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Irisin in response to acute and chronic whole-body vibration exercise in humans☆,☆☆

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ABSTRACT

Objective. Irisin is a recently identified myokine, suggested to mediate the beneficial effects of exercise by inducing browning of white adipocytes and thus increasing energy expenditure. In humans, the regulation of irisin by exercise is not completely understood. We investigated the effect of acute and chronic whole-body vibration exercise, a moderate-intensity exercise that resembles shivering, on circulating irisin levels in young healthy subjects.

Materials/Methods. Healthy untrained females participated in a 6-week program of whole-body vibration exercise training. Blood was drawn before and immediately after an acute bout of exercise at baseline (week 0) and after 6 weeks of training.

Results. The resting irisin levels were not different at baseline (week 0) and after 6 weeks of training. At both 0 and 6 weeks of training, an acute bout of vibration exercise significantly elevated circulating irisin levels by 9.5% and 18.1%, respectively ($p = 0.05$ for the percent change of irisin levels).

Conclusions. Acute bouts of whole-body vibration exercise are effective in increasing circulating irisin levels but chronic training does not change levels of baseline irisin levels in humans.

1. Introduction

Irisin, a recently discovered myokine, is suggested to mediate beneficial effects of exercise by inducing browning in adipose tissue [1]. In mice, overexpression of irisin precursor, fibronectin type III domain-containing protein 5 (FNDC5), resulted in mitigation of diet-induced insulin resistance [1]. Irisin has also been shown to be related to various physiological and pathophysiological conditions in mice and humans [2–9]. Therefore, irisin is an attractive target for the treatment of

Abbreviations: FNDC5, fibronectin type III domain-containing protein 5; WBV, whole body vibration exercise; IGF1, insulin-like growth factor 1; IGFBP3, insulin-like growth factor binding protein 3; IL-6, interleukin-6.

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obesity and related metabolic disorders [10,11]. We have previously shown that acute bout of high-intensity exercise can induce irisin secretion in humans [12]. Although prior studies have failed to observe increased irisin levels in response to chronic, habitual exercise [13–15], several others have confirmed the increased circulating irisin in response to acute bouts of exercise, mainly employing treadmill or bicycle exercise [14–17]. It remains to be clarified whether other types of exercise can increase irisin acutely or after a period of training, and whether the increased irisin would be a result of cleavage of extracellular part of FNDC5 and/or release of intracellular irisin into the circulation, for example, by muscle damage. Here, we examine the effect of whole body vibration exercise (WBV) on circulating irisin levels. WBV is a moderate-intensity exercise employing low amplitude and low frequency mechanical stimulation to improve muscle capacity [18] shown to be a therapeutic in the treatment of osteoporosis, sarcopenia, and metabolic syndrome [18]. We examined the baseline and change of circulating irisin after an acute bout of WBV at the beginning of the study (week 0) and after 6 weeks of WBV training (week 6).

2. Methods

2.1. Exercise

Healthy untrained females (n = 14, age 24.3 ± 2.6 years, BMI 20.4 ± 1.8 kg/m^2, mean ± SD) participated in a 6-week program of WBV training with two sessions per week. Each session consisted of seven isometric exercises (Galileo 2000, Novotec, Germany) as follows: squat with the knees flexed at 120°, squat with the knees flexed at 100°, one-leg squat on each leg with the knee flexed at 120°, wide-stance squat with the knees flexed at 100°, elbow flex, triceps dip, and push-up on elbows. Vibration frequency was 16, 19, and 21 Hz (increased during training). Vibration amplitude was 2.5 mm during the first four weeks and 5 mm during the last two weeks. The duration of each training session increased progressively every two weeks from 11 to 18.5 min. Blood samples were collected before and within 5 min after the end of the first and last training session for the preparation of serum. For lactate measurement, 14 μL of blood was immediately hemolyzed with 140 μL of 0.3 mol/L $HClO_4$. All procedures were in accordance with the Code of Ethics of the Aristotle University of Thessaloniki and the Helsinki declaration, and all participants provided written informed consent.

