Journal of Exercise Physiology**online**

April 2016
Volume 19 Number 2

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Analysis of the Response of Blood Lactate, Blood Glucose, Peripheral Oxygen Saturation, and Heart Rate during the Trail Running Competition

Alexandre Reis Pires Ferreira[1,2], Walfran Silva Santos[1,2,3], Felipe José Aidar[1,2,4], Dihogo Gama de Matos[5], Raphael Fabricio de Souza[1,2,3]

[1]Department of Physical Education, Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, [2]Group of Studies and Research of Performance, Sport, Health and Paralympic Sports - GEPEPS, the Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, [3]Racing Club at the Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, [4]Graduate Program in Master's level in Physical Education, Federal University of Sergipe - UFS, São Cristovão, Sergipe, Brazil, [5]Department of Sports Science, Exercise and Health of the Trás-os-Montes e Alto Douro University, Vila Real, Portugal

ABSTRACT

Ferreira ARP, Santos WS, Aidar FJ, Matos DG, de Souza RF. Analysis of the Response of Blood Lactate, Blood Glucose, Peripheral Oxygen Saturation, and Heart Rate during the Trail Running Competition. **JEPonline** 2016;19(2):27-33. This study evaluated the response of blood lactate, HR, SpO_2, and blood glucose levels during a competition in different pathways (5km and 21km) and different levels of difficulty. This study included 20 male volunteer runners who were enrolled in the trail running k21 test series, Aracaju step - SE held at Serra Itabaiana National Park. The subjects were divided into two groups according to the conducted tour: Group 5km (G5km, n = 10); and Group 21km (G21km, n = 10). There was a significant difference in all variables in both modalities, in particular, lactate 5km *vs*. post 21km (P<0.001). The findings indicate that the test 5km turned out to be much more intense with an increase in blood lactate level in relation to the test of 21km.

Key Words: Trial Running, Blood Lactate, Heart Rate

INTRODUCTION

The tracks for racing mode called Trail Running have attracted many followers in Brazil due to the combination of sports dynamics and the enjoyment of nature. There is also the anticipation and excitement of pushing the boundaries of the human body (13).

Depending on the level and the varying distances, altitudes, and reliefs, Trail Running tends to be performed by professional and amateur athletes (9) with a preference for enrollment in longer distances at a high level of difficulty that is characterized by natural barriers (14). Naturally, the performance requires greater physical and psychological preparation along with specific nutritional considerations.

Specific physiological evaluations are recommended and considered increasingly important for improvement, especially in regards to the prescription of training and the monitoring of individual sports development. Otherwise, the anticipated decrease in performance, muscle damage, and other unfavorable outcomes of the athlete are often the result of failure to acknowledge relevant training variables aggravated by the increasing age of the participants (21).

For this reason, it is important to determine the participants' blood lactate concentration (5), variability of heart rate (8), depletion of glycogen (19) and peripheral saturation (SpO_2) (23). A better understanding of the participants' physiological thresholds is recommended to prescribe an optimum training workload (10). Although these assessments are widely used by sports coaches, they are not that common in determining the participants' physiological behavior during trail running tests.

Thus, the purpose of this study was to evaluate the behavior of physiological parameters such as blood lactate, HR, SpO_2, and blood glucose levels during a competition in different pathways (5km and 21km) and different levels of difficulty.

METHODS

The study included 20 male runners, volunteers and enrolled in the trail running k21 test series, Aracaju step - SE held at Serra Itabaiana National Park. The sample was divided into two groups according to the conducted tour: Group 5km (G5km, n = 10) and Group 21km (G21km, n = 10).

Participants presented the following characteristics: G5 (age 40.5 ± 9.7 yrs, weight 72.5 ± 8.4 kg, height 1.74 ± 0.04 cm, body fat 18.8 ± 4.5%) and G21 (age 41.3 ± 9.1 yrs, body weight 79.4 ± 11.5 kg 1.75 ± 0.09 cm height, body fat 19.9 ± 6.2%).

The participants were informed of the study protocol risks and signed the consent according to resolution 196/1996 of the National Health Council, in accordance with the ethical principles contained in the Declaration of Helsinki (1964, revised in 1975, 1983, 1989, 1996, 2000, and 2008), and the World Medical Association. Participants also signed a consent form according to Resolution 466/2012 of the National Committee of Ethics in Research - CONEP, the National Health Council.

Instruments

Lactate and Glucose Levels

To collect the lactate and blood glucose were used two lancing brand Accu-Chek with disposable lancets carried out drilling at the distal phalanx of the index finger. The devices used were two glucometer brand Accu-Chek (Roche, Brazil) and two lactimeter Accutrend Lactate Accu-Check (Roche, Brazil) with reagent strips BM-Lactate.

