EVALUATION OF BLOOD GLUCOSE LEVELS IN HEALTHY YOUNG ADULTS FOLLOWING A SINGLE BOUT OF HAND MUSCLE EXERCISE

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ABSTRACT

BACKGROUND

Exercise reduces blood glucose levels, improves cardio-respiratory fitness and increases muscle mass. Many studies have been conducted on different types of exercise training and their effects on glycemic control. Most of the studies include exercises involving large group of muscles like the leg muscles or whole body muscles. There is no data regarding only the hand muscle exercises and their effect on blood glucose levels. In this study, young healthy adult subjects are made to do a single bout of short duration hand exercise (Involving forearm and digital muscles) and its effect on blood glucose levels are checked.

MATERIALS AND METHODS

Normal healthy young adults of both sexes and age between 18–25 years were included in the study. Capillary blood glucose (CBG) level was measured using a glucometer. Digitalized hand grip dynamometer was used for the upper limb exercise. CBG levels were compared before and after exercise.

Statistical analysis was done using Microsoft Excel and GraphPad Prism version 5. Mean values of CBG before and after exercise were compared by Students paired T test.

RESULTS

CBG was reduced following the exercise in most of the subjects and it was found to be statistically significant.

CONCLUSION

Exercise involving small muscles like the forearm and digital muscles were also able to reduce the blood glucose levels significantly. This study may be extended and done on patients with T2DM.

KEYWORDS

Capillary Blood Glucose (CBG), Hand Muscle Exercise, Digital Hand-Grip Dynamometer.

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INTRODUCTION: In the present-day modern life people have become dependent on electronic gadgets, machines and automobiles which have made them to lead a sedentary life. The lack of physical activity/exercise has resulted in lot of metabolic diseases like Type 2 Diabetes mellitus (T2DM), Obesity, Dyslipidaemia and also Cardiovascular diseases like Coronary artery diseases and Hypertension. [1] Type 2 Diabetes mellitus is becoming an epidemic world-wide and the disease has started affecting children and adolescents because of their high-calorie diet and lack of exercise. Pharmacological and non-pharmacological (dietary modifications & exercise training) interventions are important to prevent T2DM and its complications and to improve the quality of life of the patients with Type 2 diabetes mellitus. [2]

Exercise has various benefits in our body like– Decreases visceral obesity,[3] alters endothelial function of blood vessels,[4] decreases insulin demand and thereby prevents β cell exhaustion,[5] decreases risk of cardio-vascular diseases.[6] Improves muscle mass, improves insulin sensitivity and decreases blood glucose levels.[3] It also decreases the inflammatory changes in the blood vessels and thereby decreases the vascular complications of T2DM.[7] Even a single bout of exercise drastically changes various physiological parameters such as hormone production, blood flow, and the activity of the nervous system, in addition to altering the activity of the skeletal muscle which is greatly involved in regulating blood glucose levels.[8] An acute exercise bout has positive influences not only on the physical aspects but also influences the affect and psychological well-being in subjects with type 2 diabetes.[9]

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Patients defined as Pre-diabetic, based on impaired fasting glucose (fasting glucose-110-126 mg/dL) and impaired glucose tolerance (IGT-2 h glucose 140-199 mg/dL), are associated with obesity and physical inactivity. These patients benefit out of regular physical activity and exercise reduces obesity and the prevalence of T2DM by 58% thus representing an important means of preventing diabetes in such patients. [10]

Most of the studies done to assess the effect of exercise on blood glucose levels were structured training programs of either aerobic type or resistance training exercises involving large groups of muscles in the trunk or lower limbs.

Exercise reduces blood glucose levels by improving blood flow to muscles, increase glucose uptake by skeletal muscles by inserting GLUT 4 (Contraction-stimulated) on muscle membrane & increases glucose phosphorylation in muscle cells. Following exercise, it may be, that oxidative muscles rely more on glucose supply (perfusion) and phosphorylation and glycolytic muscles probably relying more on glucose transport (GLUT 4 activity). [8] Within the same muscle fibre the limiting step for glucose uptake varies depending on a variety of factors, including the intensity and duration of exercise and muscle glycogen and interstitial glucose concentrations. [8]

Different types of exercises/Physical activity involving contractions of any skeletal muscle have shown to decrease blood glucose levels by the above mechanisms. We wanted to find out if simple exercises involving digital and forearm muscles done for a short duration could also reduce the blood glucose levels. These exercises also involve contraction of muscles and therefore there could be insertion of contraction-stimulated GLUT 4 in the muscle membrane to increase glucose uptake into the muscles and thereby decrease in blood glucose levels.

