Post-Competition Blood Lactate Concentration in Regional Level and Masters Athletes

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ABSTRACT

The measurement of blood lactate concentration ([La]b) following competition or maximal and submaximal exercise have been widely used to assess exercise intensity, to predict performance and to quantify the contribution of the anaerobic metabolism to the effort. However, few studies have focused on athletics and those available have been conducted with elite athletes. Accordingly, the aim of the present descriptive study is to assess post-competition [La]b in 72 young regional level and 36 Masters age group athletes. Overall, mean values (standard deviation) of [La]b were 8.13 (1.08), 12.46 (0.86), 15.12 (1.70), 12.73 (1.69), 15.00 (1.10) mM in males and 8.64 (0.21), 12.89 (2.16), 14.97 (2.26), 14.58 (0.50), 14.22 (0.74) mM in females for the 60m, 200m, 400m, 800m and 1500m distances respectively. Male Masters athletes, aged between 36 and 71 years, reached [La]b values between 6.57 and 18.08 mM, 7.75 and 18.53 mM, 8.25 and 17.00 mM in the 200m, 400m, 800m distances respectively, depending on age and performance. The results obtained have the potential to provide a better insight into the anaerobic metabolism of regional level and Masters athletes, with implications for training programmes.

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Introduction

The measurement of blood lactate concentration ($[La]_b$) during exercise and sport activities has been used to determine the intensity of the specific effort[1-3], to prescribe training sessions[4], and to describe the characteristics and the energy demand of different sports[5-7]. Although $[La]_b$ has been measured during maximal or sub-maximal training sessions, or following competitive events, official races create unique conditions that maximise the effort and the performance[7, 8]. Indeed, top-class athletes exhibited higher levels of $[La]_b$ following a competitive race[9] compared to laboratory tests[10]. Post-competition $[La]_b$ measurement is deemed to quantify the contribution of the anaerobic metabolism to the total energy requirement[11, 12].

A vast body of literature has examined post-competition $[La]_b$ in high-level athletes of different ages and both genders involved in a range of sports such as soccer[13], basketball[3], tennis[6], badminton[14] and judo[15]. In contrast, post-competition $[La]_b$ assessment in athletics has only rarely been investigated. In the early 1990s two studies attempted to quantify the contribution of the anaerobic metabolism to the total energy demand in 100m and 200m[7] and the 400m, 800m and 1500m races[12]. They found a correlation between peak post-competition $[La]_b$ and the average racing speed in the 400m and 800m[12]. More recently, KORHONEN et al[16] analysed post-competition $[La]_b$ in Masters age group athletes participating in races from 100m to 400m at the European Veterans Championships and found an age-related decline in peak $[La]_b$ after 70 years of age, with no gender-differences were detected. The latter investigations were carried out with elite athletes during outdoor competitions where the weather conditions (e.g. wind) could affect the final performance.

To the best of our knowledge, there has been only one study undertaken with non-elite athletes[17], where post-competition $[La]_b$ has been measured in stable and controlled weather conditions (e.g. during indoor competitions). Accordingly, the aim of the present investigation was twofold: i) describe post-competition $[La]_b$ in regional level athletes competing indoors in races from 60m to 1500m; ii) describe post-competition $[La]_b$ in Masters athletes competing indoors at national level and relate it to performance and age.

Methods

Participants

A total of 72 athletes (54 men and 18 women) taking part in the following indoor athletics races were recruited: 60m, 200m, 400m, 800m and 1500m. In addition, 36 male Masters athletes competing in 200m, 800m and 1500m at the Italian national championships agreed to be involved in this study. Before the competitions written informed consent was received from all participants (or their parents for those under age) after a brief but detailed explanation about the aims, benefits, and risks involved with this investigation, which was previously approved by the Italian athletics federation, Federazione Italiana di Atletica Leggera. Anthropometric characteristics of the participants are reported in Table 1, along with their performance time (PT) expressed in seconds and PT expressed as a percentage of their seasonal best (values below 100% mean that the athlete set a new seasonal best).

