Kinestetik : Jurnal Ilmiah Pendidikan Jasmani 8 (4) (2024)
Kinestetik : Jurnal Ilmiah Pendidikan Jasmani
https://ejournal.unib.ac.id/index.php/kinestetik/index
DOI : 10.33369/jk.v8i4.38612

Effects Of High Intensity Interval Training On The Body

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Article Info

Article History :

Received : December 2024
Revised : December 2024
Accepted : December 2024

Keywords:

HIIT,
IL-6,
HIIT, GLTU4, IL-6, Glucose

Abstract

High-intensity interval training is a form of exercise that involves strenuous activity over a short period of time followed by a recovery period with rest or low-intensity exercise before starting the next workout. AMPK can increase GLUT4 expression through response elements in the bp895 promoter and transcription factors such as guanine nucleotide exchange factor (GEF) and myocyte enhancer factor. This study used the literature review method. Getting 102 journals into 45 journals because through the selection process. The conclusion of this study says that HIIT training can increase muscle oxidation, increase Interleukin-6 (IL-6) levels, and when compared to moderate intensity training, High intensity training is better for weight loss.

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ISSN 2685-6514 (Online)
ISSN 2477-331X (Print)

INTRODUCTION

Given the enormous health benefits of exercise, there have been many studies aimed at identifying the optimal type and dose of exercise to maximize physiological adaptations and performance (Batacan et al., 2017). Among various exercise modalities, high-intensity interval training (HIIT) is recognized as a time-efficient exercise strategy to induce similar or even superior adaptations compared to moderate-intensity continuous exercise. Interval training typically involves repeated bouts of relatively intense exercise punctuated by short recovery periods (Khammassi et al., 2018).

High-intensity interval training is a form of exercise that involves strenuous activity for a short period of time followed by a recovery period with rest or low-intensity exercise before starting the next exercise (de Oliveira Teles et al., 2022). Many studies use specific exercise and recovery ratios to improve various energy systems in the body. For example, a 1:1 ratio could be 3 minutes of hard (or high-intensity) exercise followed by 3 minutes of recovery (or low-intensity) exercise. These 1:1 interval workouts usually last about 3, 4, or 5 minutes followed by the same recovery time (Gallo-Villegas et al., 2018). Another popular HIIT training protocol is called the "spring interval training method". With this type of program, exercisers perform about 30 seconds of 'sprinting or near- maximal effort', followed by 4 to 4.5 minutes of recovery. This combination of exercises can be repeated 3 to 5 times. This higher intensity work effort is usually a shorter workout (30 seconds with sprint interval training) (Hadiono & Wara Kushartanti, 2019).

A meta-analysis comparing HIIT and continuous training in patients with cardiometabolic disease found an almost two-fold improvement in cardiorespiratory fitness (measured by vO2peak) after HIIT compared to training (Astorino et al., 2017). Other health-related adaptations occurred significantly more in HIIT compared to continuous training, such as lower blood pressure, improved insulin sensitivity, increased nitric oxide availability, improved lipid metabolism and increased PGC-1α (Granata et al., 2016). Interestingly, despite the sprint nature of Wingate-based HIIT, endurance-like adaptations were documented after several weeks (2-6) of training with this HIIT format. These include increased muscle oxidative capacity and glucose transport capacity and hence improved insulin sensitivity and glycemic control, along with cardiovascular adaptations (Liu et al., 2019).

With the many benefits of the physiological response to HIIT, we gathered references from previous research studies to get a flow of how HIIT can benefit the body. By flow we mean physiologically. The update to this article is to find the pathway of the body's physiological response with HIIT Training.

METHODS

The research method used in this article is review. Collecting articles from previous research within a maximum span of 10 years. the articles in question are articles that discuss high intensity training, moderate intensity training, exercise adaptation, and body physiology. In this study there were 102 journals to 45 journals due to the selection process. Furthermore, the selected journals will be described according to several chapters, including HIIT and muscle oxidation,

HIIT and glucose, HIIT and interleukin-6 (IL-6), HIIT and lipids.

