International Journal of Physical Education, Exercise and Sports
www.physicaleducationjournal.com
Online ISSN: 2664-9896, Print ISSN: 2664-9888
Received: 24-11-2022, Accepted: 10-12-2022, Published: 26-12-2022
Volume 4, Issue 1, 2022, Page No. 50-54

Four weeks of high intensity interval training (HITT) and moderate intensity training on glucose levels of adolescent with obesity

Yona Bayu Prasetyo, Agus Kristiyanto, Sri Sabarini Santoso
Postgraduate in Sport Science, Sebelas Maret University, Surakarta, Indonesia

Abstract
The aim of this study is to find out the effect of High Intensity Interval Training (HIIT) and Moderate Intensity Training (MIT) towards glucose levels on obesity. This study was done on 45 male adolescents with obesity. Treatment was given for four weeks with a frequency of three times a week. The intensity of HIIT (80-90% of maximum capacity) and MIT (50-75% of maximum capacity), glucose levels was tested using venous blood glucose test. Data analysis test was done using Anova. The result of this study showed that there was a difference between HIIT group's glucose with control (P=0.000), there was a difference in MIT group's glucose with control (p=0.000).

Keywords: HIIT, MIT, glucose, obesity

Introduction

Nowadays, obesity becomes one of the issues that needs to be solved, especially in Indonesia. On national scale, the prevalence of obesity is going through an increase. In 2018, East Java province went through a 2.02% increase and Ngawi regency went through a 3.01% increase (Riskedas, 2018). Furthermore, a higher prevalence increase happened on adult (>18 years old) with 22.37% increase in 2018 which is higher than in 2018 with only 8.4% prevalence. For adolescent (<15 years old), there was an increase of prevalence by 2.6% in 2018 which is higher than in 2013 with only 2.3% (Riskedas, 2018).

Obesity is excessive body fat (kaukua and jarmo, 2004) [17]. Obesity can also be defined as a situation where the amount of energy from food is higher than the amount of energy needed by body (Nadulska, dkk, 2017) [21]. Obesity will enlarge adipose tissue (Gregor, 2011) [15]. For an individual, obesity will secrete FA (Fatty Acid) more because of fat expansion (Handayani dkk, 2019) [16]. FA, acyl-CoA, ceramide, and diacylglycerol will activate protein kinase C (PKC) and c-Jun N-terminal kinase (JNK). These kinases will later disturb insulin signalling by increasing serine phosphorylation which inhibits Insulin Receptor Substrate (IRS) as the main mediator of insulin receptor signalling (Handayani *et al*., 2019) [16]. When insulin signalling is disturbed (insulin resistance), it will cause hyperglycemia and potentially cause type 2 diabetes mellitus (Wondmkun, 2020) [22].

Several studies report the effect of HIIT and CMIT. Sheikh *et al*., (2020) compare HIIT and CMIT with cardio functional indicators (blood pressure, VO_2 max, lipid, BMI, waist-to-hip ratio). Writer concludes that HIIT gains significant result for functional indicators with an increase of 3.02 mL/Kg/minute onVO_2 max. Benkar and Kanase (2017) state that three times a week of aerobic training with 30-40 minutes duration for each session and 50-70% of heart rate done for four weeks at minimum will increase glycaemic control, reduce HbA1c, and give good quality of life (mental health, physical condition, lower insomnia). Another study reports that aerobic training for twelve weeks with the frequency of three times a week and thirty minutes duration in every session and 60% VO_2max will increase respiratory cardio fitness significantly (aghjayan *et al*., 2021). In addition, the study conducted by Ahmadi *et al*., (2020) shows a significant decrease for the glycosylation of haemoglobin after 24 sessions of aerobic training with thirty minutes duration for each session and 50-70% of heart intensity.

According to previous study, HIIT increases plasma lipids on adults with obesity and unspecified obesity on adolescent with obesity (Ahmad, 2019; Fisher *et al*., 2015; Ouerghi *et al*., 2017) [1, 2, 3, 24]. Insulin resistance is positively related to estradiol and negatively related to progesterone (Bistoska *et al*., 2016). It shows that hormonal fluctuation in all of human menstrual cycle plays a role on insulin resistance. However, strategy which aims on the prevention and treatment to reduce insulin resistance rarely considers genders and there is none that considers the role of menstrual cycle (Macgregor *et al*., 2021) [5, 18]. The fluctuation of hormonal profile in all of

menstrual cycle has been linked with the change in metabolic control. During luteal phase, there is an increase of insulin circulation and decrease in the circulation of glucose and triglycerides (Mumford at al., 2010, Yeung *et al*., 2010) [6, 20, 23]. Insulin resistance will fluctuate all through the menstrual cycle. The reduction of insulin resistance during luteal phase has been reported (Macgregor *et al*., 2021, Bull *et al*., 2019) [5, 18].