Lactate measurement

Blood samples were collected within five to six minutes after the end of the selected race. A member of the research team waited for the athlete at the side of the track and was responsible for checking the time for sample collection and for guiding the athlete to the laboratory situated about 30m from the track. At the completion of the recovery, blood sample was taken from the earlobe and collected in a 20 µl capillary tube and mixed with a lysing stabilising agent in a safe-lock vial, which was gently shaken for a few second. Samples were analysed within 24 hours with the Biosen 5030 (EKF Industrie, Barleben, Germany) lactate analyser and [La]b (mmol l^{-1}) determined[18].

Statistical analysis

Results are expressed as mean ± standard deviation except for with the Masters athletes, where minimum and maximum values are reported, considering the large age range (36 to 71 years of age). $[La]_b$ was checked for normality of distribution, then a one-way ANOVA was used to detect a difference in $[La]_b$ for

Table 1: Anthropometric characteristics and performance time of the athletes

Males. Mean (SD)						
Race	N	Age (y)	Height (cm)	Weight (kg)	Performance (sec)	% SB
60	12	21.3 (5.1)	175.9 (6.9)	65.1 (9.1)	7.69 (0.24)	101.4%
200	9	24.6 (4.9)	176.3 (8.3)	69.2 (8.0)	24.02 (0.88)	99.9%
400	19	22.5 (4.6)	177.9 (5.3)	70.5 (6.2)	52.81 (1.95)	102.4%
800	9	20.0 (4.1)	179.3 (4.7)	65.1 (6.7)	131.80 (11.60)	106.1%
1500	5	23.4 (4.8)	181.8 (6.3)	68.8 (11.2)	250.00 (11.77)	100.1%
Total	54					
Females. Mean (SD)						
Race	N	Age (y)	Height (cm)	Weight (kg)	Performance (sec)	% SB
60	2	21.5 (6.4)	168.5 (7.8)	56.5 (16.3)	8.82 (0.61)	103.1%
200	4	26.3 (6.2)	170.3 (6.4)	59.0 (2.7)	27.6 (1.9)	104.7%
400	6	20.2 (1.6)	166.0 (3.6)	54.8 (4.5)	58.8 (2.3)	103.3%
800	4	21.5 (7.3)	175.3 (5.2)	60.5 (11.5)	137.53 (6.77)	102.7%
1500	2	22.0 (5.7)	163.5 (3.5)	51.0 (4.2)	290.27 (9.74)	102.6%
Total	18					
Masters. Min-Max						
Race	N	Age (y)	Height (cm)	Weight (kg)	Performance (sec)	% SB
200	12	36-71	170-189	63.5-83.0	23.38-42.35	102.7%
400	11	36-71	165-190	61.0-82.0	51.57-80.05	102.3%
800	13	36-71	164-184	58.0-78.0	120.83-181.87	105.0%
Total	36					

% SB = performance expressed as a percentage of seasonal best

men competing in 60m, 200m, 400m, 800m, 1500m. When a significant effect was found, a Tukey HSD post hoc test was used to locate the differences. The ANOVA analysis could not be performed with $[La]_b$ in women due to the low number of subjects recruited.

In Masters athletes $[La]_b$ and PT have been related to age by determining a linear regression equation and the correlation coefficient for each of the three events analysed (200m, 400m, 800m). An α level of $p<0.05$ was considered statistically significant.

Results

Table 2 shows post-competition $[La]_b$ measured across the three groups of athletes competing in different events. The average highest values were recorded for the 400m, both in males and in females. Overall, no remarkable differences could be detected between males and females in each event. The peak $[La]_b$ was 18.46 mM in men and 17.65 mM in women, both after 400m. In Masters athletes the post-competition peak $[La]_b$ was 18.53 mM for a performance time of 54.22 in 400m of a male athlete aged 42.

A significant difference in $[La]_b$, as a result of the ANOVA analysis, was observed between the 60m and the 200m, 400m, 800m and 1500m ($p<0.01$), between the 200m and 400m ($p<0.01$) and between the 400m and 800m ($p<0.01$) as reported in Figure 1.