RESULT

1. Hiit and Muscle Oxidation

Mitochondria and substrate transporters play an important role in the oxidative metabolism of muscle substrates (Stephens et al., 2018). Mitochondria are central organelles for oxidation of substrates (glucose, fatty acids, and lactate) for ATP production through the tricarboxylic acid cycle (TCA cycle) and electron transport chain to maintain homeostatic ATP levels. Transporters are proteins in the membrane or collected in the cytosol that have an important role in the regulation of specific substrate transport in both plasmalemma and mitochondrial membranes. (Smith-Ryan et al., 2020) Here we focus on glucose, lactate and fatty acid transporters. Figure 1 shows a simple scheme of oxidative metabolism of substrates in skeletal muscle, involving mitochondria and associated transporters. The large energy demand of HIIT results in a significant increase in cellular ADP/ATP and AMP/ATP ratios that can activate AMPK, one of the cell's most important energy sensors. AMPK consists of α, β, and γ subunits (Shahouzehi et al., 2023). If ATP concentration decreases and AMP levels increase as a result of muscle contraction or lack of energy influx, then AMP is bound to the Bateman domain (CBS domain) of the γ subunit as the first event in mammalian AMPK activation (Antunes et al., 2020). Several studies have shown that AMPK phosphorylation in skeletal muscle is positively correlated with exercise intensity and duration (Ouerghi et al., 2017). AMPK phosphorylates several important enzymes involved in the regulation of lipid and protein metabolism and glucose transport. The combination of heterotrimers may provide an important way to adapt to different exercise stimuli. Therefore, different associations of α, β, and γ isoforms (α1, α2, β1, β2, γ1, γ2, γ3) may differ in fiber type isoform-specific AMPK activity measured by sequential immunoprecipitation after a single HIIT or MICT session. Increased α2β2γ3 structure/construct activity by 27-fold in HIIT vastus lateralis samples (Torma et al., 2019).

Many studies have examined the maximal activity and protein levels of mitochondrial enzymes as indicators of mitochondrial content and volume, such as citrate synthase (CS), COX, and SDH measured by biochemical tests. HIIT increased the maximal activity of CS and COX, reflecting increased skeletal muscle mitochondrial content, in rats, mice, horses and humans (Hadiono & Wara Kushartanti, 2019). As mitochondrial volume is related to insulin sensitivity, muscle atrophy and exercise performance, HIIT is a useful method for the enhancement of oxidative capacity that prevents muscle impairment and improves exercise performance (Smith-Ryan et al., 2020).

2. HIIT and Glucose

HIIT has been shown to improve peripheral insulin sensitivity in those with impaired metabolic control (Gallo-Villegas et al., 2018). Molecular adaptations to HIIT include increased GLUT- 4 content, increased aerobic enzyme capacity and mitochondrial biogenesis, all of which have been associated with improved peripheral insulin sensitivity (RezkAllah & Takla, 2019). In skeletal muscle, GLUT4 is the most important glucose transporter. The protein content regulates glucose uptake into muscle cells HIIT increased GLUT4 protein content in human and rat muscle (Hidayat & Suroto, 2016) Moreover, HIIT-induced increase in GLUT4 levels simultaneously improved glucose

tolerance capacity in metabolic disorder patients (RezkAllah & Takla, 2019).

Physical exercise increases FGF21 secretion from muscle as a myokine (Jandova et al., 2021). Therefore, physical exercise can induce the sympathetic nervous system to release norepinephrine, which stimulates FGF21 secretion by skeletal muscle (Holland et al., 2014). However, the sympathetic response during exercise depends on the intensity of the exercise. High intensity during exercise in healthy subjects may increase FGF21 secretion. In line with previous studies, FGF21 levels were increased by HIIT in skeletal muscle, to a greater extent than continuous moderate exercise in obese rats. However, there has been no evidence of the results of HIIT on glucose uptake in DM, specifically through FGF21 signaling (Hughes & Higgins, 2019). Therefore, the aim of this study was to determine the impact of physical activity such as high-intensity interval training (HIIT) on glucose uptake via AMPK activation by FGF21 under diabetic conditions. AMPK can increase GLUT4 expression through response elements in the bp895 promoter and transcription factors such as guanine nucleotide exchange factor (GEF) and myocyte enhancer factor (MEF) (Ahmad, 2019). Meanwhile, GLUT4 translocation is mediated by the GTPase-activating protein Rab. Physical exercise can activate AMPK, thereby increasing insulin-independent glucose uptake (Recinella et al., 2020). Previous studies have shown that rodents fed a high-fat diet and given regular physical exercise exhibit physiological changes by involving AMPK FGF21 signaling in skeletal muscle. However, previous studies did not explain AMPK activation by physical exercise through FGF21 signaling in increasing glucose uptake (Cassidy et al., 2017).

3. Interleukin-6 and Glucose

Low grade cytokines characterized by a slight increase in pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor alpha (TNF-a) and C-reactive protein (CRP) may show an association with the development of insulin resistance, metabolic syndrome and cardiovascular disease. These markers are prognostic indicators of increased risk of several chronic diseases (Ellulu et al., 2016). As calorie and fat intake increases, activation of inflammatory pathways in cells is initiated through nutrient perception and cytokine delivery, and the process of nutrient perception is carried out through molecular patterns. In addition, cytokines are produced in various organs in response to inflammatory stimuli and can act through endocrine, paracrine and autocrine pathways (Recinella et al., 2020).

