to finish. According to the government's appeal, due to the COVID-19 amount of the subjects must be restricted, no more than 10 people. Finally, this research might be better with a control group.

## Conclusion

Quarter marathon increased total blood lactate (mmol/L) concentration significantly at 2 min post running. Foam rolling as an active recovery able to decrease blood lactate concentration significantly after heavy exercise.

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