Figures 2 to 4 relate $[La]_b$ to age (graph A) and PT to age (graph B) for Masters athletes competing in the 200m, 400m, 800m, respectively. Correlation coefficients ranged from 0.63 to 0.94 and were statistically significant. By using the regression equations presented in the figures, the age-related percentage reduction for $[La]_b$ and PT were 34.9 and 35.8% for the 200m, 53.6 and 47.7% for the 400m, and 36.9 and 29.8% for the 800m, with the 400m exhibiting the greatest age-related $[La]_b$ and PT reductions.

Discussion

The main purpose of this study was to measure post-competition $[La]_b$ in regional level and Masters athletes competing in different athletics running events. There is a paucity of published data regarding non-elite athletes and this investigation aimed to fill this gap. Further, the indoor environment ensured that the athletes performed in controlled atmospheric conditions.

Table 2: Post-competition lactate values

Males					
Race (N)	60 (12)	200 (9)	400 (19)	800 (9)	1500 (5)
$[La]_b$ (mean (SD))	8.13 (1.08)	12.46 (0.86)	15.12 (1.70)	12.73 (1.69)	15.00 (1.10)
Females					
Race (N)	60 (2)	200 (4)	400 (6)	800 (4)	1500 (2)
$[La]_b$ (mean (SD))	8.64 (0.21)	12.89 (2.16)	14.97 (2.26)	14.58 (0.50)	14.22 (0.74)
Masters					
Race (N)		200 (12)	400 (11)	800 (13)	
$[La]_b$ (min-max)		6.57-18.08	7.75-18.53	8.25-17.00	

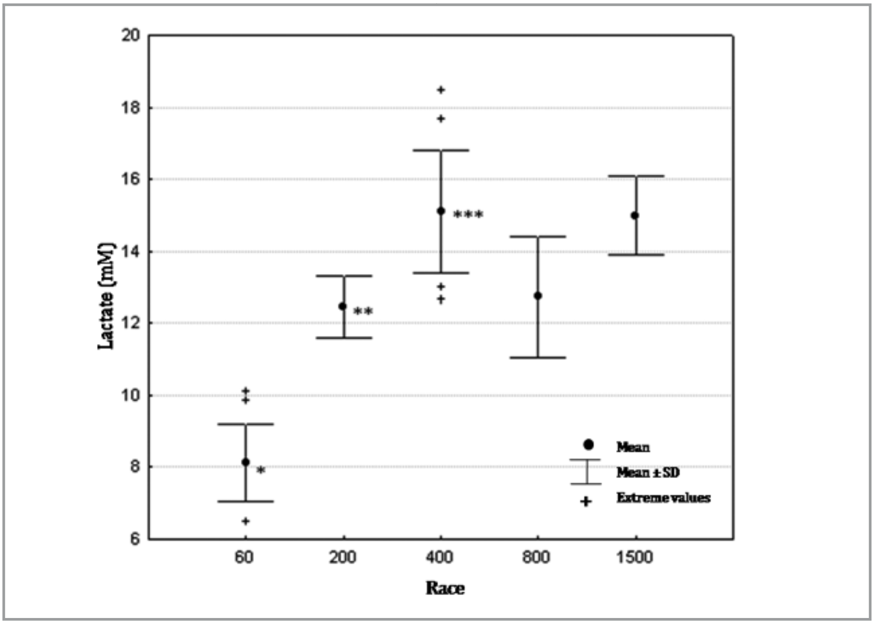

Figure 1: Post-competition blood lactate concentration (mean ± SD) measured in athletes competing in the 60m, 200m, 400m, 800m, 1500m indoors

** = significantly different from: 200m, 400m, 800m, 1500m; p < 0.01*
*** = significantly different from: 400m; p < 0.01*
**** = significantly different from: 800m; p < 0.01*

This study, however, presents some limitations that must be underlined. First, the subjects volunteered for participating in the study, therefore it was not possible to match the number of younger and older athletes, males and females, along with their performance level. Second, the level of post-competition $[La]_b$ was obtained with only one blood sample collected five to six minutes after the end of the race. Although the procedure of a single blood sample has been used previously[7, 12], a lactate kinetics would have been more accurate for determining the peak of post-competition $[La]_b$.

