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Original article:

Effect of physical exercise on blood glucose in undergraduate students

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ABSTRACT

Objectives: This study was designed to assess the effect of exercise and sex difference on blood glucose levels in undergraduate students.

Design: This study involved 110 undergraduate students selected using convenience sampling method in Sagamu, Ogun state, South-West, Nigeria, aged between 15 and 29 years. Diabetic students were exempted from the study. The subjects fasted overnight before the commencement of the experiment. Fasting blood sugar was measured using Accu-check glucometer before exercise and glucose level measured after exercise. Bicycle ergometer was used to administer exercise. All subjects were subjected to one hour of cycling exercise. On the same day, immediately after resting for two hours blood glucose was measured and thereafter, the same cycling experiment was repeated on the subjects immediately after ingestion of 50 grams of Glucose. Post-exercise blood glucose was also measured.Data was analyzed using descriptive statistic.

Results: There were 35(48.2%) males and 57(51.8%) females in the study groups. Their ages were between 15 and 29 years. The ages 15 to 19 years constituted the highest group (38 (34.5%)).The mean decrease in fasting glucose level was 16.26mg/dl±0.90 while it was 20.78mg/dl±2.89 after ingestion of 50gm of glucose. The mean decrease in glucose level in male was 15.97mg/dl±1.79 at fasting levels while postprandially it was 18.79 mg/dl ±2.74. Both figures were greater for females. The mean total glucose handling with exercise was more in females (4.97mg/dl±2.5) than in males with 2.82mg/dl±0.95.

Conclusions: The amount of glucose utilization with exercise is higher in female than male. The clinical importance using Bicycle ergometer of exercise is a useful intervention.

Key words: Bicycle Ergometer, Blood Glucose, Postprandial.

Introduction

During moderate-intensity cycling (>2 hour, 60-75%) in thermo-neutral environments, carbohydrate ingestion can delay fatigue and improve performance[1]. Such improvements have been attributed to the maintenance of blood glucose levels during latter stages of exercise, allowing high rates of carbohydrate oxidation to be maintained.

Carbohydrate ingestion immediately before and during exercise of a shorter (<1hour), more intense nature (>75% VO2max) has also been shown to improve performance. These reports include exercise performed in thermo-neutral conditionsAnantaramanet[2,3,4] and in hot ambient conditions[3,4]. The mechanism responsible for the improvement in high-intensity exercise with supplementary carbohydrate is unclear because it is unlikely that endogeneous carbohydrate is limiting during exercise of this nature in nature in well-nourished subjects[5,6]. During the first hour of exercise, it has been estimated that only 5 to 15 gram of exogenous carbohydrate is oxidized [5], and this relatively minor contribution to total carbohydrate oxidation is thought too small to exert any effect on subsequent performance. This is supported by the respiratory exchange ratio (RER) data of previous studies.[4,7.]

Among the various hormones involved in glucose regulation, insulin and glucagon (both produced in the pancreas by islets of Langerhans) are the most relevant[8]. Within the islets of Langerhans, β-cells produce insulin and α-cells produce glucagon. Insulin, a potent antilipolytic (inhibiting fat breakdown) hormone, is known to reduce blood glucose levels by accelerating transport of glucose into insulin-sensitive cells and facilitating its conversion to storage compounds via glycogenesis (conversion of glucose to glycogen) and lipogenesis (fat formation).The hormone glucagon, which also plays a central role in glucose homeostasis, is produced in response to low normal glucose levels or hypoglycemia and acts to increase glucose levels by accelerating glycogenolysis and promoting gluconeogenesis[8]. After a glucose-containing meal, however, glucagon secretion is inhibited by hyperinsulinemia, which contributes to suppression of hepatic glucose production and maintenance of normal postprandial glucose tolerance. The hormone amylin contributes to reduction in postprandial glucagon, as well as modest slowing of gastric emptying[9].

Incretins, which include glucose-dependent insulinotropic polypeptide (GIP) and glucagon-like peptide 1 (GLP- 1), are also involved in regulation of blood glucose, in part by their effects on insulin and glucagon. However, both GLP-1 and GIP are considered glucose-dependent hormones, meaning that they are secreted only when glucose levels rise above normal fasting plasma glucose levels; they do not directly stimulate insulin secretion. Normally, these hormones are released in response to meals and, by activating certain receptors (G protein—coupled) on pancreatic β-cells, they aid in stimulation of insulin secretion.[9]

Although, the use of a drink containing glucose syrup and mineral salts has been found to improve athletic performance using a cycle ergometer [10].

