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Acute Metabolic Response (Serum Glucose, Lactate & Triglyceride levels) To Fasting and Post-Prandial Exercise

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ABSTRACT

Background

Metabolic responses to exercise are extremely complex, involving many interacting variables like endocrinological, physiological (cardiovascular and neuromuscular), biochemical, nutritional, and central nervous system components. So the study was done to analyze the acute metabolic response (Serum Glucose, Lactate & Triglyceride levels) to exercise in fasting and postprandial state.

Method-

The Volunteers selected were subjected to two exercise sessions in fasting and in fed state separated by 72 hours each. Two venous samples of volunteers were obtained prior to and immediately after exercise, and used for determination of serum glucose, lactate, and triglyceride levels.

Result-

Glucose concentration was increased in the case of exercise during fasting and a significant reduction in glucose concentration in the postprandial period. The lactate concentration increased significantly as compared with the rest in both conditions Serum lactate level during fed state was significantly less than that during fasting state. Triglycerides also increased in the two experimental conditions, though they were significantly higher after exercise during fasting than in the case of postprandial exercise.

Conclusion- Postprandial exercise is better as compared to exercise in fasting state.

Keywords: Glucose, Exercise and Lactate.

INTRODUCTION

Metabolism is the set of life-sustaining chemical transformations within the cells of organisms and is divided into two categories: **catabolism**, and **anabolism**. The chemical reactions of metabolism are organized into metabolic pathway, by a sequence of enzymes Enzymes allow the regulation of metabolic pathways in response to changes in the cell's environment or to signals from other cells. Metabolic responses to exercise are extremely complex, involving many interacting variables, which include endocrinological, physiological (cardiovascular and neuromuscular), biochemical, nutritional, and central nervous system components[1]**.** As the environment of most persons is constantly changing, the reactions of metabolism must be finely regulated to maintain a constant set of conditions within cells, a condition called homeostasis[2,3]**.** There are multiple levels of metabolic regulation. **Intrinsic** regulation and Extrinsic control by means of these signals. These signals are usually

in the form of soluble messengers such as hormones and growth factors and are detected by specific receptors on the cell surface.These signals are then transmitted inside the cell by second messenger systems that often involve phosphorylation of proteins[4]. There are different levels of metabolic integration during exercise like-Intensity of exercise, Duration of exercise, Effects of prior conditioning/training, Existing hormonal level and Effects of prior dietary intake so the study was done to analyze the acute metabolic response (Serum Glucose, Lactate & Triglyceride levels) to exercise in fasting and postprandial state.

Material methods-

50 Healthy adults in Department of Medicine in Acharya Shri Chander College of Medical Sciences and Hospital (ASCOMS& Hospital), Sidhra, Jammu were selected and after taking approval by the Institutional Ethics Committee of the hospital.

The Volunteers were subjected to preliminary anthropometric assessment and assessment of maximal oxygen consumption ($_{VO2max}$) using uniform and accurate tools like for Weight,for Height, $_{VO2max}$ was measured using the formula VO_2 max = 15 x (HR_{max}/HR_{rest}) where HR refers to heart rate - maximum (HR_{max}) and at rest (HR_{rest}) [5]. The maximum heart rate was calculated by subtracting the age in years from 220 [6]. A questionnaire regarding possible pathologies, present and past history, level of physical activity, eating habits was recorded for each volunteer in a predesigned proforma to rule out any condition that could interfere with the performance on treadmill. Two exercise sessions were performed – in fasting and in fed state, separated by 72 hours each .Two venous samples of volunteers were obtained prior to and immediately after exercise and used for determination of serum glucose, lactate, and triglyceride levels. Laboratory investigations include Complete blood count and ESR, Fasting Blood Glucose ,Serum Urea and Creatinine, Routine Urine examination, Electrocardiography, Chest X-ray (PA view) and Ultrasound of Abdomen & Pelvis. The data recorded was subjected to statistical analysis and the results are being expressed with appropriate charts/tables/diagrams. A p-value of <0.05 is considered significant.

