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POST-MATCH LACTIC ACID CLEARANCE AND HEART RATE: DIFFERENCES BETWEEN WINNERS AND LOSERS

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Abstract:
During the high intensity matches, players engage in aggressive physical interactions to overcome their opponents and succeed. These competitions generally involve two teams and are characterized by prominent athleticism, great display of extraordinary skills and mental skills that have obvious energetic costs (e.g., lactate accumulation) which can affect subsequent behavior. Few studies have addressed these costs in exercise and simulated game situation. Moreover, recent studies suggest psychoneuroendocrine (catecholamines, endorphins and glucocorticoids) regulation of metabolism during and following aggressive episodes. There were two main questions addressed in this study. Do winners and losers show differences in post-match (45-min) levels of plasma lactate and heart rate? Are levels of plasma lactate correlated with heart rate recovery? For this purpose, 10 intervarsity hockey players were randomly selected from MLS University (mean VO_2max=3.32 l/min (54.4 ml/kg/min)) and SGB University (mean VO2max=3.28 l/min (53.8 ml/kg/min)), (5 from each team). The data were collected during semifinal match of zonal intervarsity tournament. A group of 5 intervarsity hockey players from LNIPE, Gwalior (mean VO2max= 3.51 l/min) were used as control in the study. Anthropometric parameters and physical fitness were not correlated with levels of plasma lactate and heart rate as subjects were assumed to have identical physical fitness. At 45-min post-match, losers had significantly higher levels of mean plasma lactate (5.35mmol/l±0.308) and heart rate (77.947 b/m±2.077) when compared to levels in winners (3.714mmol/l±0.287,67.417b/m±2.102) and controls (3.784mmol/l±0.304, 68.037b/m±2.035), and there were no significant differences between winners and controls. From these results, following conclusions are recommended. First, elevated levels of blood lactate in losers, but not winners, result from psychoneuroendocrine factors rather than simple physical exertion, which retard metabolic recovery resulting in higher lactate levels, whereas winners return to pre-match lactate levels within 2h-3h post-match. Thus, the winners may clear blood lactate

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faster and seem to reflect positivity and accomplishment while losers show depression and submissive behavior.

Keywords: blood lactate clearance, psychoneuroendocrine factors, glucocorticoids, VO2max, endorphins

1. Introduction

Professionalism, passion and external rewards associated with the result of a match force an athlete to develop "WIN AT ANY COST" attitude resulting in more efforts,(G. Schuett, 2000)[1] which overtaxes physiological and energy systems of the body. Almost all the major games and sporting events require a blend of both anaerobic and aerobic glycolytic pathways to fuel the moderate-to-high intensity exercises, which is marked by a rise in blood lactate concentration and accelerated heartbeat.

At slightly higher exercise intensity than lactate threshold a second increase in lactate accumulation can be seen and is often referred to as the onset of blood lactate accumulation or OBLA. OBLA generally occurs when the concentration of blood lactate reaches about 4mmol/L. Intracellular accumulation of lactate creates a concentration gradient favoring its release from the cell. Blood lactate concentrations peak about 5 minutes after the cessation of intense exercise (assuming cessation is due to exhaustion from acidosis). The delay is attributed to the time required to buffer and transport lactic acid from the tissue to the blood. A return to pre-exercise levels of blood lactate usually occurs within an hour and light activity during the post-exercise period has been shown to accelerate this clearance.

2. Clearance of Blood Lactate

The process of lactic acid removal takes approx. 1 hour, (approx. 67% blood lactate cleared, Fox et al. 1981)[2] but this can be accelerated by undertaking an appropriate warm-down which ensures a rapid and continuous supply of O_2 to muscles. Lactate is cleared from blood, primarily by the liver, with the kidneys (10-20%) and skeletal muscles doing so to a lesser degree. Training also increases lactate clearance. This reflects increased hepatic capacity for gluconeogenesis as well as increased lactate transport capacity and oxidative capacity and reduced glycogenolysis in muscle. Faster lactate clearance occurs during active versus passive recovery, and that the decrease in lactate is more rapid during higher (60-100% of lactate threshold) than lower (0-40% of lactate threshold) ($p < 0.05$) intensities (Menzies P. (2010), Stanley et al.)[3,4]. Losing a match may induce psychological stress which increases catecholamines and glucocorticoids (cortisol), which impair the movement of healing immune cells to the sites of injury and interfere with the removal of damaged tissues (Cramer et al.)[5].