MATERIALS & METHODS: 50 Normal healthy young volunteers of both sexes and age between 18-25 years were selected among the medical students in our institution. Ethical clearance was obtained from the Institutional ethical committee. Written, informed consent to participate in the study was obtained from the subjects.

Inclusion Criteria:

1. 50 healthy young adults of age 18 – 25 years.
2. Both sexes.
3. No H/O diabetes mellitus.
4. No H/O, hypertension.
5. No H/O other metabolic disorders.

Exclusion Criteria:

1. Alcoholics.
2. Smokers.
3. H/O any recent illness.
4. Pregnancy.
5. H/O any Muscular disorders.
6. H/O of cardiac illness.
7. Upper limb deformities.
8. Athletes and sportspersons.

Subjects were screened with general physical examination which included Height in cm, weight in Kg, Blood pressure and heart rate.

ABOUT THE INSTRUMENTS USED:

1. **Digital Hand-Grip Dynamometer:** This instrument was designed and constructed in house in the department of Bio-Medical engineering. The hand-grip dynamometer (Fig. 1) has a load cell and a digital display module to display the load in Kilograms against which the muscles are contracting. The load cell converts force generated by muscle contraction into analog voltage; this analog voltage in turn is converted to digital form and displayed in kilograms. Calibration was done using standard weights of 5KG and 10KG.

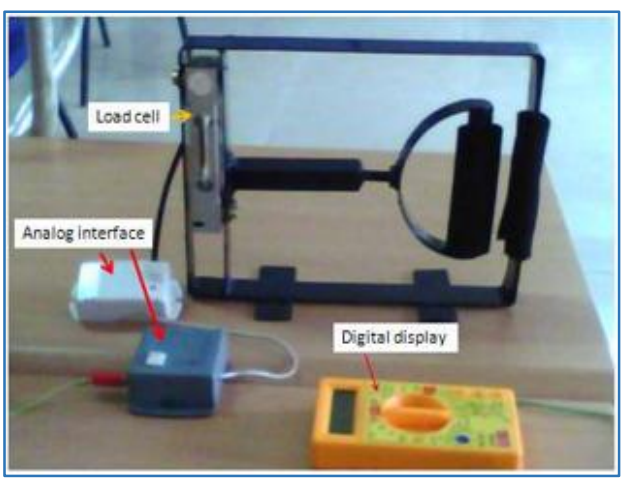

Fig. 1: Digital Hand Grip Dynamometer

We have used this instrument to perform the exercise so that there could be standardization of the load against which contractions are done among the subjects. The subjects are asked to do alternate contraction and relaxation cycles instead of sustained contraction.

2. **Automated Glucometer-(AccusureTM ver1.0, 2009-01),** using amperometric technique is used to check the CBG levels.

3. **Sphygmomanometer** is used to record the blood pressure.

Study Protocol: On the day of study the subjects are instructed to refrain from drinking beverages containing caffeine for 12 hours before the recording session. A baseline Heart rate, Blood pressure and CBG (1½-2 hours after food) were recorded. Metronome software is used to standardize the number of contractions per minute for all the subjects. The subject is comfortably seated and he/she is initially asked to compress the hand-grip maximally and the Maximum voluntary contraction (MVC) load in kilogram is noted. Then the subject is asked to follow the ticking of metronome and to press the hand-grip to 30% of the

maximum voluntary contraction and to relax and this cycle of one contraction and relaxation are repeated. 30 contractions per minute were done. This is done for 5 minutes. The 5 minutes session was split into 2minutes of contraction cycles–1minute rest–2minutes contraction cycles–1 minute rest and 1minute of contraction cycle. At the end of the protocol immediate Pulse rate & BP were recorded. CBG was estimated after 5 minutes.