2.2. Biochemical measurements

Irisin was measured using a previously validated ELISA (#EK-067-52, Phoenix Pharmaceuticals, Burlingame, CA) [10,12]. Interleukin-6 (IL-6) was measured with ELISA (R&D Systems, Minneapolis, MN). Lactate was measured according to an enzymic method from Sigma Diagnostics (data sheet of product number L3916, lactic dehydrogenase). Creatine kinase was measured using an automated analyzer (Hitachi cobas c311; Roche Diagnostics, Indianapolis, IN). Insulin, insulin-like growth factor 1 (IGF1), and insulin-like growth factor binding protein 3 (IGFBP3) were measured by Immulite 1000 (Siemens Healthcare Diagnostics, Norwood, MA). Glucose and uric acid were measured with kits from Centronic (Wartenberg, Germany). Cortisol, testosterone, and growth hormone were measured by kits from DRG (Marburg, Germany).

Table 1a – Baseline biochemical and hormonal parameters before and after a 6-week program of whole-body bilateral vibration training (n = 14).

	Week 0	Week 6	P
Irisin (ng/mL)	804.7 ± 333.6	790.5 ± 339.1	0.77
IL-6 (pg/mL)	1.4 ± 0.2	0.9 ± 0.3	0.02
Lactate (mmol/L)	1.8 ± 0.7	1.3 ± 0.5	0.56
Creatine kinase (U/L)	60.0 ± 27.5	57.5 ± 25.4	0.46
Glucose (mmol/L)	6.0 ± 1.2	6.5 ± 1.0	0.14
Insulin (μIU/mL)	9.0 ± 2.2	5.8 ± 1.3	0.20
IGF1 (ng/mL)	248.3 ± 61.8	217.6 ± 55.6	< 0.01
IGFBP3 (μg/mL)	8.4 (4.3–29.3)	39.5 (4.9–48.8)	< 0.01
Cortisol (nmol/L)	228.5 ± 80.8	348.4 ± 106.6	0.69
Testosterone (nmol/L)	3.6 ± 1.4	4.1 ± 1.2	0.10
Growth hormone (mU/L)	1.7 (0.7–15.4)	1.2 (0.4–2.0)	0.51
Uric acid (mmol/L)	0.2 ± 0.1	0.2 ± 0.1	0.72

2.3. Statistical analysis

Data are expressed as means ± SD or median (interquartile range). Differences in baseline or percentage change in hormone levels were determined with paired *t* test or Wilcoxon signed rank test, as appropriate. Changes in irisin levels with acute exercise and training were examined with 2-way repeated-measures ANOVA. Spearman's correlation coefficients were calculated to correlate irisin baseline levels or percentage changes with other parameters. Analyses were performed with the SPSS and *P* values below 0.05 were considered significant.

Table 1b – Percent change of biochemical and hormonal parameters by acute bout of whole-body bilateral vibration exercise at week 0 and week 6 i.e. after 6 weeks of training (n = 14).

	Week 0	Week 6	P
Irisin	9.5 ± 11.9	18.1 ± 9.7	0.05
IL-6	−0.1 ± 12.4	22.7 ± 6.1	0.03
Lactate	166.9 ± 103.2	292.3 ± 139.3	0.01
Creatine kinase	7.8 ± 11.0	9.0 ± 12.8	0.72
Glucose	3.9 ± 17.1	2.0 ± 13.6	0.65
Insulin	180.4 ± 72.3	28.9 ± 28.1	0.12
IGF1	3.3 ± 10.8	10.2 ± 8.9	0.02
IGFBP3	6.8 (3.8–26.8)	4.2 (2.5–7.7)	0.18
Cortisol	−13.5 ± 12.4	2.6 ± 24.6	0.07
Testosterone	10.0 ± 20.1	4.0 ± 25.3	0.30
Growth hormone	176.2 (37.6–1064.5)	458.3 (86.8–1528.1)	0.22
Uric acid	−10.0 ± 21.2	−7.9 ± 27.5	0.83

Data are means ± SD or median (interquartile range). *P* values are from paired *t* test or Wilcoxon signed rank test comparing the relative increases at the two time points. IL-6: interleukin-6, IGF1: insulin-like growth factor 1, IGFBP3: insulin-like growth factor binding protein 3.