There have been "winning effects" reported in several studies, attributed to the positive role of psychoneuroendocrine factors (catecholamines, endorphins and glucocorticoids) which are mainly associated both with changes in pain perception and mood state and are possibly of importance in substrate metabolism. The present study aimed to investigate the differences in heart rate and blood lactate recovery pattern between winning and losing teams and provide theoretical association between psychoneuroendocrine factors and blood lactate and heart rate recovery.

3. Method and Materials

For the purpose of the study, a total of 10 male intervarsity hockey players, 5 each from MLSU, Udaipur and SGBU, Amravati were randomly selected (age group 18yr-25yr) during semifinal match of west zone intervarsity hockey tournament at LNIPE, Gwalior. Additionally, 5 male intervarsity hockey players from LNIPE, Gwalior were randomly selected to serve as controls in the study. The following variables were selected:

- Blood lactate level;
- Heart rate.

3.1 Design

The design is descriptive and comprises measurements taken at certain intervals after the match in each sample and various comparisons between the subjects.

3.2 Testing Procedure

The testing was done in 2 phases. In the first phase, the maximum oxygen consumption (VO_2 max) of the players was determined 24 hours prior to the match through a graded exercise Protocol on a motor driven treadmill. The initial speed of treadmill running was 8 km/h (2.22 m/sec) and was increased at the rate of 2 km/h (0.55.m/sec) till volitional exhaustion. The ventilation and oxygen consumption were monitored by an automatic analyzer (QCPX) at 30 sec intervals.

In the second phase, Blood lactate was tested using blood lactate kit (LACTATE PRO2 and non–reusable strips)[6,18]. The test was demonstrated to the subjects prior to the actual administration of the testing program along with adequate explanation. The blood samples were collected from players at 5min, and 45 min post-match. The subjects were allowed to intake minimum amount of water as fluid during recovery. The heart rates were counted by the team of qualified scholars by palpation at radial artery for 10sec, multiplied by 6 and recorded instantaneously.

3.3 Statistical Technique Employed

For comparing the lactic acid clearance and heart rate among winning and losing candidates, two Univariate Analysis of Covariance (ANCOVA) were applied using the Statistical Package for Social Sciences (SPSS 20) to partial out any differences in lactate levels and heart rate immediately after match. Correlational statistical analysis (Pearson’s product moment coefficient) was employed using SPSS 20 to investigate the relationship between recovery patterns of blood lactate and heart rate. The level of significance used in the statistical analysis was α=0.05. The normality of data was checked beforehand to ensure absence of outliers.

4. Results

Table 1 contains the descriptive values for mean and standard deviation of the participants in 3 different match result situations on the variables- postlac and postHR.

Table 1: Descriptive Statistics

Dependent Variables: Blood lactate at 45min, heart rate at 45min

Groups	Blood lactate (mmol/l)		Heart rate (beats/min)		N
	Mean	Std. dev	Mean	Std. dev.	
Win	3.72	0.58	66.60	3.21	5
Loss	5.28	0.76	78.60	6.99	5
Control	3.85	0.52	68.20	3.11	5
Total					**15**

Table 1 shows the unadjusted descriptive statistics (means and standard deviations) for the variables.

Table 2: Adjusted estimates

Dependent variable: Blood lactate at 45min (postlac)

Match result	Mean	S.E.	95% confidence interval	
			Lower bound	Upper bound
Win	3.714[a]	0.287	3.083	4.345
Lose	5.350[a]	0.308	4.673	6.027
Control	3.784[a]	0.304	3.125	4.454

a. Covariates appearing in the model are evaluated at the following values: blood lactate at 5min=10.2947

Table 2 shows the descriptive statistics of the data on blood lactate at 45 min after adjusting for pretesting (covariate). The values are adjusted to eliminate the effect of any initial differences in the dependent variable postlac.

Table 3: Adjusted estimates

Dependent variable: Heart rate at 45min (postHR)

Match result	Mean	S.E.	95% confidence interval	
			Lower bound	Upper bound
Win	67.417[a]	2.102	62.791	72.042
Lose	77.947[a]	2.077	73.376	82.518
Control	68.037[a]	2.035	63.558	72.576

a. Covariates appearing in the model are evaluated at the following values: heart rate at 5 min=139.60

Table 3 shows the descriptive statistics of the data on heart rate at 45 min after adjusting for pretesting (covariate). The values are adjusted to eliminate the effect of any initial differences in the dependent variable postHR.