There is paucity of knowledge on the effect of physical exercise using ergometer with relationship to gender difference in this environment. Many previous studies obtained from literature search are from the Western world and none were from this region. Our eating habits and culture differ, coupled with the variant degree of obesity we observe in Sagamu.

Moreover, there have been no accurate determination of rate of endogenous and exogenous glucose oxidation and subsequent effect of exercise using bicycle ergometer; hence the aim of this study is to determine the gender difference in glucose utilization in undergraduate students.

Method

The study population is 110 undergraduate students of Olabisi Onabanjo University, Sagamu campus, who were aged 15 to 29 years. Selection was by convenience sampling method. Lecturers, postgraduate and diabetic students were exempted from the study.

The subjects fasted overnight before the commencement of the experiment. The finger tip of subject was pricked with the aid of a lancet each time blood glucose is measured using Accu-Check Glucometer (IdiaMART) Fasting blood sugar was measured using Accu-check Glucometer before exercise and glucose level measured after exercise. All subjects were subjected to one hour of cycling exercise using Bicycle Ergometer (Lode Corival, Netherland). On the same day, immediately after resting for two hours blood glucose was measured. The same cycling experiment was repeated on the subjects immediately after ingestion of 50 grams of Glucose. Post-exercise blood glucose was also measured. All measurements were recorded in the recording book.

Ethical Approval and Informed Consent

Ethical clearance for the study was obtained from the Health Research Ethics Committee (HREC) of Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu All participants (110) of this study signed an informed consent form, in accordance to the committee regulations, before completing a questionnaire and taking their anthropometric measurements. The use of preforma was adopted.

Results:

There were 35(48.2%) males and 57(51.8%) females in the study groups. Their ages were between 15 and 29 years. The ages 15 to 19 years constituted the highest group (38 (34.5%)).

Table 1 showed the mean decrease in fasting glucose level was 16.26mg/dl±0.90 while it was 20.78mg/dl±2.89 after ingestion of 50gm of glucose. As shown in table 2 and 3 the mean decrease in glucose level in male was 15.97mg/dl±1.79 at fasting levels while postprandially it was 18.79 mg/dl ±2.74. The mean decrease in glucose level in female was 17.31mg/dl±1.70 at fasting levels while postprandially it was 22.28 mg/dl ±4.25. The mean total glucose handling with exercise was more in females (4.97mg/dl±2.5) than in males with 2.82mg/dl±0.95.

Table 1: Effect of exercise on Mean Blood Glucose Levels

Variable(mg/dl)	Pre-exercise	Post-exercise	Glucose Change	
Fasting Blood Glucose	97.33±1.87	81.07±2.77	16.26±0.90	
Post-prandial Blood Glucose	133.27±2.47	112.49±5.36	20.78±2.89	

Table 2: Effect of exercise on Mean Blood Glucose Levels in male subjects

Variable(mg/dl)	Pre-exercise	Post-exercise	Glucose Change	
Fasting Blood Glucose	96.72±1.44	80.75±3.23	15.97±1.79	
Post-prandial Blood Glucose **Glucose handling**	132.21±1.64	113.42±4.38	18.79±2.74 2.82±0.95	

Table 3: Effect of exercise on Mean Blood Glucose Levels in female subjects

Variable(mg/dl)	Pre-exercise	Post-exercise	Glucose Change	
Fasting Blood Glucose	96.76±0.99	79.45±2.69	17.31±1.70	
Post-prandial Blood Glucose **Glucose handling**	134.07±1.87	111.79±6.12	22.28±4.25 4.97±2.55	

Discussion:

In this study, it was noticed that the amount of glucose utilized by females were more than males. This may be because of the biological and genetic make-up of the body of females vis- a- vis increase in both the visceral and total body fats seen in them. It may be due to various hormones elaborate by the females. It suffices to say that females are complacent to doing exercises, making them do one will require them elaborating more glucose to cope with energy status they found themselves in.[11]