One of the main outcomes of this investigation is that apparently there are no differences in $[La]_b$ between males and females athletes of regional level, with the exception of 800m, where females exhibited a higher values of post-competition $[La]_b$. The latter could be somewhat explained with the particularly low-level of performances in the men's 800m. However, the comparison between males and females could not be supported by statistical analysis because of the low number of female athletes. Further research is required to investigate the differences in post-competition $[La]_b$ between men and women.

Post-competition $[La]_b$ in 60m sprint is lower than that of the other events essentially because it is a much shorter and faster race, where the athletes mostly rely on the alactic system for energy production. The level of post-competition $[La]_b$ in 200m, both in men and women, is higher than that reported by HAUTIER et al[7] in men competing at national level, i.e. at a higher level than those assessed in this study. Although this may look surprising, a difference in the site for blood collection[19] along with the different timing (2-3 min after the end of the race) could at least partially explain the divergent results. In contrast, results of $[La]_b$ for 400m, 800m, and 1500m races recorded in this study are lower than those presented by LACOUR et al[12] for the same events involving

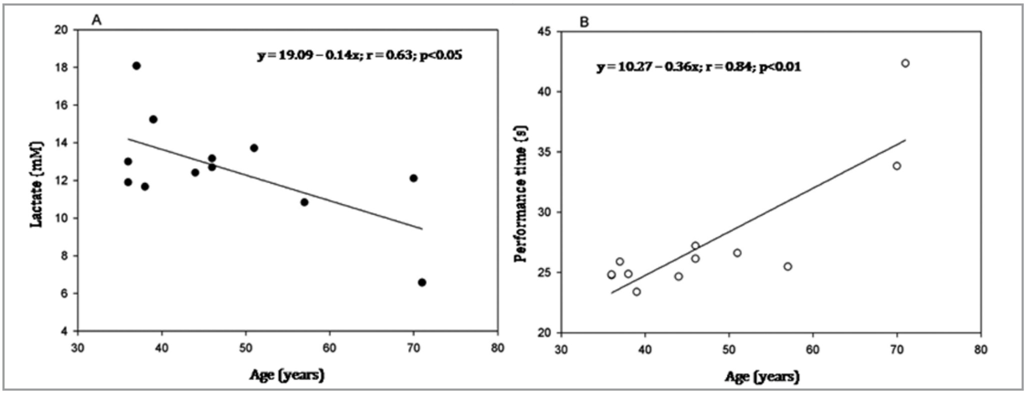

Figure 2: Post-competition blood lactate concentration (A) and performance time (B) related to age in Masters athletes competing in the 200m (the linear regression, coefficient of correlation and statistical significance are also reported)