Obesity levels on adolescents increase as school is closed. A report from U.S mentions that 1.27 million cases of obesity on adolescents (from age 15-24 years old) are recorded until December 2020 if school is not open again (Cuschieri and Grech, 2020) [13]. With that elaboration, it is decided that the target of this research is HIIT and MIT training on Glucose levels of male adolescents with obesity.

Method

This study is a True Experimental study using Post-test only with Control Group Design, with no-treatment control group (Fraenkel Jack R *et al*., 2010). Forty-five male adolescents with obesity (BMI >30kg/m^2) at the age of eighteen were chosen as sample. Treatment was given for four weeks (three times for every week). In each HIIT session, 80-90% of heart rate with HIIT was given in two sets of six repetitions (table 1) while MIT with 50-70% of heart rate and 40 minutes training duration for each session. Blood sample collection up to data finding stage were done by Prodia Laboratory in Madiun. Data analysis was done with the help of SPSS with significance level of 0.05.

Table 1: HIIT Training Program (2 sets of 6 repetitions for each session)

Exercise	Duration	Heart Rate	Description	Total 1 set	Total/week
On	10 sec	80 %		40 sec with 180 sec (3 minutes) passive cooldown. The obtained ratio is 1:4	20 minutes/week
Of	10 sec	50%	Active cooldown		
On	10 sec	80%			
Of	10 sec	50%	Active cooldown		
Recovery	180 sec	0%	Cooldown between set		
On	10 sec	80 %			
Of	10 sec	50%	Active cooldown		
On	10 sec	80%			
Of	10 sec	50%	Active cooldown		

MIT treatment was given with 40 minutes duration for each session with 60% intensity in earlier week. The intensity of training increased every week up until 70% intensity (table 2).

Table 2: MIT Training Program

Week	Training	Intensity	Duration	Frequency	Total duration/week
1	1	60%	40 minutes	3 times/week	120 minutes/week
	2				
	3				
2	4	63%	40 minutes	3 times/week	121 minutes/week
	5				
	6				
3	7	65%	40 minutes	3 times/week	122 minutes/week
	8				
	9				
4	10	70%	40 minutes	3 times/week	123 minutes/week
	11				
	12				

Result

The blood test shows that the insulin levels for the HIIT group was lower than MIT group and control group. Meanwhile, the control group had higher glucose levels than the MIT group.

Table 3: Glucose Levels (mg/dL)

Group	Glucose
Control	142.08 +0.70
HIIT	101.16 +0.41
MIT	118.13 +1.11

Subchapter Result

A significant difference is shown between HIIT group's glucose levels with control group (p= 0.000) and MIT group's Glucose levels with control group (p=0.000).

Table 4: Glucose levels difference (mg/dL) HIIT and MIT group

Group	f	sig
Control-HIIT	30341.553	0.000
Control-MIT	4022.433	0.000

Discussion

This study is in line with a study conducted by Mendes *et al*., (2019) [7, 19] which uses 70% of maximum heart rate with 30% of heart rate active cooldown and additional active cooldown for 3 minutes method. It reports that both HIIT and MIT methods can help decrease glucose levels where HIIT shows better result than MIT. Another study reports that HIIT is more effective to reduce glucose levels with 85% and 50% of active cooldown method (Viana *et al*., 2019) [11]. This study is different with the study done by Spers *et al*., (2005) which reports that MIT can help reduce insulin levels after 24 weeks of training. In the same study, insulin resistance can also go up with 70% of maximum heart rate. Alizadeh *et al*., (2017) [10] report that both HIIT and CMIT can reduce insulin resistance, however, if they get compared, HIIT is more effective in reducing insulin resistance by 0.01 level of significance. That study uses diabetic male rat with 90% heart rate and 5 minutes cooldown as sample.