Before drilling the toes of the athletes, they were cleaned with cotton soaked in alcohol 90° and, then, ~25 µl of blood was collected. The blood sample was placed directly in the test strips for both the lactate and for glucose using the same drill.

Peripheral Blood Saturation and Heart Rate

The saturation of peripheral oxygen (SpO_2) was performed using an oximeter (Dixtal Superbright-DX Model 2455, Philips, The Netherlands) with the sensor positioned on the 3rd finger of the right hand. At the same time, heart rate (HR) was also determined. The devices have a receptacle to accommodate the distal portion of the finger, with one side having a light source - consisting of two light Photoemitters (LED) - and across a photodetector. An LED emits red light (≅ 660 nm) and another infrared light (≅ 940 nm) (1).

Procedures

Lactate concentration, blood glucose, SpO_2, and HR were determined 1 hr before the start of the race and immediately after the end time, from was determined the average speed and pace of the participants.

Average Speed and Pace

Verification of the athletes' pace was done by kilometers traveled using the results provided by the race competition and the system Chiping team fixed to the shoes of runners. The average speed during the race was calculated by the total time of completion of the test *vs.* the distance converted to $m \cdot sec^{-1}$.

Statistical Analyses

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20.0. The central tendency measures were used, mean ± standard deviation. To verify the normality of the variables, the Shapiro-Wilk test was used given the sample size. For verification of possible differences between the groups, we used the ANOVA (two way), and *post hoc* Bonferroni. To check the effect size, the Cohen's f2 test was used. The cutoff points of 0.02 to 0.15 were adopted as small effect, 0.15 to 0.35 as median, and greater than 0.35 as large Statistical significance was set at $P<0.05$.

RESULTS

Table 1 shows the evaluated variables (glucose, lactate, HR, and SpO_2%). The values shown in the table correspond to the results obtained in the pre and post trial running.

Table 1. Blood Glucose Levels, Lactate, HR, and SpO_2% mean ± SD Responses of 21km and 5km Trail Running Tests.

	G21 km-pre	G5 km-pre	G21 km-post	G5 km-post	f^2 Cohen
Lactate ($mmol\cdot L^{-1}$)	3.3 ± 2.3	2.8 ± 1.6	5.3 ± 1.4#	10.5 ± 1.31*&Ω	0.352
Glucose ($mg\cdot dL^{-1}$)	93.9 ± 14.3	95.0 ± 10.2	103.3 ± 24	119.1 ± 51	0.042
HR ($beats\cdot min^{-1}$)	75.7 ± 10.3	77.7 ± 8.4	127.2 ± 13*Ω	140.2 ± 17.0#&	0.412
SpO_2 (%)	89.1 ± 22.6	87.8 ± 16.0	96.9 ± 1.9	97.3 ± 0.4	0.012

Lactate *post 5km *vs.* pre 21km P<0.001; #post 21km *vs.* pre 5km P=0.018; &post 5km *vs.* pre 5km P<0.001; Ωpost 5km *vs*. post 21km P<0.001; HR *post 21km *vs*. pre 21km P<0.001; #post 5km *vs*. pre 21km P<0.001; Ωpost 21km *vs*. pre 5km P<0.001; &post 5km *vs.* pre 5km P<0.001

Table 2 shows the values of average speed and pace of the subjects. Statistically significant differences were found (P>0.05) between variables lactate and HR.

Table 2. Average Speed and Pace during the 21km and 5km of Trail Running Tests.

	G21km	G5km	P	f^2 Cohen
Speed ($m\cdot sec^{-1}$)	1.66 ± 0.3	1.47 ± 0.1	0.041	0.157
Pace (min)	10:20 ± 1:59	11:20 ± 1:05	0.035	0.178

Figure 1 shows the blood lactate and values before and after the test of 21km and 5km from the trail running competition.

