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Moderate Intensity Interval Training (MIIT) and High Intensity Interval Training (HIIT) exercise therapy against irisin levels in obesity

Trening interwałowy o umiarkowanej intensywności (MIIT) i trening interwałowy o wysokiej intensywności (HIIT) a poziomy iryzyny w otyłości

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Abstract
Obesity can cause physiological disorders. These physiological disturbances cannot be separated from the roles of irisin. Exercising with the right measure, measurable, and regularly is a strategy for dealing with obesity. The aims of this study were (1) to determine the effect of irisin levels on exercise with the Moderate Intensity Interval Training (MIIT) and High Intensity Interval Training (HIIT) levels models in obese rats.
This research is a true experimental laboratory study with a pretest-posttest control group design. This research was conducted at the Bioscience Laboratory of Brawijaya University, Malang. The research sample used 27 obese male Wistar rats divided into 9 MIIT group rats, 9 HIIT rats, and 9 control rats. Exercise intervention is given for 6 weeks at a frequency of 4 times per week. The intensity of MIIT (60–80% of base line ability), HIIT (90–100% of base line ability), irisin levels are obtained from blood tests using enzyme-linked immunosorbent assay (ELISA). Data analysis used the Anova test and post hoc Tukey analysis with a significance level of 0.01.
The results showed that there was no significant difference in irisin levels (p = 0.507). The HIIT irisin difference was lower than MIIT (p = 0.932) and Control (p = 0.491), and there was no difference in irisin value between the MIIT and Control groups (p = 0.708).

Key words
obesity, MIIT, HIIT, irisin

Streszczenie
Otyłość może powodować zaburzenia fizjologiczne. Zaburzenia te są związane z rolą iryzyny. Ćwiczenia o odpowiedniej intensywności, mierzalne i regularne, stanowią jedną ze strategii radzenia sobie z otyłością. Celem tego badania było (1) określenie wpływu poziomu iryzyny na ćwiczenia w modelach treningu interwałowego o umiarkowanej intensywności (MIIT) i treningu interwałowego o wysokiej intensywności (HIIT) u otyłych szczurów. Badanie to miało charakter laboratoryjnego eksperymentu prawdziwego z zastosowaniem układu z grupą kontrolną i pomiarem przed oraz po interwencji. Badanie zostało przeprowadzone w Laboratorium Bioscience Uniwersytetu Brawijaya w Malang. Próbkę badawczą stanowiło 27 otyłych samców szczurów Wistar, podzielonych na 9 szczurów z grupy MIIT, 9 szczurów z grupy HIIT oraz 9 szczurów kontrolnych. Interwencja treningowa była prowadzona przez 6 tygodni, z częstotliwością 4 razy w tygodniu. Intensywność MIIT wynosiła 60–80% wyjściowej zdolności, natomiast HIIT 90–100%. Poziomy iryzyny uzyskiwano z testów krwi przy użyciu metody ELISA. Analiza danych została przeprowadzona za pomocą testu Anova oraz analizy post hoc Tukeya przy poziomie istotności 0,01. Wyniki wykazały brak istotnych różnic w poziomach iryzyny (p = 0,507). Różnica poziomu iryzyny w grupie HIIT była niższa niż w grupie MIIT (p = 0,932) oraz w grupie kontrolnej (p = 0,491), a także nie stwierdzono różnic w poziomie iryzyny między grupą MIIT a grupą kontrolną (p = 0,708).