From the elaboration above, various maximum heart rate capacities show the same result that HIIT is more effective in reducing glucose level and insulin level. Variation showed also exist in cooldown, cooldown is 3 minutes at minimum and 5 minutes at maximum depending on the demanded maximum heart rate. The research that we have conducted has not been able to be used as reference for alternative medication because of the existing limitation in the research, such as: 1) this study did not use treadmill, 2) this study did not measure the amount of fat loss for each training session, 3) the samples' food consumption cannot be controlled by the team, 4) the samples' stress level.

Relating to the difference in the results of the study, we predict that there are several factors which cannot be controlled by us, especially the samples' psychological stress. Physiological and psychological stress will have effect on cortisol secretion and adrenal tissue. Too much cortisol secretion (hypercortisolism) can induce IR by disturbing insulin secretion, developing visceral adipose, activating lipoid, and releasing free fatty acid (Ogura *et al*., 2017) [8]. Additionally, physiological stress can accelerate ROS rate as a higher oxidative stress signalling. Oxidative stress is related to obesity, hypertension, and IR (Spiers *et al*., 2015; Walvekar *et al*., 2015) [9, 12].

Conclusion

HIIT and MIT can reduce glucose levels on adolescent with obesity. In comparison, HIIT is more effective than MIT. This study has not been able to be used as an accurate reference to reduce glucose levels on adolescent with obesity. It is because the samples' diet and psychological stress cannot be controlled by the researchers.

References

1. Ahmad, Ahmad Mahdi. "Moderate-Intensity Continuous Training: Is It as Good as High-Intensity Interval Training for Glycemic Control in Type 2 Diabetes?" Journal of Exercise Rehabilitation,2019:15(2):327-33.
2. Fisher Gordon, Andrew W, Brown Michelle M, Bohan Brown, Amy Alcorn, Corey Noles *et al*. "High Intensity Interval- vs Moderate Intensity- Training for Improving Cardiometabolic Health in Overweight or Obese Males: A Randomized Controlled Trial." PLoS ONE,2015:10(10):1-15.
3. Ouerghi Nejmeddine, Mohamed Kacem Ben Fradj, Ikram Bezrati, Marwa Khammassi, Moncef Feki, Naziha Kaabachi *et al*. "Effects of High-Intensity Interval Training on Body Composition, Aerobic and Anaerobic Performance and Plasma Lipids in Overweight/Obese and Normal-Weight Young Men." Biology of Sport,201734(4):385-92.