Table 4: Tests of Between-Subjects Effects

Dependent Variable: Blood Lactate at 45min (postlac)

Source	Type I Sum of Squares	df	Mean Square	F	Sig.
Prelac	.566	1	.566	1.377	**.265**
Result	7.096	2	3.548	8.632	**.006**
Error	4.522	11	.411		
Corrected total	12.184	14			

Table 4: ANCOVA table for data on blood lactate at 45min in different match result situations.

Table 4 shows F-value for comparing the adjusted means of postHR in 3 match result situations. The significant F-value ($p < 0.05$) for result row shows that there is significant difference among group means of different groups. Also it is interesting to find insignificant F-value for prelac row which is as desired because it shows that initially all the match result groups had similar levels of blood lactate. For investigating which group is best, pairwise comparison among group means was conducted as shown in table 5.

Table 5: Pairwise Comparison of Match Result Groups

(I) match result	(J) match result	Mean difference (I-J)	Std. error	Sig.^{b}
Win	Lose	-1.636*	.423	.003
	Control	-.070	.416	.869
Lose	Win	1.636*	.423	.003
	Control	1.565*	.458	.006
Control	Win	.070	.416	.869
	Lose	-1.565*	.458	.006

Dependent variable: blood lactate at 45min (postlac)

*=significant at 0.05 level

Table 5 shows pairwise differences between different match result groups. Here, significant differences occur between win-lose and lose-control pairs of groups while win-control pair showed no significant difference.

Table 6: Tests of Between-Subjects Effects

Source	Type I Sum of squares	Df	Mean square	F	Sig.
Prehr	146.150	1	146.150	7.078	.022
Result	326.435	2	163.218	7.904	.007
Error	227.148	11	20.650		
Corrected Total	699.733	14			

Dependent Variable: heart rate at 45min (postHR)

Table 6: ANCOVA table for data on heart rate at 45min in different match result situations.

Table 6 shows F-value for comparing the adjusted means of postHR in 3 match result situations. The significant F-value ($p < 0.05$) shows that there is significant difference among group means of different groups. Also, interesting to find is the significant F-value for preHR row, which shows that the groups were not similar initially on heart rate and validate the application of ANCOVA. For investigating which group is best, pairwise comparison among group means was conducted as shown in table 7.

