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The comparison of glucose and insulin concentration in elite sprint and endurance runners after an exhaustive aerobic exercise

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Abstract.

Introduction: The aim of present study was to comparison of glucose and insulin concentration in elite sprint and endurance runners after an exhaustive aerobic exercise.

Material & Methods: Sixteen elite sprint (n=8; 3.8±1.8 years experience of tournament playing, mean±SD) and endurance (n-8; 6.2±2.3 years experience of tournament playing, mean±SD) runners volunteered to participate in this study. Blood samples were taken before, immediately, 30 and 120 min after the Bruce test. Glucose solution containing 75 g oral glucose dissolved in 250 ml of water to drink was consumed by subjects after the exercise.

Results: The results showed that glucose and insulin level increased 30 and 120 min after the exercise in compare to basal level in both groups ($P<0.05$), while no significant difference was observed between the groups.

Conclusion: In conclusion, sprint and endurance running have similar effects on glucose and insulin concentration after an exhaustive exercise.

Key words: Glucose, Insulin resistance, Endurance runners, Sprint runners

1. Introduction

Insulin resistance is defined as the decreased peripheral tissue response to insulin-mediated cellular actions and the term "insulin resistance" refers to reduced whole-body glucose uptake in response to physiological levels of insulin (1). Insulin resistance is a common feature of obesity and is strongly associated with the etiology of type 2 diabetes, hypertension and coronary heart disease (2). Currently, the gold standard method to evaluate insulin resistance is the hyperinsulinemic-euglycemic clamp technique (3).

Epidemiologic studies suggest that regular physical activity is protective against development of type 2 diabetes (4-7). Intervention studies report that engaging in regular exercise is associated with significant improvements in glycemic control (8) and insulin sensitivity (9,10) in nondieting men and women.

Skeletal muscle is the major site of insulin-mediated glucose uptake in the postprandial state as the majority (~85%) of glucose uptake by peripheral tissues occurs in muscle (11). Exercise has an "insulin-like effect" to facilitate glucose transport from the circulation into the working muscles (12). It has been suggested that the mechanism by which exercise increases glucose uptake may be via the translocation of glucose transporters (e.g., GLUT-4) from an intracellular pool to the surface of the cell, where glucose uptake takes place (12,13). Indeed, studies demonstrated increased GLUT-4 concentrations with aerobic training, which is accompanied by increases in insulin-mediated glucose uptake in adults (14-16). However, the exercise-induced increase in muscle GLUT-4 concentration and the corresponding increase in insulin sensitivity decreases rapidly after the cessation of exercise (15), which suggests that exercise should be performed on a regular basis to maintain enhanced insulin sensitivity. By our knowledge, no previous study has been investigated the changes of glucose and insulin concentration among endurance and sprint runners. Thus the aim of present study was to comparison of glucose and insulin concentration in elite sprint and endurance runners after an exhaustive aerobic exercise.

2. Material & Methods:

Subjects

This semi-quasi study was conducted on sixteen elite sprint and endurance runners of Fars province. The subjects consist of 8 elite sprint and 8 elite endurance runners that they have at least 3 years experience of tournament playing. Informed consent was given to all subjects and prior the study.

Anthropometric and body composition measurements

Height was measured with a fixed stadiometer (Seca, Germany) and weight was measured with a regularly calibrated electronic scale (Seca, Germany). Body mass index (BMI) was calculated by dividing weight (kg) by height (m2). Subcutaneous body fat was measured at 3 sites (chest, abdominal, and thigh) with a Harpenden caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK). Body fat percent was calculated from the formula developed by Jacson and Pollock (17). Anthropometric and body composition parameters of the subjects are presented in the Table 1.

Table 1. Anthropometric and body composition characteristics (mean $\pm$ SD) of the subjects

Variables	Sprint runners	Endurance runners
Age (year)	18.5 ± 3.9	23.1 ± 6.5
Experience of tournament playing (year)	3.8 ± 1.8	6.2 ± 2.3
Height (cm)	176.0 ± 5.4	177.9 ± 5.1
Body weight (kg)	67.8 ± 8.4	68.4 ± 6.6

Variables	Sprint runners	Endurance runners
BMI (kg/m^2)	21.8 ± 2.0	21.0 ± 2.3
Body fat percent (%)	4.7 ± 0.9	5.7 ± 1.5

Study protocol

All the subjects fasted at least for 12 hours and a fasting blood sample was obtained by venipuncture. Fasting blood samples were collected at rest (30 min before training) and immediately after the exhaustive exercise. The Bruce test protocol was used as the exhaustive exercise training. This test includes 7 phases. This test is done on the treadmill and started with low intensity; every 3 minutes. The speed and the gradient (slope) of the device increased up to the level in which the subject could not perform the test anymore and became totally exhausted. Each participant was equipped with a heart rate monitor (Polar, FS3c, Finland) for heart rate monitoring. After this, the subjects underwent a 120 min oral glucose tolerance test (ingestion of a 250 ml solution containing 73 g of anhydrous glucose and 2 g of [U-^{13}C] glucose). Blood samples were collected 30 min and 120 min after the oral glucose tolerance test again. The study protocol is presented in the Table 2.