Słowa kluczowe
otyłość, MIIT, HIIT, iryzyna

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Introduction

Obesity, particularly prevalent in Indonesia, requires serious treatment due to the increasing number of affected individuals. Obesity is a problem that occurs as a result of an energy imbalance, namely consuming too many calories and burning too few. It is considered as one of the most important risk factors for several diseases including cardiovascular disease, type 2 diabetes mellitus, respiratory disorders, and several types of cancer [1]. Several factors can influence how many calories a person burns each day, such as age, body size, and genes. Obesity or overweight is the biggest contributing factor to the occurrence of metabolic syndrome [2]. Metabolic syndrome can result in financial and physiological disruptions. From a financial perspective, it can be explained that the cost burden of the National Health Insurance (JKN) through the Social Security Administration Agency (BPJS) continues to swell, it is noted that during 2016 heart disease spent state funds of 6.9 trillion, stroke 1.5 trillion, kidney 1, 5 trillion and diabetes mellitus 1.2 trillion. Increased obesity if not treated immediately can cause metabolic syndrome in a person. Obesity is cause for atherosclerosis (hardening of the blood vessel walls) [4]. Obesity is the biggest cause of the process of insulin resistance [5]. Metabolic syndrome can also increase the risk of coronary heart disease, stroke, renal insufficiency and cancer [6]. Diabetes mellitus has become the biggest factor causing polyneuropathy (a peripheral nerve disorder) [7]. Exercise is one of the non-pharmacological approaches to combating obesity. Experiments using Wistar rats showed that exercise plays a role in the process of browning adipose tissue. Adipose tissue is considered as an endocrine organ that regulates energy homeostasis and inflammation [8]. There are two types of adipocytes: fat-storing white adipocytes and thermogenic brown adipocytes. The physiological disturbances caused by obesity cannot be separated from the role of Irisin.

In obese conditions Irisin levels will decrease. It is shown that obesity causes a significant decrease in FNDC5 and Irisin in skeletal muscle. This is because obesity can increase the expression of myostatin (MSTN) in skeletal muscle. The process of beiging (browning) of adipose tissue can increase thermogenesis activity which can increase lipid catabolism and heat release thereby preventing excessive fat accumulation [9]. The results of research by Bostrom et al. (2012) identified a new exercise-induced myokine that acts as a mediator of the beiging process, irisin [10]. Exercise involves muscle contraction and can stimulate the secretion of proteins (myokines) that mediate communication between skeletal muscles and other networks through endocrine mechanisms. Myokines, which are released through skeletal muscle contractions, mediate the overall effect of improving the body's metabolism, including in cases of obesity. Irisin is released by the muscles into the blood through the breakdown (proteolysis) of the FNDC5 transmembrane protein. It has been suggested that intracellular ATP depletion in skeletal muscle also plays a role in influencing irisin secretion [11]. Following secretion from skeletal muscle, irisin acts to express UCP-1 in adipose tissue causing browning of white adipose tissue. Changes in the browning process, among others, are marked by increased expression of the UCP-1 gene. UCP-1 is an integral membrane protein found in the mitochondrial membrane to generate heat through uncoupling oxidative phosphorylation. In brown adipose, UCP-1 activity is induced via the sympathetic nervous system, in response to cold or overeating.

However, the effect of exercise on serum irisin levels showed conflicting results. Jia et al. (2019) through a meta-analysis study found that irisin levels were higher in obesity than individuals with normal weight [12]. Similar results from the Norheim et al. (2014) showed a decrease in irisin levels after 12 weeks of combination training (endurance and strength training) in sedentary individuals aged 40-65 years [13]. The conflicting results of exercise-induced irisin responses may be due to differences in training formulas (dose). Benefit health from training can be obtained if the application pays attention to Frequency, Intensity, Time, Type (FITT).