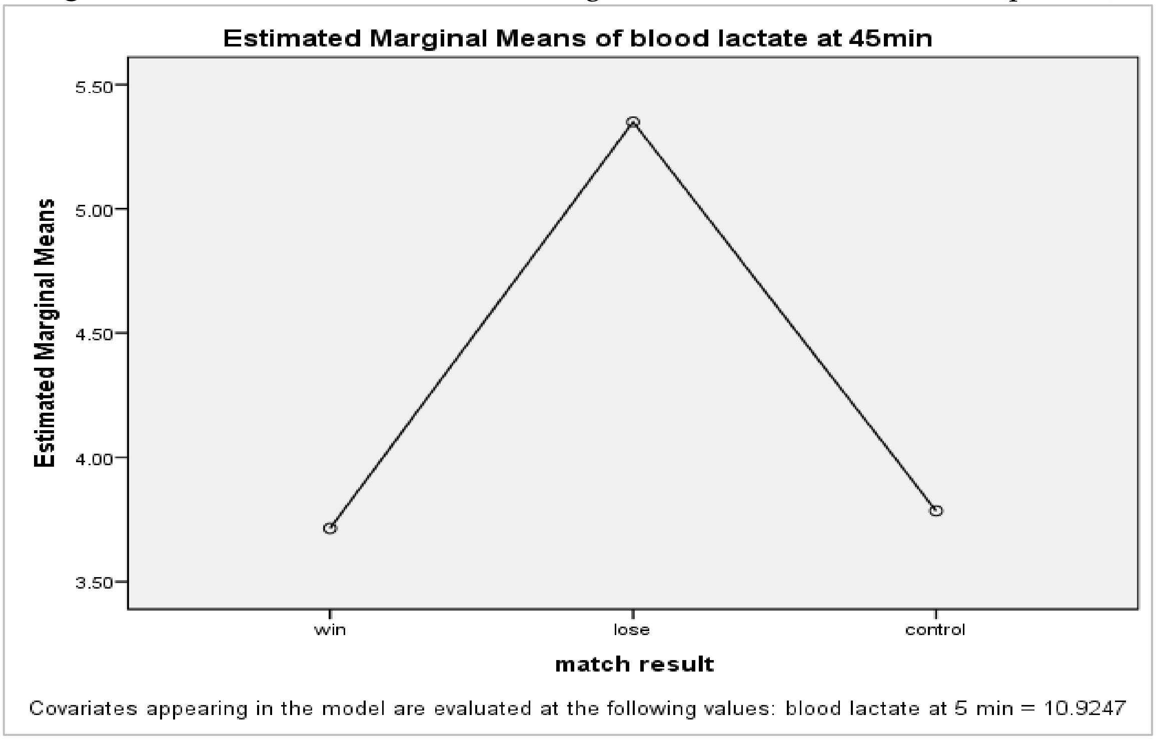
Table 7: Pairwise Comparisons

(I) match result	(J) match result	Mean difference (I-J)	Std. error	Sig.[b]
Win	Lose	-10.530*	3.031	.005
	Control	-.620	2.945	.837
Lose	Win	10.530*	3.031	.005
	Control	9.910*	2.892	.006
Control	Win	.620	2.945	.837
	Lose	-9.910*	2.892	.006

Based on estimated marginal means.
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

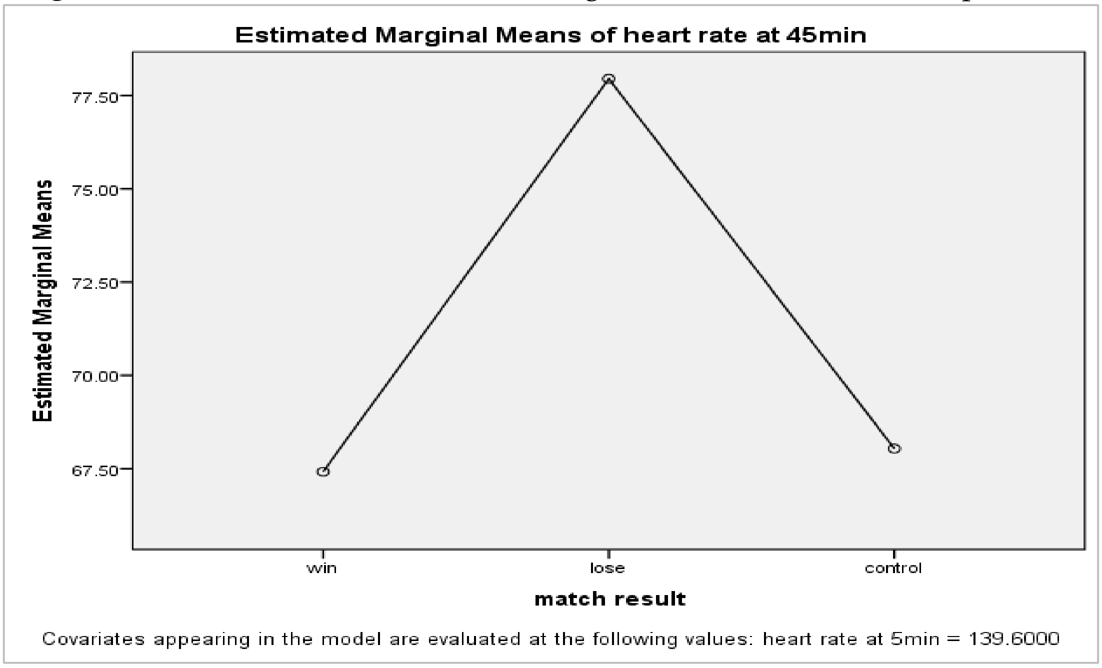
Table 7 shows pairwise comparison among various match result situations for heart rate at 45min in which significant differences occur between win-lose and lose-control groups while win-control pair is insignificant.

Figure 1: Profile Plot for match result against blood lactate at 45min (postlac)



By looking at profile plot, it is quite clear that in losing group, blood lactate levels at 45min are significantly higher than at win and control level which can be verified by looking at table 5.

Figure 2: Profile Plot for match results against heart rate at 45min (postHR)



By looking at profile plot, it is quite clear that in losing group, blood lactate levels at 45min are significantly higher than at win and control level which can be verified by looking at table 7.