INCLUSION CRITERIA

- Age 20 to 30 years
- Both genders
- Non smoker
- No known Cardiovascular,Metabolic,or Musculoskeletal Disease that could affect the performance on procedures
- Regular physical activity for at least 12 months

EXCLUSION CRITERIA

- Age <20 or >30 years
- Currently suffering from any ailment
- Sedentary lifestyle
- Participants who will refuse to cooperate with the study

Results-

Majority of subjects were in the age group of 26-30 years (43; 86%), followed by 21-25 years (7; 14%). Mean age of the subjects was 26.76 with a range of 21 to 30 years. Male subjects dominated the study group (37; 74%) with male to female ratio of 2.85:1.Most subjects had height in the range of 1.6-1.69 meter (22; 44%), followed by 1.7-1.79 meter (17; 34%), ≥1.8 meter (7; 14%) and 1.5-1.59 meter (4; 8%).Mean height of the subjects was 1.67 with a range of 1.5 to 1.85 .Majority of subjects had weight in the range of 70-79 kg (26; 52%), followed by 60-69 kg (14; 28%), 80-89 kg (5; 10%), 50-59 kg (4; 8%) and ≥90 kg (1; 2%).Mean weight of the subjects was 70.04 with a range of 52 to 90

Equal number of subjects(25;50%) had BMI in the range of 18.5 to 24.9 kg/m^2 (normal) and 25 to 29.9 (overweight) respectively. No subject was obese in this study. Mean BMI of the subjects was 25.03 with a range of 20.76 to 29.38 kg/m^2. Mean values of haemodynamic parameters like pulse rate (74.18 beats/minute), SBP (123.72 mmHg), DBP (74.6 mmHg) and respiratory rate (14.3 breaths/minute) were in the normal range .During cardiorespiratory fitness test, female subjects performed better as compared to male subjects

.Mean values of hemogram and biochemical parameters were found to be within normal range in the study group. Before exercise, mean serum glucose level during fed state was significantly more than that in fasting state (115.76 vs 87.4 mg/dL;

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p<0.0001). Similarly after exercise, mean serum glucose level during fed state was significantly more than that in fasting state (100.88 vs 92.72 mg/dL; p<0.0001

Table 1: Comparison of mean serum glucose during fasting and fed state before exercise and after exercise (n=50)

Variable	Serum glucose (mg/dL)		Statistical inference (Unpaired t test)
	Fasting state (n=50) Mean ± SD	Fed state (n=50) Mean ± SD	
Before exercise	87.4 ± 5.67	115.76 ± 4.67	t=27.30; p<0.0001; HS
After exercise	92.72 ± 5.64	100.88 ± 5.43	t=7.36; p<0.0001; HS

HS = highly significant

Mean serum lactate level during fasting state before exercise was 1.42 mmol/L, which increased significantly after exercise to 3.71 mmol/L (p<0.0001).

Similarly, serum lactate level during fed state before exercise was 1.54 mmol/L, which increased significantly after exercise to 3.25 mmol/L (p<0.0001

Table 2: Comparison of mean serum lactate before and after exercise in fasting and fed state (n=50)

Variable	Serum lactate (mmol/L)		Statistical inference (Unpaired t test)
	Before exercise Mean ± SD	After exercise Mean ± SD	
Fasting state (normal 0.5-2 mmol/L)	1.42 ± 0.18	3.71 ± 0.16	t=67.23; p<0.0001; HS
Fed state (separated by 72 hours) (normal 0.5-2 mmol/L)	1.54 ± 0.16	3.25 ± 0.19	t=48.67; p<0.0001; HS

HS = highly significant

Mean serum triglyceride level during fasting state before exercise was 99.44 mg/dL, which increased significantly after exercise to 135.18 mg/dL (p<0.0001).

