The effect of glucose intake on plasma visfatin response following an aerobic exercise session in male students

Mandana Gholami [1] Ahmad Abdi [2] Asieh Abbasi Delooie [2] Abbass Ghanbari-Niaki [3]

Department of Physical Education & Sport Science [1], Science and Research Branch, Islamic Azad University, Tehran, Iran. Department of Physical Education & Sport Sciences [2] , Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran. Department of Physical Education & Sport Science [3] , Exercies Biochemistry Branch, Faculty of Sports Sciences, Univesity of Mazandaran, Babolsar, Iran.

(Received 22 Dec, 2016 Accepted 25 Feb, 2017)

Original Article

Abstract

Introduction: Visfatin is predominantly secreted from visceral adipose tissue and mimics the effect of insulin by binding to insulin receptors. The purpose of the present research is to examine the effect of glucose intake on plasma visfatin concentration following an aerobic exercise session.

Methods: In a quasi-experimental study, 16 male non-athlete students (21.91±2.31 yrs., 77.53±8.93 kg, 1.768±0.07 cm, 24.31±2.07 kg/m2) were randomly divided into water and glucose groups. Blood samples were collected at five stages: before exercise, immediately after exercise, and 30, 60, and 90 minutes after exercise. The subjects were instructed to perform a 45-minute aerobic exercise (a 10-min warm-up, followed by a 1-mile running at maximum speed with 3-minute rests between bouts). Immediately after the second blood sampling, sugary liquids (1.5g glucose for each kg body weight) and water (similar volume) were administered. The data was analyzed using repeated measures ANOVA and LSD test at $P<0.05$.

Results: Plasma visfatin levels increased immediately after exercise, but the increase was not significant. At the following times (30, 60, and 90 minutes after exercise), plasma visfatin levels decreased in both groups, but the decrease was not significant. Significant difference was observed in the visfatin levels of the glucose group at 60 and 90 minutes after exercise compared to immediately after exercise. The plasma glucose level of the glucose group was significantly lower than the water group. Significant increase in plasma insulin was observed by glucose intake at 30 and 60 minutes after exercise. Although at 90 minutes after exercise the plasma insulin level of the glucose group was higher than that of the water group, but the difference was not significant.

Conclusion: According to the findings, changes made in visfatin levels following acute exercise and glucose intake is not significant. So, probably visfatin has no role in improving the acute exercise-induced metabolic status and glucose intake in healthy subjects.

Correspondence:
Mandana Gholami, PhD.
Sciences and Research Branch, Islamic Azad Universit.
Tehran, Iran
Tel:+98 9121491868
Email:
gholami_man@yahoo.com

Key words: Glucose, Visfatin, Aerobic Exercise

Citation: Gholami M, Abdi A, Abbasi Delooei A, Ghanbari-Niaki A. The effect of glucose intake on plasma visfatin response following an aerobic exercise session in male students. Hormozgan Medical Journal 2017;20(6):365-372.

Introduction:

Visfatin is a newly discovered adipocytokine that consists of 491 amino acids. It is predominantly secreted from visceral adipose tissue and mimics the effect of insulin by binding to insulin receptors (1,2). Visfatin is also expressed by the liver, heart, and skeletal muscle (3,4). Visfatin can play two important roles: autocrine/paracrine function that facilitates differentiation and fat deposition on visceral adipose tissue, and an endocrine function that modulates insulin sensitivity in peripheral organs (5). Therefore, visfatin can facilitate glucose control by increasing glucose uptake. It also prevents glucose secretion from liver cells (6).

Evidence shows that aerobic exercise reduces visceral adipose tissue. Exercise also has a positive effect on the visfatin concentration of patients with type 1 and 2 diabetes mellitus (7,8) and obese women. Aerobic exercise, which results in weight loss, decreases plasma visfatin and insulin resistance in obese female adolescents (9). Visfatin regulation is a complex issue and there are conflicting results about the effect of exercise on visfatin concentration (9,10). Studies have mostly reported a significant decrease in plasma visfatin concentration following exercise (11), but the effect of exercise on circulating adipocytokines is not well-established (8). Control mechanisms of regulating visfatin are not still clearly known (1). When delivered to diabetic mice, visfatin improved insulin sensitivity in vivo and resulted in decreased glucose and insulin levels (1).