Events	Day 1	Day 2 (30 minutes)		
		0-15 Mins	16–23 Mins	24–30 Mins
Protocol detailing to volunteers	✓			
Informed consent Issuing	✓			
Informed consent Signing		✓		
Base line Pulse rate, BP and CBG measurement		✓		
Study Exercise			✓	
Post Exercise Pulse rate, BP and CBG Measurement				✓
Study Closure				✓
STUDY PROTOCOL				

STATISTICAL ANALYSIS: The results were analyzed in Microsoft office excel and GraphPad Prism version 5. Mean values of the Capillary blood glucose (CBG) for fifty subjects before and after exercise were compared and analyzed using Student paired T test. P value<0.05 is considered to be significant.

RESULTS:

Parameter	Before exercise	After Exercise	p Value
CBG	88.2Mgs/dl	82.1mgs/dl	<0.0001

Table 1: Comparison of mean values of CBG and pulse rate in 50 subjects before and after exercise

The study included 50 normal healthy subjects. The CBG levels were compared in the subjects before and after exercise.

This study evaluates the effect of exercise done with forearm and digital muscles on the blood glucose levels in the normal healthy adults. The mean value of the blood glucose levels of all the subjects were compared before and after the exercise. The above table shows that there is a significant decrease in CBG noted after exercise from mean value of 88.2mg/dl to 82.1mg/dl with the P value of less than 0.0001. This significant drop in blood glucose levels following a single bout of moderate hand muscle exercise shows that even minimal muscle contractions can help in regulating blood glucose levels.

DISCUSSION: It is clearly evident in our study that there was a significant drop in blood glucose levels (6%) even after a very short duration, single bout of hand muscle exercise involving smaller group of muscles like forearm muscles and digital muscles and muscles of the palm.

In normal healthy subjects, not much drop in blood glucose level is expected following mild to moderate intensity exercise because of a balance between hepatic glucose output (By neuro-humoral mechanisms) and glucose disposal by the skeletal muscles (Through GLUT 4s). Only high intensity exercises are expected to produce mild hypoglycaemia. [2] Grzegorz Raczak et.al have also shown that a single bout of moderate intensity aerobic exercise using a treadmill in normal healthy adults was able to decrease the blood glucose by 5%, not much different from our readings. [11]

During exercise Insulin secretion is decreased and therefore the drop we have noted here could be due to glucose uptake into the muscle cells through the contraction-stimulated GLUT4s, rather than insulin-stimulated glucose uptake by GLUT 4, which are inserted on the muscle membrane following exercise. Kennedy et al by doing muscle biopsy in the exercised muscles have proved that following exercise, contraction-stimulated GLUT 4 content in muscle membrane is increased in patients with Type 2 diabetes mellitus and also in normal healthy adults.[12]

Some subjects did not show a drop in blood glucose and some had even a mild increase in blood glucose levels. Sheri R Colberg et al has cited that the effect of a single bout of exercise on insulin action and blood glucose levels varies with the duration & intensity of exercise and also the diet taken. Since we had no regulation about the diet intake of subjects the effect of exercise on blood glucose levels could have varied in our study. Exercise-induced catecholamine response also varies among individuals which could also be the reason for increase in blood glucose levels. [2]

This study was undertaken to find out if such a simple hand exercise could also decrease blood glucose levels so that it can be used for patients with Type 2 diabetes mellitus who could not do the regular exercises like walking, jogging etc. because of old age/obesity/foot ulcers. But since we have used normal healthy subjects the effect of this exercise on blood glucose levels were not very evident and uniform and also the duration of exercise was very short. If we had done the exercise for a longer duration the drop in blood glucose level would have been of greater significance.

But this study has given us some idea that the hand muscle exercise can also decrease blood glucose levels.

CONCLUSION: All types of physical activities/exercises can reduce blood glucose levels. In this study we have tried exercises with the small muscles like hand muscles. Even though there was a significant drop in blood glucose levels, the results could have been better if we had prolonged the duration of exercise for at least 15 minutes and if we had given a regulation in the diet pattern for the subjects, because we had selected normal subjects in whom the drop in blood glucose is not much following any type of exercise. So as a continuation of this study we have decided to use this type of exercise in diabetic patients and to evaluate its effect on their blood glucose levels.

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