Similarly, serum triglyceride level during fed state before exercise was 94.3 mg/dL, which increased significantly after exercise to 116.7 mg/dL (p<0.0

Table 3: Comparison of mean serum triglyceride before and after exercise in fasting and fed state (n=50)

Variable	Serum triglyceride (mg/dL)		Statistical inference (Unpaired t test)
	Before exercise Mean ± SD	After exercise Mean ± SD	
Fasting state (normal 70-150 mg/dL)	99.44 ± 3.87	135.18 ± 17.09	t=14.42; p<0.0001; HS
Fed state (separated by 72 hours) (normal <200 mg/dL)	94.3 ± 4.42	116.7 ± 5.74	t=21.86; p<0.0001; HS

HS = highly significant

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Before exercise, mean serum triglyceride level during fed state was significantly less than that during fasting state (94.3 vs 99.44; p<0.0001).Similarly after exercise, serum triglyceride level during fed state was significantly less than that during fasting state (116.7 vs 135.18; p<0.0001}

DISCUSSION

- In this study, blood glucose increases significantly during exercise while fasting, probably due to the release of glucose by the liver via glycogenolysis and gluconeogenesis, stimulated by glucagon, catecholamines, and cortisol. In the fasting state, cortisol rises considerably, stimulating the release of glucagon and reducing the sensitivity of the liver to this hormone[7,8] . Glucose concentration in the postprandial exercise was reduced due to the release of insulin stimulated by carbohydrate intake Thus, the glucose present in the blood was used as fuel without having to resort to the liver glycogen. During exercise, the increase in cortisol followed by glucagon stimulates gluconeogenesis and glycogenolysis, while the decrease in insulin concentration increases the sensitivity of the liver to glucagon, due to the increase in the number of receptors**.** Insulin concentration is reduced during moderate exercise, while the increased sensitivity of glucagon in the liver results in the production of glucose.
- In this sense, not only intensity, type, and duration of exercise but also carbohydrate intake before exercise seems to affect the behavior of blood glucose[11]**.**Glucose concentration is influenced by exercise intensity. According to Thompson[12] et al (2001), blood glucose is maintained constant even with strenuous exercise,.
- In a study by Lima[13] et al., 2015 exercise in the fasting state performed for 36 minutes at 65% of Vo_2max cannot significantly alter blood glucose, while feeding increases resting levels and modifies the response of glucose to exercise.
- In this study, the plasma lactate concentration increases significantly in the two experimental conditions, with rise during fed state being significantly less than that during fasting state. The intensity of exercise selected seems to be sufficient to stimulate the glycolytic metabolism, since the lactate production was enhanced to values above the threshold. Furthermore, the influence of catecholamine secretion in lactate kinetics[14]is crucial to explain the behavior of this metabolite after the two experimental conditions studied here.
- This study shows that there was significant increase in triglycerides in both situations, with significantly less levels postprandial than that during fasting state.
- The enhancement of lipolysis seems to occur during physical activity, generating an increase in plasma triglyceride concentration, and consequently its subcomponents, glycerol and free fatty acids[15,]**.** The increase in lipolysis rate is due to the accentuated catecholamine secretion in addition to a higher sensitivity of adipose tissue to these hormones generated by the exercise.[16] The stimulation of the release of triglycerides by increased secretion of epinephrine and norepinephrine helps explain the higher rate of lipolysis of the exercise in the fasting state, since the hormonal response of this protocol is increased[17]
- The triglycerides concentration can be affected by other factors besides lipolysis stimulation. The reduction of triglyceride concentration may occur due to the decrease in production of hepatic very-low density lipoprotein or lipoprotein lipase response[18], as well as the activity of chylomicrons**.** The behavior of triglycerides after exercise is influenced by the level of training of individuals, providing higher releases in trained individuals[19]**.** This relationship seems to be favorable to the subjects in the study because they were all regular physical activity practitioners.

CONCLUSION

Exercise in the fasting state performed for 36 minutes at 65% of Vo_2max cannot significantly alter blood glucose, while feeding increases resting levels and modifies the response of glucose to exercise. The two

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experimental conditions promoted a significant increase in blood lactate values considered above lactate threshold. However, feeding does decrease lactate production. The plasma triglyceride concentration suffered elevation in both the procedures; however, fasting promoted greater release, showing an increase in lipolysis generated by this protocol.

Thus postprandial exercise is better as compared to fasting exercise as per this study, as it maintains fairly normal blood glucose levels, has decrease risk of lactic acidosis and promotes lipolysis to a greater extent as compared exercise performed while fasting, thus having a favorable effect on carbohydrate, lipid and protein metabolism.

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