Table 8: Correlation

			Heart rate at 45min
Win	Blood lactate at 45min	Pearson r Sig.(1-tailed) N	0.195 **0.377** 5
Lose	Blood lactate at 45min	Pearson r Sig.(1-tailed) N	-0.215 **0.364** 5
Control	Blood lactate at 45min	Pearson r Sig.(1-tailed) N	-0.475 **0.209** 5

Table 8 shows correlation between blood lactate at 45min and heart rate at 45min. Noticeable observation is that no correlation coefficient is statistically significant at 0.05 level of significance.

But since theory suggest (Brooks et al., Baker)[7,8] that blood lactate linearly increases with increments in exercise intensity and that heart rate almost linearly increases with exercise intensity, thus this phenomenon needs further investigation

5. Discussion on Findings

It is well documented that the removal of lactate following exercise is enhanced if, during recovery, the subject exercises at a reduced intensity. Although lactate can serve as a substrate for the kidney and heart muscle and is resynthesized back to glycogen in the liver, it can also be utilized by resting and exercising skeletal muscle.

It has been found that blood lactate clearance rate is greater in winning team as compared to losing team but no significant difference has been shown between winning and control groups. The reasons might be associated, as discussed by Cramer et al., to the possible role of depression and stress on healing and recovery of body tissues. The findings of the present study emphasize the possible role of psychological factors and psychological skill training in the coping of stress and depression in order to enhance recovery of physiological variables (Anshel, (1997), Serrano, (2000))[9,10]. The possible role of hormones like serotonin, dopamine, chatecholamines and other factors which contribute to fatigue cannot be overlooked which opens the new horizon of psycho-physiological research domain (Schwarz etal.)[11]. Present study confirmed that blood lactate clearance rate is significantly different in win and lose situation, but failed to establish any meaningful relationship between heart rate and blood lactate clearance rate in winning, losing and control groups.

The levels of plasma lactate we report are within the ranges reported in previous studies on human samples (Diamant et al., Belcastro et al., Stallknecht et al.)[12,13,14]. Thus, the differences in plasma lactate levels in winners and losers may demonstrate the influence of aggressive interactions and stress responses on energy metabolism. Studies on aggression demonstrated a greater metabolic cost of agonism for subordinate relative to dominant individuals.

The binary outcome of competition may be a key factor with respect to the differences in post-match levels of plasma lactate and heart rate in winners and losers. This study, to the best of my knowledge, is the first of its kind in that it investigates lactate clearance in different match result situations.

Wilson and Gatten[15] suggested that increased sympathetic activity, resulting from the agonistic interaction, generated increased catecholamine levels that subsequently stimulated glycogenolysis in skeletal muscle and the liver. These conclusions are consistent with a recent study on athletes, and suggest that the neuroendocrine response to the agonistic interaction may be differentially modulating plasma lactate levels in winners and losers. Finally, during match, both the teams showed exceptional athleticism and efforts that are consistent with post-match lactate and heart rate data which showed insignificant differences among winning, losing and control groups. In the study, higher levels of post-match plasma lactate in losers appear to result from psychoneuroendocrinological factors rather than metabolic responses to exercise per se. This interpretation is consistent with a study by Schuett and Grober [16] which showed in snakes, that the duration of a fight was not correlated with muscle lactate levels, and that winners and controls had lower lactate levels than losers.

Also, since the increased levels of brain monoamines and reduced stress hormones enhance intracellular metabolism of lactate in winners while opposite in losers, thus, greater blood lactate is oxidized intracellular in winners while, it diffuses into blood in losers that account for elevated blood lactate in losing group. Table 8 shows correlation between blood lactate at 45min and heart rate at 45min. Noticeable observation is that no correlation coefficient is statistically significant at 0.05 level of significance. But since theory suggest (Phillips)[17] that blood lactate linearly increases with increments in exercise intensity and that heart rate almost linearly increases with exercise intensity, thus this phenomenon needs further investigation. By addressing some of the limitations of present study, future studies can provide a more detailed explanation of the hormonal and metabolic correlates of male agonistic behavior. The measurement and analysis of psychoneuroendocrine factors could have provided causal attribution for varying blood lactate recovery pattern in winning and losing teams. Replication of present study on large sample is necessary to generalize the claim.