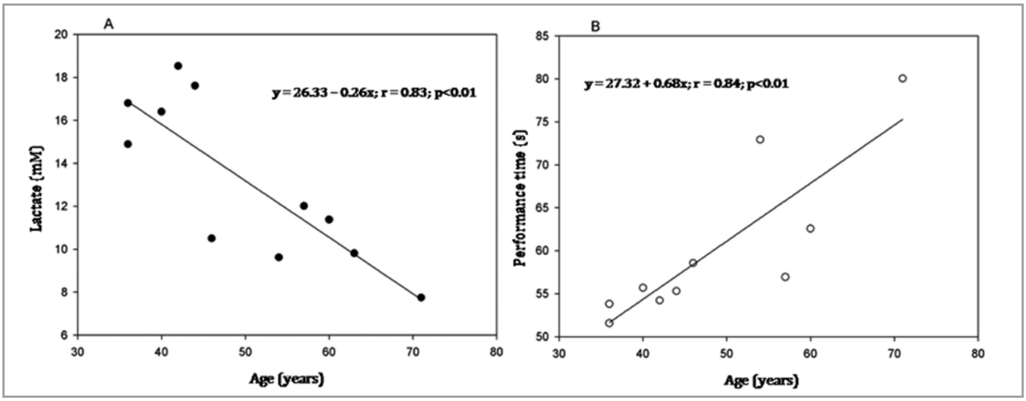

Figure 3: Post-competition blood lactate concentration (A) and performance time (B) related to age in Masters athletes competing in the 400m (the linear regression, coefficient of correlation and statistical significance are also reported)

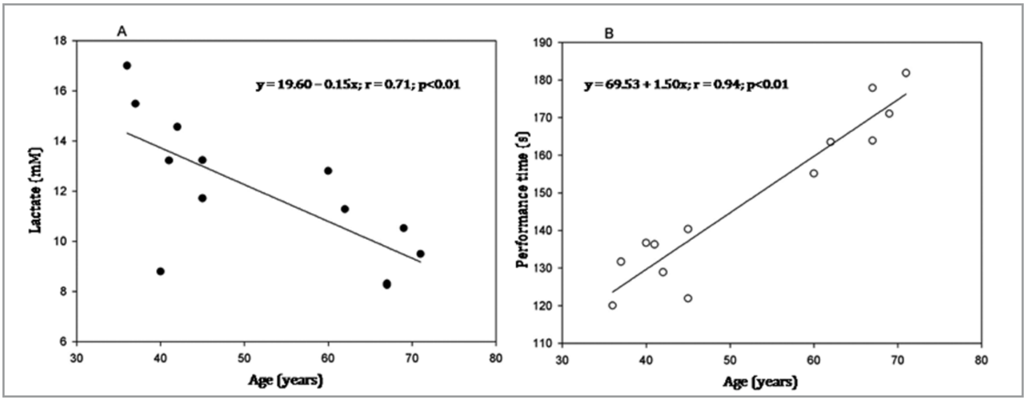

Figure 4: Post-competition blood lactate concentration (A) and performance time (B) related to age in Masters athletes competing in the 800m (the linear regression, coefficient of correlation and statistical significance are also reported)

top-level athletes. Since $[La]_b$ following competition can quantify the contribution of the anaerobic metabolism to the effort[11], top-level athletes are expected to exhibit greater lactic capacity than regional level athletes.

Masters athletes competing in the 200m, 400m and 800m displayed an age-related reduction in performance and $[La]_b$, particularly in the 400m where $[La]_b$ halved and PT doubled over a span of 35 years. This is in partial disagreement with another investigation[16] showing a much less steep age-related reduction in $[La]_b$, which becomes statistically significant only after 70 years of age. Nonetheless, these authors found in athletes aged 70 considerably higher levels of $[La]_b$ compared to those reported in this study, especially in the 200m and 400m. This discrepancy can be attributed to the greater performance level and training background of the athletes studied by KORHONEN et al[16], although the latter information is not available in the present study.

Conclusions

In this descriptive study a number of non-elite athletes participating in different running events have been assessed for post-competition $[La]_b$. For all categories of athletes, the event with the greatest level of $[La]_b$ is the 400m. No differences were evident between men and women, although this requires further research because performance level and sample size could not be matched in this study. Male Masters athletes exhibited a large age-related decline in performance and $[La]_b$, and further investigations should look at female Masters athletes. The results of this study add to the knowledge of energetics of running and have to potential to assist coaches in devising training programmes.

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REFERENCES

1. Coutts, A.; Reaburn, P. & ABT, G. (2003). Heart rate, blood lactate concentration and estimated energy expenditure in a semi-professional rugby league team during a match: a case study. J Sports Sci., 21(2):97-103.

2. Keskinen, K.L.; KOMI, P.V. & Rusko, H. (1989). A comparative study of blood lactate tests in swimming. Int J Sports Med., 10(3):197-201.