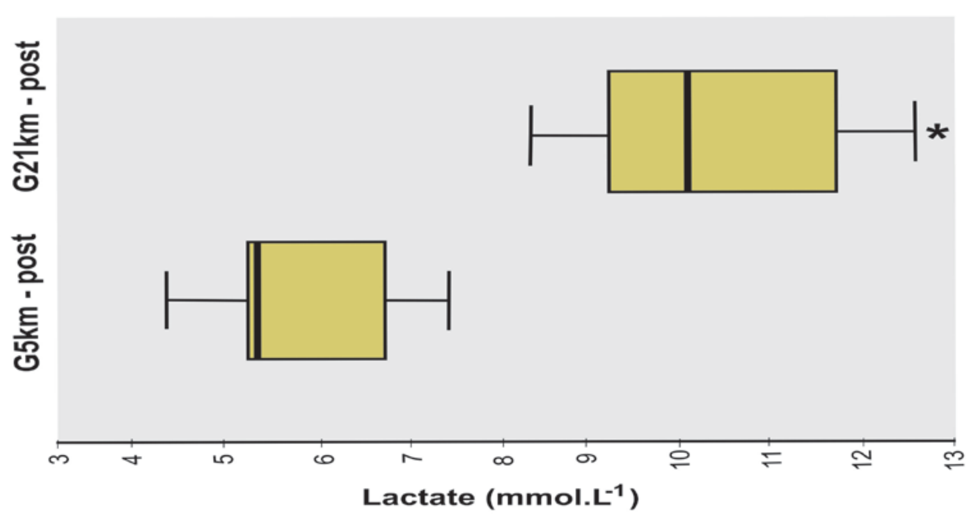

Figure 1. Lactate Post-Competition from the 21km and 5km Trail Running Tests. *Post 5km *vs.* post 21km P<0.001

DISCUSSION

This study examined predictors of performance in subjects during Trail Running, which was the expected competitive environment that anaerobic threshold in both groups would be realized at the end of the race (12). It was also expected that the race represented the maximum demand and stress placed on the subjects during competition (17).

To measure the subjects' maximum demand and stress, lactate concentration was determined. It was found that lactate concentration in both groups was higher than 4 $mmol \cdot L^{-1}$, which was statistically significant when compared to the G5km pre and post test conditions (2.8 ± 1.6 *vs.* 10.5 ± 1.31 $P<0.001$). Although the G21km lactate concentration was above anaerobic threshold at the end of the race, it was less compared to the G5km (5.3 ± 1.4 *vs.* 10.5 ± 1.31 $P<0.001$).

Although the lactate concentrations are in agreement with previous studies (7,11) in long distances athletes, it is clear from the subjects' lactate response during the 21km competition (20) occurred regardless of the level of difficulty presented by the distance and the altitude of >700 m. Moreover, given the difference in the concentration of lactate post test, the fact that the G5km produce a higher concentration is linked to training that was reinforced by the average speed and pace in both groups. The speed used during the race is directly proportional to the distance of the race. The G5km showed 76% lower speed, which is an estimated amateur feature for this group.

Unfortunately, this study did not clarify the measurement of aerobic threshold measured by the glycemic index because its determination is subject to tipping the index occurred during exercise stimulated by hormonal regulation. While performing the physical activity itself, adrenaline is responsible for both glycogenolysis in response to the stimulus as well as the production of lactate (19).

A limitation in the present study is the lack of control in the use of carbohydrate gel, which is commonly used by runners (given the influential factors on the glycemic index behavior) (6,22). The post test HR had to be greater than the pre condition, thus following a normal pattern of the cardiovascular system in regards to autonomic adjustment during sports practice (3,4). There was a 55% increase in the post proof for G5km and 59% for G21km while there was no difference in HR compared to the conditions post G21km *vs.* post G5km.

Regarding SpO_2 the subjects were not prone to arterial hypoxia induced independent exercise volume and altitude of the routes, yet there are contradictory studies that have identified a decxrease (2,18) suggesting further studies with methodologies applied in varying altitudes. Åstrand (2) showed that SpO_2 could fall below 95% without a corresponding reduction in oxygen pressure (PO_2). At high altitudes, alveolar PO_2 is lower and can adversely influence the arterial saturation, which is aided by the decrease in pH and the increase in carbon dioxide pressure (pCO_2) and temperature. The fall of $\%SpO_2$ below the normal levels is linked to the decrease in oxygen-carrying capacity of the blood, which is also a limiting factor in the performance of endurance exercise (15). This fact was not addressed in the present study.

CONCLUSIONS

While it was not well defined the kind of individuals who engage in such competitions, it is now clear that the 5km and 21km subjects are predominantly adult recreational athletes. Another very important point noted is that the 5km turned out to be much more intense with an increase in blood lactate and HR above the values detected in the 21km.

Address for correspondence: Alexandre Reis Pires Ferreira - Cidade Universitária Prof. José Aloísio de Campos - Avenida Marechal Rondon, s/n Jardim Rosa Elze - CEP 49100-000 - São Cristóvão/SE - (79) 99873-7395, Email: alexandrerpf92@gmail.com

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