It seems that visfatin release is a nutrient sensor of adipocytes. Many studies have been conducted on the effects of exercise on visfatin response (12-15), but the acute effects of hyperglycemia in healthy subjects along with exercise has received little attention. Therefore, the effect of stimulation of insulin receptors following an exercise with glucose consumption on plasma visfatin, insulin, and glucose response is not clearly known. Therefore, the present research aims to investigate this issue.

Methods:

In this quasi-experimental study, 16 male, non-athlete student of Amol city voluntarily participated in the research after becoming familiar with the aims and procedure of the study and completing a consent form. According to the invitation to participate in the test 50 people announced. The number of tests based on medical criteria and conditions of the study (students who had no behavioral disorders and hormonal therapy, they were not under drug treatment and supplements, they had no a history of hematological diseases and diseases that affect the biochemical factors and also they were not smokers) invited 20 people. Finally, among the students attending these conditions, based on body weight and BMI matched and 16 subjects were randomly divided into glucose and water groups.

The subjects were instructed to avoid any high-intensity exercise or recreational sports for at least one week before the study. After a 10-minute warm-up (slow gait and stretching exercises), the subjects performed an aerobic exercise consisting of running at maximum speed for a mile with 3-minute rests between bouts. The entire exercise session lasted for 45 minutes. The research started at 8 A.M. and ended at 11:45 A.M. At 4 A.M. on the day of the test, the subjects had a light breakfast (250 ml pasteurized milk with 1% fat, 50 g biscuits, and 20 g date) including 300 calories (51.6 g sugar, 12g protein, and 5g fat). The food was analyzed using the USDA National Nutrient Database for Standard Reference.

The 8 cc blood was collected from the basilic vein, with subjects at seated position, at five intervals: 5 minutes before exercise, immediately after exercise, and 30, 60, and 90 minutes after exercise (stages 1-5) using Venoject. The blood samples were kept at -80˚C temperature. Visfatin response was measured using Elisa Assay Kit (0.07 ng/ml sensitivity, Belmonte Inc.). D (+)-glucose monohydrate (dextrose), D (-)-fructose, and sucrose were purchased from Merck KGaA, Darmstadt, Germany.

The subjects in the experimental group received 1.5 g glucose per kg body weight. Also, the subjects in the control group received.3.5 ml water per kg body weight immediately after exercise.

All data have been expressed as mean±SD. Statistical analysis was performed using a commercial software package (SPSS version 22.0 for Windows). After testing the normal distribution

of the data, repeated measures analysis of variance was applied to examine between-group and within-group differences. The effect of time on between-group differences was also accounted for. If the effect of time was significant, repeated measures ANOVA would be applied for examining differences of each group at a given time. Independent t-test was applied for testing between-group differences. Differences were considered statistically significant at $P<0.05$.

Results:

The personal characteristics of the subjects are provided in Table 1. The data shows that there is no significant difference between the subjects in anthropometric parameters.

Table 1. Personal characteristics of the subjects

	Water group (n=8)	Glocuse group (n=8)
Age (yr)	21.5±1.6	22.33±2.94
Height (cm)	176.42±7.71	180.42±8.1
Weight (kg)	75.82±9.99	79.25±8.28
BMI (kg.m^{-2})	24.27±2.43	24.36±1.87

Based on the results of repeated measures ANOVA, the effect of time on visfatin changes was significant (F=10.806; P=0.004). However, group-time interaction was not significant (F=0.027; P=0.998) (Table 2).

The results showed significant differences in water and glucose groups only at 60 and 90 minutes after exercise compared to before exercise.

The results of repeated measures ANOVA showed that glucose changes of the groups were not significant over time (F=2.527; P=0.134). However, group-time interaction was significant (F=6.943; P=0.014). The effect of group was also not significant (F=0.874; P=0.372) (Table 3).

Due to the significance of group-time interaction, repeated measures ANOVA was used to examine differences between the groups at different stages of the test. The results showed significant differences in glucose levels of the glucose group at stage 3 compared to stage 2, and at stage 5 compared to stages 3 and 4. Meanwhile, between-group comparisons suggest significantly lower glucose levels in the glucose group at 90 minutes after exercise (stage 5). Therefore, it can be concluded that glucose intake significantly reduced plasma glucose of the subjects.