Table 2. Study protocol

30 min before the Bruce test (>12 h fasting)		Immediately after the Bruce test	Immediately after the Bruce test	30 min after the Bruce test	120 min after the Bruce test
Blood sampling	Bruce test	Blood sampling	Ingestion of a 250 ml solution containing 75 g glucose	Blood sampling	Blood sampling

Laboratory analysis

Blood samples were kept in the temperature of –20°c. Glucose was determined by the Enzymatic Colorimenteic Method. Insulin was also determined by ELISA kit (Monobind, USA) with sensitivity of 31 pg/ml.

Statistical analysis

Results were expressed as the mean ± SD and distributions of all variables were assessed for normality. Data were analyzed using 2 × 4 repeated measures ANOVA. The level of significance in all statistical analyses was set at P<0.05. Data analysis was performed using SPSS software for windows (version 17, SPSS, Inc., Chicago, IL).

3. Results

Glucose concentration

As shown in the figure 1; glucose concentration has not significant changes immediately after the exhaustive exercise in sprint runners, however, blood glucose increase 34.7% and 21.05% at 30 min and at 120 min after the exhaustive exercise respectively in these runners (P<0.05). The results also indicated that blood glucose was higher 30 min after the exhaustive exercise in compare to the immediately after the exercise (20.2%, P<0.05). On the other hand, the data demonstrated that glucose concentration increase after the exhaustive exercise in endurance runners (22.03%, P<0.05) and this was higher than the baseline until 30 min after the exercise (31.3%, P<0.05). No significant difference was observed between 120 min after the exercise in compare to the baseline in endurance runners and no significant differences were observed between two groups in the glucose concentration during the different phase of blood sampling.

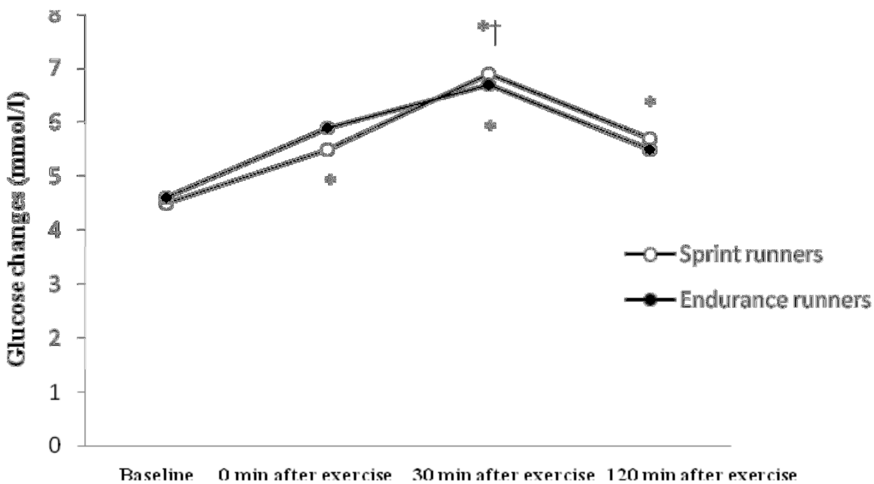

Figure 1. Changes of glucose concentration in sprint and endurance runners after an exhaustive exercise

* signifficant differences in compare to the baseline (P<0.05)
† signifficant differences in compare to immediately after the exercise (P<0.05)

Insulin concentration

Changes of insulin concentration are presented in the figure 2. Insulin concentration had tendency to decrease after the exhaustive exercise in compare to the baseline in two groups however these changes were not significant. Insulin concentration increase 30 min after the exhaustive exercise in the sprint runners (67.4%) and in the endurance runners (78.2%) in compare to the immediately after the exercise respectively ($P<0.05$). The insulin concentration was higher until 120 min after the exercise in compare to the baseline in the sprint runners (77.8%) and in the endurance runners (82.6%) respectively ($P<0.05$).

No significant differences were observed in the insulin concentration between two groups during the different phase of blood sampling.