Metabolic syndrome can be overcome and prevented by exercising. People with metabolic syndrome experience a decrease in risk factors through increased physical fitness after being intervened with regular physical training [14]. In addition, regular exercise can increase irisin levels in obese individuals. Exercising with the right measure, measurable, and regular is a strategy for dealing with overweight and obesity [15]. Currently there are two models of exercise that are in vogue done and explored its roles are Moderate Intensity Interval Training (MIIT) and High Intensity Interval Training (HIIT). Many studies show that HIIT can promote weight loss. HIIT workouts provide the same fitness benefits as continuous resistance training, but over a shorter period of time. This can happen because HIIT exercises tend to burn more calories and trigger Excess Postexercise Oxygen Consumption (EPOC) to burn calories because the body needs a lot of energy to process recovery to pre-workout levels. Additionally, HIIT can also increase the oxidative capacity of mitochondria, which results in an increase in the potential for fat oxidation through the activation pathway of AMP protein kinase [16]. Study results regarding the effects of the two training models are still varied and even contradictory. MIIT exercises can last longer because the body is not pushed to its full potential above, it is not yet known the optimal training model to induce irisin secretion. Therefore it needs more study in about influence exercise carried out using Moderate Intensity Interval Training (MIIT) and High Intensity Interval Training (HIIT) methods on irisin levels in cases of obesity.

Materials and methods

Animal

For this study, researchers used rats of the Rattus norvegicus strain Wistar. Male rats were chosen to avoid the menstrual cycle which affects the hormonal system. The rats used in this study weighed more than 160 grams. Within two months, this weight was indicative of obesity in Wistar rats.

The calculation results showed that (n = 7) rats were taken as the minimum sample for each group. To prevent sample damage and death during the study, the control group (n = 9), MIIT (n = 9), and HIIT (n = 9) totaled 27 rat samples. For permission for research procedures using experimental animals, ethical clearance was obtained from University of Brawijaya Research Ethics Commission.

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Exercise protocol

This exercise program was designed based on saturation obtained from studies of several research journals discussing exercise intervals, saturation of the age range between experimental animals and humans, saturation of total capacity and baseline in experimental animals, methods of implementing exercise programs in experimental animals using a treadmill running, and the implementation time of the training program for experimental animals. The exercise intensity is determined based on the baseline total capacity. MIIT (65-70%) baseline and HIIT (8-90%) baseline. The duration of the exercise is determined based on the time achieved to the exhaustion threshold. Exercise frequency 4x/week. Load progression is increased after entering the 2nd week and increases at the beginning of each training week. Exercises are carried out 24x which will be carried out in 6 weeks.

Table 1. Training program

Weeks	Exercise		Intensity (%)	Speed on (m/minute)	Speed off (m/minute)	Duration on (minutes)	Duration off (minutes)	Distance on (m)	Distance off (m)	Reps (x)	Total distance per session (m)	Total distance per day (m)	Total duration per day (m)
1	MIIT	Day 1, 2, 3, 4	65	13.8	5	5.5	2	75.68	10	10	85.7	857	75
2	MIIT	Day 1, 2, 3, 4	66	14.0	5	5.5	2	76.85	10	10	86.8	868	75
3	MIIT	Day 1, 2, 3, 4	67	14.2	5	5.5	2	78.01	10	11	88.0	968	82.5
4	MIIT	Day 1, 2, 3, 4	68	14.4	5	5.5	2	79.18	10	11	89.2	981	82.5
5	MIIT	Day 1, 2, 3, 4	69	14.6	5	5.5	2	80.34	10	12	90.3	1084	90
6	MIIT	Day 1, 2, 3, 4	70	14.8	5	5.5	2	81.50	10	12	91.5	1098	90

Exercise	Start	Maximum	Interval	On	Off
HIIT	19	20.1	2:1	4	2
MIIT	13.8	14.8	2.75:1	5.5	2

Statistical Analysis

Data was processed using descriptive statistics. Normality test will be carried out using the Shapiro-Wilk test with a significance level of $\alpha = 0.01$. Homogeneity test using the Barlett test with a significance level of $\alpha = 0.01$. Differences in the effect of the Moderate Intensity Interval Training (MIIT) and High Intensity Interval Training (HIIT) training models on irisin levels in the blood were tested using ANOVA statistics, whereas if the data were not normally distributed then a non-parametric Kruskal - Wallis test was performed followed by a Post Hoc test. Tukey with a significance level ($p < 0.01$). All data were tested using the computer program SPSS (Statistical Package for the Social Sciences) Version 20 for Windows.