Table 2. Visfatin (ng/ml) in groups

Stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Group	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd
Water	24.254±4.378	32.172±3.135	28.658±7.981	20.869±5.475 bP=0.015	9.853±2.125 aP=0.000,bP=0.030
Glocuse	24.901±5.429	31.729±2.769	30.303±6.768	21.204±6.682 aP=0.015,bP=0.036	9.048±1.984 aP=0.008,bP=0.034

a: difference from stage 2 b: difference from stage 3

Table 3. Glocuse in groups

Stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Group	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd
Water	90.333±5.252	94.746±4.606	81.046±5.301	83.122±5.146	86.308±4.058
Glocuse	86.500±5.769	80.669±3.975	112.373±4.914 aP=0.002,bP=0.002	92.887±4.699	77.789±4.957 aP=0.012,bP=0.004 cP=0.012

a: difference from stage 2 b: difference from stage 3 c: difference from water stage

Table 4. Insulin in groups

Stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Group	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd	Mean±Sd
Water	9.033±1.801	7.210±1.537	6.573±3.250	5.531±5.983	5.530±6.422 aP=0.0302
Glocuse	9.785±2.106	7.182±1.883	33.540±3.886 aP=0.004,bP=0.005, cP=0.000	34.139±6.153 aP=0.024,bP=0.019, cP=0.018	27.264±5.332

a: difference from stage 2 b: difference from stage 3 c: difference from water stage

The results of repeated measures ANOVA showed that the effect of time on insulin changes was significant (F=12.178; P=0.003). Group-time interaction was also significant (F=14.597; P=0.002). Moreover, the group effect was also significant (F=17.447; P=0.002) (Table 4).

Given the significance of group-time interaction, repeated measures ANOVA was applied to examine differences of the groups at stages 1 to 5. The results indicated significant changes in the insulin levels of the water group at stages 4 and 5 compared to stage 1 (P=0.026; P=0.030), while in the glucose group significant changes were observed at stages 3 and 4 compared to stages 1 and 2. Between-group comparisons revealed significantly higher insulin levels in the glucose group at stages 3 and 4 (P=0.000; P=0.018). Therefore, it can be concluded that glucose intake led to significant increase in insulin levels of the subjects.

Conclusion:

Visfatin was first identified as an adipokine that is exclusively secreted from visceral adipose tissue (16). However, research has shown that visfatin is also expressed by the liver, heart, and skeletal muscle (3,4). The present research showed glucose intake after an aerobic exercise session has no immediate effect on plasma visfatin concentration. However, plasma visfatin levels decreased at 30, 60, and 90 minutes after exercise. Only there is a study about the effects of acute exercise on visfatin concentration. Consistent with the results of this study Ghanbari et al. (17) showed a significant increase in plasma visfatin, insulin, and glucose concentrations immediately after the exercise session. Also, they showed that at 45 min of after the exercise session, visfatin levels decreased. In the current study visfatin immediately after exercise compared with 60 and 90 minutes after training increased. The elevation in plasma visfatin, together with increased plasma glucose and insulin concentrations immediately after exercise, may sensitize tissues for post exercise glucose uptake and glycogen restoration. The mechanisms of visfatin regulation are still unknown, but some researchers are looking for changes in visfatin concentration as a result of changes in insulin and glucose levels (18). Hyperglycemia may increase circulating visfatin concentration. Glucose signaling for visfatin release in adipocytes involves the PI3-kinase/AKT pathway (19). Since the insulin-mimetic function of visfatin may be a part of glucose homeostasis, visfatin concentration can be affected by glucose or insulin levels in human blood. In the present research, however, glucose intake did not have a significant effect on post-exercise visfatin levels. Haider et al. showed that visfatin release from adipocytes in response to hyperglycemia depends on glucose levels and can be suppressed by injection of insulin (19).

On the other hand, some studies have reported decreased visfatin fallowing long period of training (20-22). This difference in findings may be due to different exercise protocols, models of human samples in contrast to animal, study samples of healthy and diseased conditions and the methods of measurement vary. Due to inconsistencies in the field of impact of exercise as well as little researches exercise on visfatin, is not well known the exact mechanism of the effect of exercise on visfatin. Also, it is likely that changes in plasma visfatin regardless of the tissue expression of a number of factors influenced the increase or decrease in blood glucose, insulin, changes in body composition, intensity and duration of exercise and calorie restriction factors are considered.