The study done by James et al, 2004[12] showed that the delivery of exogenous CHO improves performance by increasing CHO oxidation during time-trial exercise lasting approximately 60minutes (>75% $V0_{2max}$). Although, the infused glucose contributed significantly to total CHO oxidation, no improvement in performance was observed compared with the infusion of saline. [12]

Numerous studies have reported that exogenous CHO improves performance during relatively short (1 h), high intensity exercise[1,2,3,4] However, the mechanism responsible for this improvement has been uncertain. One possibility is that exogenous CHO makes a significant contribution to the total CHO oxidation rate, permitting high rates of energy expenditure in the latter stages of the exercise. Similar RER (Respiratory exchange ratio) values between CHO and PLA(plasma lactate) trials during previous high intensity exercise studies provided no support for this mechanism [3,8]. However, their subjects had purposefully lowered muscle glycogen concentrations at the start of the exercise. Furthermore, it has been suggested that the amount of exogenous CHO oxidized in the first hour of exercise would be too small to exert a significant effect on subsequent performance[5].

Glucose, a fundamental source of cellular energy, is released by the breakdown of endogenous glycogen stores that are primarily located in the liver. Glucose is also released indirectly in the muscle through intermediary metabolites. These whole-body energy stores are replenished from dietary glucose, which, after being digested and absorbed across the gut wall, is distributed among the various tissues of the body. Although glucose is required by all cells, its main consumer is the brain in the fasting or "post-absorptive" phase, which accounts for approximately 50% of the body's glucose use. Another 25% of glucose disposal occurs in the splanchnic area (liver and gastrointestinal tissue), and the remaining 25% takes place in insulin- dependent tissues, including muscle and adipose tissue.4 Approximately 85% of endogenous glucose production is derived from the liver, with glycogenolysis (conversion of glycogen to glucose) and gluconeogenesis (glucose formation) contributing equally to the basal rate of hepatic glucose production. The remaining 15% of glucose is produced by the kidneys[11].

Normally, following glucose ingestion, the increase in plasma glucose concentration triggers insulin release, which stimulates splanchnic and peripheral glucose uptake and suppresses endogenous (primarily hepatic) glucose production. In healthy adults, blood glucose levels are tightly regulated within a range of 70 to 99 mg/dL, and maintained by specific hormones (eg, insulin, glucagon, incretins) as well as the central and peripheral nervous system, to meet metabolic requirements[8]. Various cells and tissues (within the brain, muscle, gastrointestinal tract, liver, kidney, and adipose tissue) are also involved in blood glucose regulation by means of uptake, metabolism, storage, and excretion[11].

This highly controlled process of glucose regulation may be particularly evident during the postprandial period, during which, under normal physiologic circumstances, glucose levels rarely rise beyond 140 mg/dL, even after consumption of a high-carbohydrate meal[11]

Additionally, strength and flexibility activities that maintain or increase muscular strength and endurance should be performed at least two days per week[13]. These are the guidelines generally accepted and recommended worldwide[14], although in the UK the Department of Health[14] has simplified the recommendation into a minimum of 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity per week, without a minimum daily amount. Accumulating 150 minutes of moderate physical activity per week is estimated to reduce the risk of ischemic heart disease by approximately 30%, the risk of diabetes by 27%, the risk of breast and colon cancer by 21 to 25%, among others[14].

In a scientific statement from the American Heart Association summarizing the evidence of the benefits of exercise and physical activity for the prevention and treatment of atherosclerotic CVD, Thompson et al (2003) [15] reported strong evidence that the most physically active individuals generally demonstrated half the rates of CAD(coronary artery disease) than physically inactive individuals. The studies demonstrated a graded relationship of decreasing CAD' with increasing levels of physical activity and, in many studies, the lower rates of CAD were independent of several other known atherosclerotic risk factor[15]. Physical activity can also be used as a treatment for many already established atherosclerotic risk factors, such as hypertension, insulin resistance, elevated blood triglyceride concentrations, and obesity[15]

Conclusions

The amount of glucose utilization with exercise is higher in female than male. The clinical importance of exercise is a useful intervention. However, physical activity can be used as therapy for people with metabolic syndrome.

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