Original article:

Effects of exercise on plasma lactic acid and body temperature in man, following a standardized meal

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Abstract

Background*:* The effects of exercise on plasma lactic acid level and body temperature following a standardized meal were carried out on 20 healthy young individuals (aged between 18 and 29 yrs.), consisting of 10 males and 10 females. The physical fitness of the subjects was determined measuring their blood pressure, pulse rate and other physical examinations. ***Methodology****:* Each subject was made to ride the bicycle ergometer for 6mins, at a rhythmic cadence of 50revolution/min via 100beats metronome counts. Blood samples were collected before and after the exercise to analyze for the pre and post exercise plasma lactate levels. Pre and post-exercise values for body temperature were also measured. Statistical tests were carried out at 95% CI (P=0.05). ***Result:*** The result obtained showed that exercise causes a statistically significant increase ($p < 0.05$) in both plasma lactate concentration (from a pre-exercise mean value of 0.98 ±0.07mmol/L to post- exercise mean value of 2.84 ±0.21mmol/L) and body temperature (from a mean value of 36.45 ±0.13^{0}C before exercise to a mean value of 36.91 ±0.19^{0}C after exercise). ***Conclusion****:* There was a statistically significant increase in plasma lactateand body temperature because of exposure to exercise which is in line with findings from most previous studies.

Keywords: Exercise; Plasma; Lactate; Temperature.

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Introduction

Over the past decades, numerous scientific researchers have examined the relationship between physical activity and physical fitness. Exercise is the physical activity that is planned, structured and repetitive for the purpose of conditioning any part of the body. It is utilized to improve health, maintain fitness and is important as a mean of physical rehabilitation.[1] Typical exercise activities include treadmill exercise, fast walking, running, bicycle ergometer exercise, cycling etc.[2] Exercise is a muscular activity that involves activation of voluntary muscles and chemical demands of the muscles underlies most of the phenomena of exercise.[2]

Glucose is one of the major substrate that is used by the body during exercise and the body has two ways to use glucose: aerobic and anaerobic glycolysis.[3] Lactic acid is a product, which results from anaerobic glycolysis. The liver can convert it back to glucose by gluconeogenesis. The expression "Lactic acid" is used most commonly by athletes to describe the intense pain felt during exhaustive exercise, especially in events like the 400 metres and 800 metres.[4]

Many coaches and athletes routinely perceive lactic acid (specifically lactate) as a dead end waste product that is completely unfavourable to all athletes' performance.[4] Though this assumption may no longer be considered accurate as many studies are beginning to evolve investigating effects of lactate accumulation.[4-6] While sports scientists are largely in agreement that lactate behaves more like an athlete's friend than foe, recent research has now begun to question one of the basic tenets of muscular fatigue; increased acidity or lactic acidosis.[4]

Exercise is a form of physical activity and may

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offer insight into how the body responds after being subjected to regular strenuous activity.[7] During exercise, lactic acid is produced in skeletal muscle cells by glycogenolysis, typically caused by inadequate oxygen supply to the mitochondria and the accumulation of lactic acid causes intracellular pH to decline.[8] Lactic acidosis develops at a metabolic rate that is specific to the individual and the task being performed.[5] The capacity to perform maximally during brief maximum dynamic exercise is enhanced following training but increases in muscle and blood lactate remain unchanged.[4] Although other substrates, such as glucose, can enter glycolysis and lead to pyruvate production, only glycogenolysis can provide enough glucosyl units to result in excess lactate production and intracellular acidosis.[9]

Normal human body temperature, also known as normothermia or euthermia, is a concept that depends upon the place in the body at which the measurement is made, and the time of day and level of activity of the body.[10] There are basically two types of body temperatures based on body parts; the core and skin temperature.[10]No single core temperature can be considered normal, because measurements in many healthy people have shown a range of normal temperatures measured orally, from less than 97°F (36°C) to over 99.5°F (37.5°C). The average normal core temperature is generally considered to be between 98.0° and 98.6°F when measured orally and about 1°F higher when measured rectally.[8] The body temperature varies with temperature extremes of the surroundings and metabolic activities of the body.[8]

Thus, the aim of this study is to investigate the effects of exercise on both plasma lactic acid and body temperature of selected subjects after a standardized meal. This work seeks to investigate established facts and possibly find out new information on the effects of exercise on plasma lactic acid in man while also looking at it effects on body temperature.

Materials and methods

Twenty(20) healthy subjects (consisting of 10 male and 10 female undergraduate students) participated in this study, after an informed consent. All the subjects were non-athletes and their health status was ascertained via the use of a case record form and physical examination by medical personnel. The age range for the subject was between eighteen to twenty nine years. An ethical approval for the study was obtained from the research and ethics of the university.