The results of the present study showed that plasma insulin levels significantly increased by glucose intake at 30 and 60 minutes after exercise. Although at 90 minutes after exercise the plasma insulin level of the glucose group was higher than that of the water group, but the difference was not significant. It has been shown that insulin does not affect visfatin synthesis in adipocytes, and no significant difference has been observed in the serum visfatin levels of diabetic patients and those who injected insulin or received hypoglycemic agents (23,24). In addition, the effect of insulin-sensitizing agents on serum visfatin has not yet been confirmed (25,26). Fukuhara et al. have reported that visfatin exerts insulin- mimetic actions in cultured cells and lowers plasma glucose levels in mice (1). Choi et al. showed that exercise training with weight loss induced a significant reduction of plasma visfatin in healthy subjects (20). In general, the effect of exercise on adipokines differs with respect to the intensity and duration of exercise as well as changes in body composition. There is especially considerable disagreement regarding the effect of exercise on circulating adipokines. Inconsistencies may be related to differences in the type, intensity, and duration of exercises as well as the number of repetitions (27). Research has shown that aerobic exercise followed by weight loss can decrease plasma visfatin levels (9). Moreover, higher levels of visfatin have been observed in patients with inflammatory bowel disease and visfatin may have proinflammatory properties (28).

Temporary increase in the concentration of visfatin after exercise may be due to the proinflammatory effect of this adipokine. Studies have often reported significant decrease in plasma visfatin levels after exercise (11). There is enough evidence that visfatin is expressed by macrophages, is filtered in adipose tissue, and is released in response to inflammatory signals (29,30).

Also, the plasma glucose level of the glucose group was significantly lower than the water group. Harasim et al. showed that in vitro exposure to visfatin/eNAMPT increases skeletal muscle glucose transport (31). The inconsistency is apparently due to increased insulin release as a result of glucose intake that reduced plasma glucose. On the other hand, Harasim et al. argued that visfatin/eNAMPT plays a rather limited role in regulating skeletal muscle glucose transport and fatty acids metabolism (31). Moreover, this study showed that visfatin stimulates higher glucose transport in glycolytic skeletal muscles (31). It is also possible that glucose transport is affected not only by GLUT-4 translocation to the plasma membrane, but also by the intrinsic activity of GLUT-4 (32). Moderate visfatin levels (as compared to insulin stimulation) may have adipokine effects in the skeletal muscle glucose transport (31). It has also been shown that visfatin cannot be considered a direct activator of insulin signaling in human fat cells (33). This means that visfatin plays little role in regulating glucose transport across myocytes (and fat cells) (31).

Although in this study, factors such as limited samples size could have affected the results. Therefore, conduction of further studies with a greater sample size and more precise control over limitations on the same statistical population is recommended to achieve more complete results. In addition to these, the duration and volume exercise effective indicators that more accurate understanding of the details require further research.

In conclusion, According to the findings, changes made in visfatin levels following acute exercise and glucose intake is not significant. So, probably visfatin has no role in improving the acute exercise-induced metabolic status and glucose intake in healthy subjects. Finally, according to the results suggest that in future studies investigate the effect of aerobic exercise training and glucose intake on changes in levels Plasma visfatin and Visfatin response to acute exercise in individuals and different groups

Acknowledgment:

The authors express their gratitude of the Science and Research Branch of IAU for funding this project.

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اثر مصرف گلوکز بر پاسخ ویسفاتین پلاسمایی پس از یک جلسه فعالیت هوازی در مردان جوان دانشگاهی

ماندانا غلامی [۱] احمد عبدی [۲] آسیه عباسی دلویی [۲] عباس قنبری نیاکی [۳]

[۱] گروه تربیت بدنی و علوم ورزشی، واحد علوم و تحقیقات، دانشگاه آزاد اسلامی، تهران، ایران. [۲] گروه تربیت بدنی و علوم ورزشی، واحد آیت‌الله آملی، دانشگاه آزاد اسلامی، آمل، ایران. [۳] گروه تربیت بدنی و علوم ورزشی، شاخه بیوشیمی ورزشی، دانشکده علوم ورزشی، دانشگاه مازندران، بابلسر، ایران.