3. RODRIGUEZ-ALONSO, M.; FERNANDEZ-GARCIA, B.; PEREZ-LANDALUCE, J. et al. (2003) Blood lactate and heart rate during national and international women's basketball. J Sports Med Phys Fitness. 43(4):432-436.

4. BONIFAZI, M.; SARDELLA, F. & LUPO, C. (2000). Preparatory versus main competitions: differences in performances, lactate responses and pre-competition plasma cortisol concentrations in elite male swimmers. Eur J Appl Physiol., 82(5-6):368-373.

5. ARSAC, L.M. & LOCATELLI, E. (2002). Modeling the energetics of 100-m running by using speed curves of world champions. J Appl Physiol., 92(5):1781-1788.

6. FERNANDEZ, J. MENDEZ-VILLANUEVA, A. & PLUIM, B.M. (2006). Intensity of tennis match play. Br J Sports Med., 40(5):387-391; discussion 391.

7. HAUTIER, C.A.; WOUASSI, D.; ARSAC, L.M. et al. (1994). Relationships between postcompetition blood lactate concentration and average running velocity over 100-m and 200-m races. Eur J Appl Physiol Occup Physiol., 68(6):508-513.

8. SAWKA, M.N.; KNOWLTON, R.G.; MILES, D.S. et al. (1979).Post-competition blood lactate concentrations in collegiate swimmers. Eur J Appl Physiol Occup Physiol. 41(2):93-99.

9. KINDERMANN, W. & KEUL, J. (1972). Lactate acidosis with different forms of sports activities. Can J Appl Sports Sci., 2:177-182.

10. SCHNABEL, A. & KINDERMANN W. (1983). Assessment of anaerobic capacity in runners. Eur J Appl Physiol Occup Physiol. 52(1):42-46.

11. di PRAMPERO, P.E. & FERRETTI, G. (1999) The energetics of anaerobic muscle metabolism: a reappraisal of older and recent concepts. Respir Physiol., 118(2-3):103-115.

12. LACOUR, J.R.; BOUVAT, E. & BARTHELEMY, J.C. (1990). Post-competition blood lactate concentrations as indicators of anaerobic energy expenditure during 400-m and 800-m races. Eur J Appl Physiol Occup Physiol., 61(3-4):172-176.

13. STOLEN, T.; CHAMARI, K. CASTAGNA, C. et al. (2005). Physiology of soccer: an update. Sports Med., 35(6):501-536.

14. CABELLO MANRIQUE, D. & GONZALEZ-BADILLO, J.J. (2003). Analysis of the characteristics of competitive badminton. Br J Sports Med., 37(1):62-66.

15. FRANCHINI, E.; Yuri Takito, M.; Yuzo Nakamura, F. et al. (2003). Effects of recovery type after a judo combat on blood lactate removal and on performance in an intermittent anaerobic task. J Sports Med Phys Fitness, 43(4):424-431.

16. KORHONEN, M.T.; SUOMINEN, H. & MERO, A. (2005). Age and sex differences in blood lactate response to sprint running in elite master athletes. Can J Appl Physiol., 30(6):647-665.

17. COLAKOGLU, M.; TURGAY, F.; COLAKOGLU, S. et al. (1993). Turkiye salon atletizm sampiyonasinda musabaka sonrasi ekstraselluler kan laktadi ve performans arasindaki iliskinin incelenmesi. (Relationship between extracellular lactate and performance times in various events during Turkish National Indoor Track and Field Championship). Spor Hekimligi Dergisi (Turkish Journal of Sports Medicine), 28(4):181-190.

18. DAVISON, R.C.; COLEMAN, D.; BALMER, J. et al. (2000). Assessment of blood lactate: practical evaluation of the Biosen 5030 lactate analyzer. Med Sci Sports Exerc., 32(1):243-247.

19. CASTAGNA, C. (2006). L'influenza del sito di prelievo sulla concentrazione del lattato ematico (How the site of blood collection affects the level of blood lactate concentration). Coach & Sport Sci J., 1(3):14-15..