4. Bitoska Iskra, Branka Krstevska, Tatjana Milenkovic, Slavica Subeska-stratrova, Goran Petrovski, Sasha Jovanovska. “Effects of Hormone Replacement Therapy on Insulin Resistance in Postmenopausal Diabetic Women.”,2016:4(1):83-88.
5. Macgregor Kirstin A, Iain J, Gallagher, Colin N Moran. “Relationship between Insulin Sensitivity and Menstrual Cycle Is Modified by BMI, Fitness, and Physical Activity in NHANES.” Journal of Clinical Endocrinology and Metabolism,2021:106(10):2979-90.
6. Mumford Sunni L, Enrique F, Schisterman, Anna Maria Siega-riz, Richard W, Browne Audrey J *et al*. “A Longitudinal Study of Serum Lipoproteins in Relation to Endogenous Reproductive Hormones during the Menstrual Cycle : Findings from the BioCycle Study.”,2010: 95:80-85.
7. Mendes Romeu, Nelson Sousa, José Luís Themudo-Barata, Victor Machado Reis. “High-Intensity Interval Training versus Moderate-Intensity Continuous Training in Middle-Aged and Older Patients with Type 2 Diabetes: A Randomized Controlled Crossover Trial of the Acute Effects of Treadmill Walking on Glycemic Control.” International Journal of Environmental Research and Public Health,2019:16(21):1-14.
8. Ogura Yuji, William H, Parsons, Siddhesh, S Kamat, Benjamin F. “乳鼠心肌提取 HHS Public Access.” Physiology & Behavior,2017:176(10):139-48.
9. Spiers Jereme G, Hsiao Jou Cortina Chen, Conrad Sernia, Nickolas A, Lavidis. “Activation of the Hypothalamic-Pituitary-Adrenal Stress Axis Induces Cellular Oxidative Stress.” Frontiers in Neuroscience,2015:9:1-6.
10. Alizadeh Mahdieh, Mohammad Reza Asad, Mohammad Faramarzi, Roghayeh Afroundeh. “Effect of Eight-Week High Intensity Interval Training on Omentin-1 Gene Expression and Insulin-Resistance in Diabetic Male Rats.” Annals of Applied Sport Science,2017:5(2):29-36.
11. Viana AA, Fernandes B, Alvarez C, Guimarães GV, Ciolac EG. Prescribing high-intensity interval exercise by rpe in individuals with type 2 diabetes: Metabolic and hemodynamic responses. Appl. Physiol. Nutr. Metab,2019:44:348-356.
12. Walvekar, Sanjeev S, Jeevan G, Ambekar, Basavaraj B, Devaranavadagi. “Study on Serum Cortisol and Perceived Stress Scale in the Police Constables.” Journal of Clinical and Diagnostic Research,2015:9(2):10-14.
13. Cuschieri, Sarah, Stephan Grech. “COVID-19: A One-Way Ticket to a Global Childhood Obesity Crisis?” Journal of Diabetes and Metabolic Disorders,2020:19(2):2027-30.
14. Dias Katrin A, Charlotte B, Ingul Arnt E, Tjønna Shelley E, Keating Peter A. Cain Gary M *et al*. “Effect of High-Intensity Interval Training on Fitness, Fat Mass and Cardiometabolic Biomarkers in Children with Obesity : A Randomised Controlled Trial.” Sports Medicine, 2017.
15. Gregor Margaret F, Gökhan S, Hotamisligil. “Inflammatory Mechanisms in Obesity.” Annual Review of Immunology,2011:29(1):415-45.
16. Handayani, Rosmeri, Siti Muchayat Purnamaningsih, Usi Sukorini. “Prevalence Ratio of Free Fatty Acid in Obese Group with Non-Alcoholic Fatty Liver Disease.” Journal of Thee Medical Sciences (Berkala Ilmu Kedokteran),2019:51(2):145-51.
17. Kaukua Jarmo. Academic Dissertation.. Health-Related Quality of Life in Clinical Weight Loss Studies, 2004.
18. Macgregor Kirstin A, Iain J, Gallagher, Colin N, Moran. “Relationship between Insulin Sensitivity and Menstrual Cycle Is Modified by BMI, Fitness, and Physical Activity in NHANES.” Journal of Clinical Endocrinology and Metabolism,2021:106(10):2979-90.
19. Mendes Romeu, Nelson Sousa, José Luís Themudo-Barata, Victor Machado Reis. “*High-I*ntensity Interval Training versus Moderate-Intensity Continuous Training in Middle-Aged and Older Patients with Type 2 Diabetes: A Randomized Controlled Crossover Trial of the Acute Effects of Treadmill Walking on Glycemic Control.” International Journal of Environmental Research and Public Health,2019:16(21):1-14.
20. Mumford Sunni L, Enrique F, Schisterman, Anna Maria Siega-riz, Richard W, Browne Audrey J *et al*. “A Longitudinal Study of Serum Lipoproteins in Relation to Endogenous Reproductive Hormones during the Menstrual Cycle : Findings from the BioCycle Study.”,2010:95:80-85.
21. Nadulska, Anna, Dominik Szwajgier, Grzegorz Opielak. “*V (1) MEDtube Science*.”,2017:5(1):35-44.
22. Wondmkun, Yohannes Tsegyie. “Obesity, Insulin Resistance, and Type 2 Diabetes: Associations and Therapeutic Implications.” Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy,2020:13:3611-16.

23. Yeung Edwina H, Cuilin Zhang, Sunni L, Mumford Aijun Ye, Maurizio Trevisan, Liwei Chen *et al*. Division Epidemiology. "Longitudinal Study of Insulin Resistance and Sex Hormones over the Menstrual Cycle : The BioCycle Study.",2010:95:5435-42.
24. Ouerghi Nejmeddine, Mohamed Kacem Ben Fradj, Ikram Bezrati, Marwa Khammassi, Moncef Feki, Naziha Kaabachi. "Effects of High-Intensity Interval Training on Body Composition, Aerobic and Anaerobic Performance and Plasma Lipids in Overweight/Obese and Normal-Weight Young Men." Biology of Sport,2017:34(4):385-92.