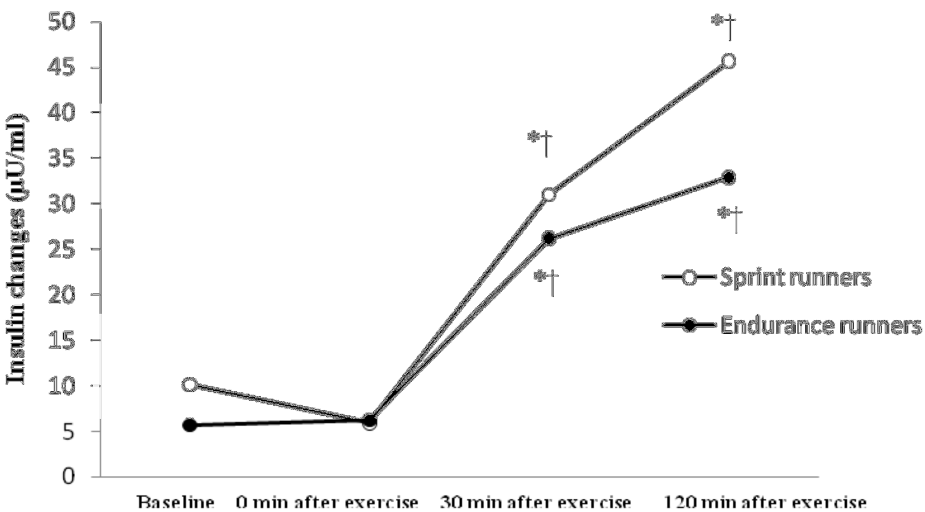

Figure 2. Changes of insulin concentration in sprint and endurance runners after an exhaustive exercise

* signifficant differences in compare to the baseline ($P<0.05$)
† signifficant differences in compare to immediately after the exercise ($P<0.05$)

Discussion

Although fat and carbohydrate oxidation are the main fuel that utilized during long term activities, but the utilization of free faty acids dereased and carbohydrate utilization increased during moderate to high intensity exercises. Thus liver glycogen depletion and low levels of blood glucose are the main reasons of fatigue during these activities (18,19). Previous studies indicated that glucose ingestion durin activity suppresses the glycogen depletion from the liver and glucose that ingected is the main fuel during activity and even after this (20).

Our results in line with Knudsen et al. (2014) (21) indicated that gllucose concentration increase significantly 30 min after the exhaustive exercise in the both groups and this was higher than the baseline until 120 min after the exercise in the sprint runners; however, no significant differences were observed between two groups in the glucose concentration during the different phase of blood sampling. Studies demonstrated that blood glucose is higher during and after activities in responsible to glucose ingestion (22).

The exercise-induced increase in postprandial glucose response found in the present study is in accordance with previous findings (21,23) and could simply reflect normal postexercise glucose excursion in healthy subjects (24). Several factors may explain these results. First, exercise-induced elevation of plasma catecholamine levels is known to increase hepatic glucose output in healthy subjects (25), increasing glucose availability in the circulation. However, we cannot measure the catecholamine levels. Second, exercise increases muscle-contraction-induced glucose disposal via insulin-independent GLUT-4 translocation (26). Third, prior work has shown that in healthy subjects a single bout of exercise can increase the appearance of orally ingested exogenous glucose in the circulation (27). In animal models, this phenomenon has been found to be related to the stimulatory effect of catecholamines (28).

Our results showed that insulin concentration had tendency to decrease after the exhaustive exercise in compare to the baseline in two groups however these changes were not significant. Insulin concentration increase 30 min after the exhaustive exercise in the both groups in compare to the immediately after the exercise. The insulin concentration was higher until 120 min after the exercise in compare to the baseline in the both groups. No significant differences were observed in the insulin concentration between two groups during the different phase of blood sampling. Osali et al. (2009) reported that the secretion of insulin 30 min after the Bruce test in the group which used the complex supplementation of carbohydrates + branched chain amino acid supplements was significantly higher than the group which used carbohydrates and the placebo group (29).

Insulin secretion from the beta-cells in the islets of Langerhans is mainly regulated by glucose entry via its transporter. The intracellular glucose metabolism induces a rise in ATP/ADP ratio which increases the degree of closure of ATP-sensitive potassium channels (K(ATP) channels), inducing a higher intracellular K^+, which, in turn, depolarizes the membrane and opens voltage-sensitive calcium channels. The ensuing $Ca2^+$ entry triggers extrusion of insulin-containing secretory granules and, thus, hormone secretion (30). In healthy subjects, it is known that exercise-induced increases in adrenaline suppresses insulin secretion (31). However, as mentioned above we did not measure catecholamines. As such, exercise-induced changes in clearance of either insulin or C-peptide (32) may alternatively explain these discrepancy results.

Conclusion

In conclusion, sprint and endurance running have similar effects on glucose and insulin concentration after an exhaustive exercise.

Conflict of interests: No conflict of interests amongst authors.

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