Exercise was performed with the use of a bicycle ergometer. Subjects were made to familiarize themselves with the bicycle ergometer a day before the actual test protocol. During the actual test protocol, each of the subjects was made to ride the bicycle ergometer for 6mins, at a rhythmic cadence of 50revolution/min via 100beat metronome counts against a uniform resistance (work load) of 600kilopound/min for both males and females. The exercise was carried out in the morning an hour after a uniform meal of bread and water were given to all the subjects.

A 2mls volume of blood was collected before and after the exercise from each subject through the anticubital vein of the subjects using 2mls pyrogen free plastic disposable needle and syringes. The blood was added to fluoride oxalate bottle. Plasma was separated by centrifugation at 1500revolution/min for 5mins. Plasma was then stored at-20^{0}c which was later used for lactate analysis.

On the other hand, the body temperature of the subjects were measured using clinical thermometer before/after the exercise. The bulb of the thermometer was inserted to their armpit for the measurement.

The statistical analysis was carried out using unpaired and paired T-Test. The level of significant was set at 95% CI (P=0.05).

Ethical approval was sought from the university ethics committee.

Results

All readings related to demographic and anthropometric information of the subjects were taken before exercise.

The table 1 below shows the sex and age of the subjects.

Table 1: Demographic data of subjects

Variables	Frequency (n=20)	Percentage (%)	Cumulative Percentage (%)
Sex of subjects			
Female	10	50.0	50.0
Male	10	50.0	100.0
Age (yrs.) of Subjects			
18 - 20	7	35.0	35.0
21 - 23	8	40.0	75.0
24 - 26	4	20.0	95.0
27 - 29	1	5.0	100.0
Mean ±SEM = 21.60 ±0.55 yrs.			
Minimum = 18 yrs.			
Maximum = 28 yrs.			

Majority of the subjects (75%) were between age 18 to 23 years with a mean age of 21.60 ±0.55 years.

Table 2: Anthropometric data of subjects

Variables	Frequency (n=20)	Percentage (%)	Cumulative Percentage (%)
Weight (kg)			
51 - 55	6	30.0	30.0
56 - 60	6	30.0	60.0
61 - 65	3	15.0	75.0
66 - 70	2	10.0	85.0
> 70	3	15.0	100.0
Mean ±SEM = 61.15 ±2.24 kg.			
Minimum = 51 kg.			
Maximum = 92 kg.			
Height (m)			
1.50 - 1.59	4	20.0	20.0
1.60 - 1.69	9	45.0	65.0
1.70 - 1.79	7	35.0	100.0
Mean ±SEM = 1.65 ± 0.02m			
Minimum = 1.54m			
Maximum = 1.79m			
BMI (kg/m^2)			
Underweight (<18.5)	2	10.0	10.0
Normal (18.5 - 24.9)	15	75.0	85.0
Overweight (25.0 - 29.9)	2	10.0	95.0
Obese (> 29.9)	1	5.0	100.0
Mean ±SEM = 22.42 ±0.80 kg/m^2			
Minimum = 17.43 kg/m^2			
Maximum = 32.21 kg/m^2			

From the table above, most of the subjects (60.0%) were between 51 to 60 kg in weight and also 65% were between 1.50 to 1.69m in height. The mean weight and height of the subjects were 61.15 ± 2.24 kg and 1.65 ± 0.02m respectively.

The BMI results of the subjects shows that majority of them (75%) were normal.

Table 3: Mean plasma lactate level and body temperature of subjects before and after exercise.

	Plasma Lactate Level (mmol/l)		P value	Body Temperature (^0C)		P value
	Before Exercise	After Exercise		Before Exercise	After Exercise	
	Mean ± SEM	Mean ± SEM		Mean ± SEM	Mean ± SEM	
N = 20	0.98 ±0.07^a	2.84 ±0.21^b	0.001*	36.45 ±0.13^c	36.91 ±0.19^d	0.012*

*=statistically significant.

Mean values with different superscript letters are significantly different.

N = Total number of Subjects.

SEM= Standard Error of Mean.

There was a statistically significant difference between plasma lactate level before and after exercise ($P<0.05$). Mean value after exercise was greater than mean value before exercise. Also, there was statistically significant difference between body temperature before and after the exercise. Body temperature showed a significant increase in mean values after exercise ($P<0.05$).