Interleukin 6 (IL-6) also works as a pro-inflammatory cytokine and anti-inflammatory myokine expressed by the IL6 gene in humans (Sarkar et al., 2021). IL-6 has both anti-inflammatory and anti-inflammatory effects. Given the role of Il-6 in the inhibition of pro-inflammatory cytokines (IL-1b and TNF-a) as well as metabolic activation, several mechanisms are responsible for increasing serum levels of Il-6 during and after activity. Insulin and leptin primarily act through hypothalamic neurons to regulate feeding, energy homeostasis, and systemic insulin sensitivity and central IL-6Ra expression was shown to be very tightly localized in the hypothalamus (Timper et al., 2017).

HIIT significantly increased in the one-hour and 24-hour phases after HIIT training. The increase in IL-6 in the one hour after training compared to the pre-test phase was nearly 32%. Insulin and leptin mainly act through hypothalamic

neurons to regulate feeding, energy homeostasis, and systemic insulin sensitivity and central IL-6Ra expression was shown to be very close to that in the hypothalamus, especially considered as a pro-inflammatory cytokine involved in many pathophysiological conditions (Sarkar et al., 2021). However, IL-6 release through skeletal muscle contraction appears to have beneficial effects on insulin-stimulated glucose disposal and fatty acid oxidation. Therefore, IL-6 may be important for muscle metabolism during contraction (RezkAllah & Takla, 2019). depending on the duration, intensity and mode of exercise. Although there is some evidence that HIIT significantly affects the post-exercise IL-6 response (Siddiqui, 2018).

Interleukin-6 (IL-6) has been shown to play a role in the control of body weight and body fat. For example, in animal studies, IL-6 overexpression has been reported to reduce fat accumulation and weight gain, whereas IL-6-deficient mice are obese in adulthood (Kaspar et al., 2016). Previous studies have shown a complex relationship between IL-6 and body weight and fat. It is generally accepted that high levels of inflammatory mediators such as IL-6 and TNF-ÿ are cachectogenic and possibly anorexigenic, that is, associated with weight loss and decreased food intake (Recinella et al., 2020). Previous studies show strong evidence for the role of il-6 in the prevention of obesity and insulin resistance. For example, found that IL-6 improved glucose disposal in healthy humans. In addition, IL-6-deficient mice are obese in adulthood, which is partly due to reduced energy expenditure, and conversely, overexpression of IL-6 leads to increased thermogenesis of energy expenditure (Siddiqui, 2018) .

4. HIIT and Lipid

Reported the impact of HIIT on fat and weight loss and concluded that HIIT can increase fat oxidation (even up to 18%), especially on post-exercise days. In addition, reported that low lactate accumulation and reduced glycogen utilization with improved muscle buffering capacity efficiency resulted from high-intensity sprint interval training (HISIT) compared to resistance training. Lipid profile is an indicator to predict the development of cardiovascular disease (CVD) in adults, with increased low-density lipoprotein cholesterol (LDL-C) and decreased serum high-density lipoprotein cholesterol (HDL-C) levels also indicating the onset of coronary heart disease (CHD) in adults (Recinella et al., 2020).

During physical activity, 30-80% of energy comes from fat and muscle utilizes free fatty acids and triglycerides (TG), either circulating or stored, for energy production. Previously, reported that an 8-week HIIT protocol significantly increased HDL-C and reduced total cholesterol (TC) in healthy adults (Akhoundnia et al., 2019). Exercise has a clear physiological impact on hematologic variables depending on the type, intensity, and duration of exercise. During HIIT, an increase in erythrocyte count is reported, which may compensate for the increased oxygen demand (Hughes & Higgins, 2019). Previous studies reported that resistance training likely impacts blood volume changes mainly due to exercise-induced plasma volume (PV) expansion, which results in lower hemoglobin (Hb) and hematocrit (HCT) levels in athletes. Leukocytes and circulating platelet count (PLT) were found to increase during the post- exercise phase in healthy adults (Ahmad, 2019). Intense exercise can increase plasma viscosity and erythrocyte

stiffness, but may decrease sedimentation rate. Studies confirmed acute HIIT-induced changes in hematological variables from immediate post- exercise conditions, but 12-24 hours recovery conditions were only reported (Hammond et al., 2019). Other results stated that HIIT and MIT training can be used as an alternative to overcome obesity (Hadiono et al., 2023).

CONCLUSION

The review above states that when compared to moderate intensity training, high intensity interval training has a positive impact on the body. these include an increase in il-6 as a myokine, maximized muscle ossification, decreased levels of low density lipoprotein, and decreased glucose levels. however, the question is whether all hiit methods can cover all the impacts mentioned. that question will certainly be the subject of further research.

ACKNOWLEDGEMENT

Thanks are given to the academic community of PGRI Madiun University who have supported the success of this research.

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