Results

The results of the pre- and post-tests for each variable showed no significant difference in irisin levels, with a significance value of 0.255, which is greater than 0.01.

Table 2. Test different Pre and Post dependent variable

Variable	PRE-POST Control	MIIT	HIITs
Irisin	0.998	0.071	0.255

Table 3. ANOVA test between dependent variables

Variable	Sig. Value
Irisin	0.507

The results of the ANOVA test between variables from all groups on the irisin showed no significant difference in all groups. The above data presentation shows that there was no significant difference in irisin levels ($p = 0.507$). The HIIT irisin difference was lower than MIIT ($p = 0.932$) and Control ($p = 0.491$) and there was no difference in irisin value between the MIIT and Control groups ($p = 0.708$).

Discussion

The purpose of this study was to find out how the effect of training with HIIT and MIIT on irisin levels in obese subjects. In this study, it was found that irisin levels of all groups did not increase significantly between HIIT & MIIT groups with control group. The results of the study stated that the high-intensity exercise (HIIT) group did not experience an increase in irisin le-

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vels [17], the study was conducted for 12 weeks. Differences in training methods such as intensity and duration are factors that influence the results of irisin levels [18].
High-intensity exercise stimulates the production of irisin via FNDS 5 in skeletal myocytes 3 hours after exercise [19]. Production of greater irisin levels occurs after high-intensity exercise compared to moderate or low intensity exercise, marked by signal secretion from PGC-1α. In another study, irisin levels increased after 3 weeks of moderate intensity exercise in rats and could be checked 30 minutes after exercise [20]. Exercise increases Peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1α) in skeletal muscle and Fibronectin type III which contains protein 5 (FNDC5) which in turn will increase the production of irisin. Activation of protein kinase (AMPK) during HIIT is one of the factors that increase PGC-1α. Another study stated that exercise cannot increase irisin [21]. Exercises performed at high and moderate intensity also did not affect the increase in irisin levels [22]. Consistent with these findings, plasma irisin levels were higher in overweight pre-diabetic subjects compared to healthy controls. The fact that circulating irisin levels are increased in prediabetic subjects compared to healthy controls, and decreased after high-intensity exercise, can be explained by the role of irisin in glucose metabolism. Significant positive association between irisin and all lipid panels except HDL-C which showed significant negative association. Therefore, irisin is higher than the atherogenic lipid panel. The results of previous studies showed a positive correlation between irisin and total cholesterol and triglycerides among non-diabetic subjects. A positive correlation also exists between circulating irisin and IL-6, suggesting that irisin secretion tends to increase during inflammatory states. The treatment of the metabolic syndrome and its complications, as well as the prevention and management of cardiometabolic risk, has always depended on physical activity [23]. HIIT and MIIT can Induced TNF-α in obesity [24]. Genes and a variety of non-modifiable (sex, age) and modifiable factors (cardiorespiratory fitness, type of training, and time of day) influence heterogeneity in response to exercise. One of the factors that contribute to adaptation to exercise is myokine which is secreted by skeletal muscles. Irisin, which controls UCP1 during beige cell formation, was the most promising adipo-myokine for cardiometabolic health. It has been demonstrated in rats that exercise-induced irisin produces white fat thermogenesis that mimics brown fat, as discussed in the previous section.

Conclusion

Training with the MIIT and HIIT models for 6 weeks had no significant effect on irisin. The inconsistent results are due to a number of factors including, but not limited to, physiological approaches. In animal and human studies, age, BMI, anthropometric parameters, sex, health status, and duration of training had a significant effect on the results of irisin enhancement [25]. Exercises with HIIT and MIIT models can be suggested for use in dealing with metabolic syndrome problems, but it is hoped that they can be monitored and with strict protocols considering that in this exercise the intensity of the exercise is quite high and minimizes injury.

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