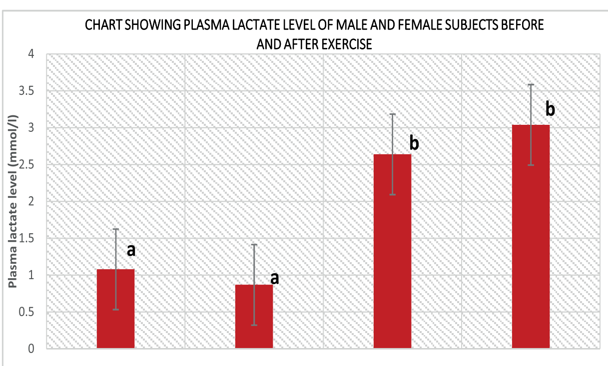
Table 4: mean difference between plasma lactate level and body temperature before and after exercise based on gender.

	Plasma Lactate Level (mmol/l)			Body Temperature (^{0}C)		
	Before Exercise	After Exercise	P value	Before Exercise	After Exercise	P value
	Mean ± SEM	Mean ± SEM		Mean ± SEM	Mean ± SEM	
Male N=10	1.08 ±0.10	2.64 ±0.35	0.042	36.70 ±0.16	36.99 ±0.27	0.001
Female N=10	0.87 ±0.08	3.04 ±0.22	0.011	36.20 ±0.17	36.84 ±0.28	0.003

*=statistically significant.
N = Total number of Subjects.
SEM= Standard Error of Mean.

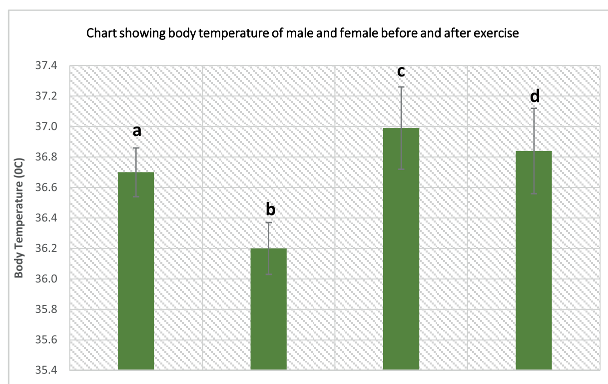
In both before and after exercise, the males Vs females plasma lactate level was insignificant. The mean value for male plasma lactate level was lower when compared with female mean value in both instances.

Also, from the table above the mean pre and post-exercise body temperature of male vs female was not significant ($P<0.05$), although values in male were greater than those in female.



NB: Graph with the same letters are not statistically significant. Graphs with differerent letters ae statistically significant at (P<0.05)

Fig 1: Chart showing plasma lactate level of male and female sujects before and after exercise.



NB: Graphs with the same alphabet are not statistically significant. Graphs with different letters were satistiically significant (P<0.05)

Fig 2: Chart showing body temperature of male and female sujects before and after exercise.

Discussion and conclusion

The muscle produced lactic acid, but also use lactic acid.[11] Many studies have confirmed that majority of lactic acid is removed from our bloodstreams through oxidation. That is, it is converted to energy and used to fuel our muscles. Also some are cleared by conversion to glycogen which is used to produce further energy.[3,4,9] The result of the pre and post exercise plasma lactate levels (Table 2) shows that the mean value for pre-exercise measurement was 0.98 ± 0.07mmol/l while that of the post-exercise was 2.84 ± 0.21mmol/l and also, there was a significant difference when the post-exercise values was compared with the pre-exercise values ($p<0.05$). This significant increase in blood lactate immediately after exercise is consistent with reports from several literatures which supported the fact that blood lactic acid levels increases after exercise.[4,5,9] The significant increase in blood lactic acid level might be an important cog in mechanisms that fuel running activities.[5] This accumulation cannot be tolerated by the cell which convert pyruvate to lactate and evacuates it into the blood.[8] Like blood lactate, the pre and post-exercise body temperatures were increasingly significant ($p<0.05$). The increase in body temperature was as a result of increase in basal metabolic rate which involves heat generation.[8] The extra rate of metabolism can also result from increase muscle activity including muscle contractions caused by exercise.[8] The significant increase in body temperature is in line with work carried out on influence of the development of fatigue, in which it was reported that when the rate of heat production in the body is greater than the rate at which heat is being lost, heat builds up in the body and the body temperature rises.[12] The pre and post-exercise comparism among male and female body temperature were statistically insignificant ($p<0.05$) showing that gender does not have influence on this parameter. In conclusion, this study has affirmed the myriad information that participation in a given duration of exercise will increase the level of plasma lactate. Such increase can be beneficial in energy generation by the muscles and may not necessary have an adverse effect (fatigue) as argued by some studies that lactic acid may not be the cause of fatigue following exercise.

Also the significant increase in body temperature following a bout of exercise which is as a result of increased metabolic rate is in consonance with the widely reported information in several literatures that exercise increases body temperature.[4-6]

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