References

1. Gordon W. Schuett, Matthew S. Grober (2000) Post-fight levels of plasma lactate and corticosterone in male copperheads, Agkistrodon contortrix (Serpentes, Viperidae): differences between winners and losers, Physiology & Behavior, 71 (2000), 335-341.
2. Edward l Fox and Donald K, Mathews The Physiological basis of physical education and athletics, 3rd edition, 1981, CBS College Publishing, WB Saunders company, p.p. 33-34.
3. Menzies P, Menzies C, McIntyre L, Paterson P, Wilson J, Kemi O J.(2010) Blood lactate clearance during active recovery after an intense running bout depends on the intensity of the active recovery, Journal of Sports Sciences,28(9): 975-82.
4. Stanley W. C., Gertz E. W., Wisneski J. A., Morris D. L., Neese R. A., Brooks G. A., Systemic lactate kinetics during graded exercise in man, American Journal of Physiology-Endocrinology and Metabolism, December 1985 Vol. 249 no. 6, 595-602.
5. Cramer Roh, J. L., & Perna, F.M. (2000) Psychology/counseling: a universal competency in athletic training, journal of athletic training, 35(4),458-465.
6. Rebecca K. Tanner, Kate L. Fuller, Megan L. R. Ross (2010) Evaluation of three portable blood lactate analyzers: Lactate Pro, Lactate Scout and Lactate Plus, Eur J Appl Physiol (2010) 109:551–559.
7. Brooks G. A. (1986) The lactate shuttle during exercise, evidence and possible control. In: Watkins J, Reilly T, Burwits L, editors. Sports Science. E and FN Spon Ltd; London: 1986. p. 69.
8. Baker S. J. (1982) Post competition lactate levels in canoe slalomists. Br J Sports Med 1982; 16: 112.
9. Anshel, Mark H., (1997),Sports Psychology from theory to practice, Gorsuch Scarisbrick publishers, Scottsdale, Arizona, p.p. 27.
10. M. A. Serrano, Alicia Salvador, E. González-Bono, C. Sanchís and F. Suay (2000) Hormonal responses to competition, Psicothema, Vol. 12, no. 3, pp. 440-444

11. Schwarz L, Kindermann W. Changes in beta-endorphin levels in response to aerobic and anaerobic exercise, Sports Med. 1992 Jan;13(1):25-36.
12. Diamant, B., J. Karlsson, and B. Saltin. Muscle tissue lactate after maximal exercise in man. Acta Physiol. &and. 72: 383-384, 1968.
13. Belcastro A. N., Bonen A. Lactic acid removal rates during controlled and uncontrolled recovery exercise. J Appl Physiol 1975; 39: 932-7.
14. Stallknecht B, Vissing J, Galbo H.Lactate production and clearance in exercise. Effects of training. A mini-review. Scand J Med Scie. Sports.1998 Jun; 8(3):127-31.
15. Wilson, M. A., and R. E. Gatten, Jr. 1989. Aerobic and anaerobic metabolism of paired male lizards (Anolis carolinensis). Physiol. Behav. 46:977-982.
16. Schuett, Gordon W, Grober, Matthew S (2000) Post-fight levels of plasma lactate and corticosterone in male copperheads, Agkistrodon contortrix (Serpentes, Viperidae): differences between winners and losers, Physiology Behavior. 2000 Nov 1-15;71(3-4):335-41.
17. Phililps, Shaun (2015) Fatigue in sport and exercise.
18. Jacinta M. Bonaventura, Ken Sharpe, Emma Knight, Kate L. Fuller, Rebecca K. Tanner, and Christopher J. Gore (2015) Reliability and Accuracy of Six Hand-Held Blood Lactate Analyzers, J Sports Sci Med. 2015 Mar; 14(1): 203–214.
19. Masatoshi, Matsumasa and Minoru, Murai (2005) Changes in blood glucose and lactate levels of male fiddler crabs: effects of aggression and claw waving, Animal Behaviour Volume 69, Issue 3, March 2005, Pages 569-577.
20. Hermansen L., Stensvold I. Production and removal of lactate during exercise in man. Acta Physiol Scand 1972; 86: 191-201.
21. Ghosh A. K., Mazumdar P., Goswami A., Ahuja A., Puri T. P. S. Heart rate and blood lactate response in field hockey. Ann Sports Medicine. 1990;5:85–88.
22. McDermott, J. C., Bonen, A., "Lactate transport by skeletal muscle sarcolemmal vesicles." Mol. Cell. Biochem. 122: 113-121. 1993.
23. McCullagh, K. J. A., Juel, C., O'Brien, M., Bonen, A. "Chronic muscle stimulation increases lactate transport in rat skeletal muscle." Mol. Cell. Biochem. 156: 51-57, 1996.