مجله پزشکی هرمزگان سال بیستم شماره ششم ۹۵ صفحات ۳۷۲-۳۶۵

چکیده

مقدمه: *ویسفاتین عمدتاً از بافت چربی احشایی ترشح می‌شود و اثر انسولین را با اتصال به گیرنده‌های انسولین تقلید می‌کند. هدف از پژوهش حاضر، بررسی اثر مصرف گلوکز روی غلظت ویسفاتین پلاسما به دنبال یک جلسه تمرین هوازی بود.*

روش کار: *۱۶دانشجوی مرد غیر ورزشکار (سن ۲/۳۱ ±۲۱/۹۱سال؛ وزن ۸/۹۳ ±۷۷/۵۳ کیلوگرم؛ قد ۰/۰۷ ±۱/۷۶ سانتی‌متر و شاخص توده ۲/۰۷ ±۲۴/۳۱ کیلوگرم / مجذور متر) به طور تصادفی به دو گروه دارونما و گلوکز تقسیم شدند. نمونه‌گیری از خون در پنج مرحله انجام شد؛ قبل از ورزش، بلافاصله پس از ورزش و ۳۰، ۶۰ و ۹۰ دقیقه بعد از ورزش. آزمودنی‌ها ۴۵ دقیقه ورزش هوازی (شامل ۱۰دقیقه گرم کردن، سپس یک مایل دویدن با حداکثر سرعت و ۳دقیقه استراحت بین وهله‌ها) را اجرا کردند. بلافاصله پس از نمونه خون دوم، آزمودنی‌ها مایعات شیرین (۱/۵گرم گلوکز به ازای هر کیلوگرم وزن بدن) و آب (حجم مشابه) دریافت کردند. داده‌ها با استفاده از آزمون اندازه‌گیری مکرر ANOVA و آزمون تعقیبی LSD در سطح معنی‌داری $P \leq 0/05$ تجزیه و تحلیل شدند).*

نتایج: *سطوح ویسفاتین پلاسما بلافاصله پس از تمرین افزایش یافت، اما این افزایش معنی‌دار نبود. در زمان‌های (۳۰، ۶۰ و ۹۰ دقیقه بعد از ورزش)، سطح ویسفاتین پلاسما در هر دو گروه کاهش یافت، ولی این کاهش معنی‌دار نبود. تفاوت معنی‌داری در سطح ویسفاتین گروه گلوکز در ۶۰ و ۹۰ دقیقه بعد از ورزش نسبت به بلافاصله پس از تمرین مشاهده شد. سطح گلوکز پلاسما در گروه گلوکز به طور معنی‌داری کمتر از گروه آب بود. افزایش معنی‌داری در سطح انسولین پلاسما با مصرف گلوکز در ۳۰ و ۶۰ دقیقه بعد از ورزش مشاهده شد. اگرچه در ۹۰دقیقه بعد از ورزش سطح انسولین پلاسما در گروه گلوکز بالاتر از گروه آب بود، اما تفاوت معنی‌دار نبود.*

نتیجه‌گیری: *با توجه به یافته‌های تحقیق حاضر، تغییرات ایجاد شده در سطوح ویسفاتین به دنبال تمرین حاد و مصرف گلوکز معنی‌دار نمی‌باشد. بنابراین، احتمالاً ویسفاتین در بهبود وضعیت متابولیکی ناشی از تمرین حاد و مصرف گلوکز در افراد سالم نقشی ندارد.*

کلیدواژه‌ها: *گلوکز، ویسفاتین، ورزش هوازی*

نویسنده مسئول:
دکتر ماندانا غلامی
واحد علوم تحقیقات، دانشگاه آزاد اسلامی،
تهران - ایران
تلفن: ۹۱۲۱۴۹۱۸۶۸ ۹۸+
پست الکترونیکی:
a.abdi58@gmail.com

نوع مقاله: پژوهشی

دریافت مقاله: ۹۵/۱۰/۲ اصلاح نهایی: ۹۵/۱۱/۲۵ پذیرش مقاله: ۹۵/۱۲/۷

ارجاع: غلامی ماندانا، عبدی احمد، عباسی دلویی آسیه، قنبری نیاکی عباس. اثر مصرف گلوکز بر پاسخ ویسفاتین پلاسمایی پس از یک جلسه فعالیت هوازی در مردان جوان دانشگاهی. مجله پزشکی هرمزگان ۱۳۹۵؛۲۰(۶):۳۷۲-۳۶۵.