Comparison of the Acute Effect of Light and Moderate Intensity Aerobic Exercise on Cortisol in Obese Adolescents

Rahmi Isma[1*], Ahmad Zulfa Juniarto[2], Rudy Handoyo[1]

[1] Physical Medicine and Rehabilitation Departement, Faculty of Medicine, Diponegoro University, Semarang, Indonesia
[2] Division of Human Genetics, Centre for Biomedical Research, Faculty of Medicine, Diponegoro University, Semarang, Indonesia
*Corresponding Author : rahmiisma@gmail.com

ABSTRACT

Introduction: Obesity is a global health problem that contributes to 2.6 million deaths worldwide each year. Obese adolescent have 80% chance to become obese when grow adult. Aerobic exercise is exercise that is recommended for the obese but aerobic exercise that is done excessive has also adverse effect, which increases levels of cortisol. Vigorous aerobic exercise at least 60% VO2max intensity triggers the release of cortisol. Obese individuals may experience hypersensitivity HPA axis that enables increased levels of cortisol in the exercise below the threshold.

Objective: To prove the difference of cortisol serum level in obese adolescents after light and moderate intensity aerobic exercise.

Method: It was an experimental study with pre-post test group design. 30 obese subjects were divided randomly into two groups, the first group received light intensity aerobic exercise (15 partisipants) and the second group received moderate intensity aerobic exercise (15 partisipants). Partisipants underwent single bout aerobic exercise consist of 5 minute warming up, 20 minutes of core exercises (running) and a 5 minute cooling down.

Results: There were no significant differences in serum cortisol levels before treatment in both groups (p=0,267), as well as cortisol levels after treatment (p=0,305). There was no significant difference in serum cortisol levels change after treatment in both groups (p=0,967).

Conclusion: light and moderate intensity aerobic exercise did not cause significant differences in serum cortisol levels in obese adolescents

Keywords: *Obesity, adolescent, cortisol, aerobic exercise*

INTRODUCTION

Obesity is a global health problem that contributes to 2.6 million deaths per years around the world.[1] Obesity is a risk factor for cardiovascular disease, leading to an increase in morbidity and mortality.[1] The obesity epidemic has increased over the past five years. There is an increasing prevalence of obesity in the last decade,[2] in Indonesia based on data from basic health research, there is an increase in prevalence of central obesity in the population aged 15 years or more from18.8% (2007) to 26.6% (2013).[3]

There are various attempts to overcome obesity problems, one of them is aerobic exercise.[4] Aerobic exercise is very useful in improving cardiovaskular fitness, reduce the risk of cardiovascular disease and help weight loss programs in obesity.[4-7] Regardless of the benefits of aerobic exercise, excessive vigorous aerobic exercise also have an adverse effect in increasing the levels of cortisol. Increased levels of excessive cortisol in the body can lead to glucose and fat metabolism disorders, insulin resistance, decreased immune system and decreased bone density. [8-12]

Duclos and Tabarin in their study also stated that exercises with a minimum intensity of 60% VO2max or those categorized as vigorous intensity exercise according to the American College of Sports Medicine (ACSM) may lead to an increase cortisol levels [12,13], but not in light and moderate intensity aerobic exercise. This may be different in people with obesity. Obese people with predominant central obesity have hypersensitivity of HPA axis.[14,15] The HPA axis hypersensitivity causes exercise of the same intensity will increase more cortisol levels than

lean individuals.[16,17]

METHODS

This was a randomized, controlled, pre-post experimental study. The subjects of this study were obese adolescents who attended the SMA Negeri 14 Semarang which fulfilled the inclusion and exclusion criteria, with the following inclusion criteria were age 15-18 years, Body Mass Index (BMI)> 25kg / m2, healthy for research based on physical activity readiness questionnaire (PAR-Q) , Got permission from parents to be included in the study. Exclusion criteria were Hb <10 g / dl, unwilling to follow the study and / or mood and feeling questionnaire score (MFQ)> 11, taking steroid medications less than 8 hours before the study, smokers, consumed alcoholic beverages and coffee, Addison and or cushing syndrome, routinely performed aerobic exercise with a frequency at least 3x / week, underwent hormonal gonadotrophin therapy. The number of participants in the study were 30 subjects divided into two groups, those who received light intensity aerobic exercise (group 1 = 15 people) and the group who received moderate intensity aerobic exercise (group 2 = 15 people). Aerobic exercise was performed only once for 30 minutes consisting of 5 minutes of warming, 20 minutes of core exercise (running) and 5 minutes of cooling down. Intensity of exercise based on maximal heart rate calculation (HRmax). Maximum heart rate is calculated by the HRmax formula = 206.9 - (0.67 x age). The group 1 received the exercise with intensity of 50-63% HRmax, while the group 2 received the exercise with intensity 64-76% HRmax. Exercise prescribtion based on the American College of Sports Medicine (ACSM). Participants used pulsemeter (omron) for heart rate monitoring during exercise. The researchers monitored the participants heart rates at minutes 5, 10, 15 and 20 while underwent core exercises (running) to ensure participants heart rates were in the targeted aerobic exercise zone (mild and moderate intensity). Participants were considered dropped out if not exercising in accordance with the training protocol and / or fatigue that cause could not performed exercise until completion. None of the participants dropped out in this study.

Blood sampling for cortisol examination was performed twice, before treatment and immediately after treatment. Pre-post blood collection was not performed on the same day, Examination of cortisol (ELISA DRG cortisol reagent (EIA 1887)) was carried out at the central laboratory of the Nasional Diponegoro Hospital in September 2015.

Results analysis using SPSS for windows 17.0. This study has received approval from the Ethics Committee of the Faculty of Medicine Diponegoro University / Dr. Kariadi Hospital Semarang (Ethical Clearance Number 445 / EC / FK-RSDK / 2015).

RESULTS

Characteristics of the subjects can be seen in table 1. There was no significant difference (p> 0.05) in all variables (sex, age, BMI, 6MWT and baseline cortisol).

Table 1. Subject Characteristics

Variable	Group 1	Group 2	*p*
Sex			
- **Male**	8 (53.3%)	8 (53.3%)	1.00*
- **Female**	7 (46.67%)	7 (46.67%)	
Age	15.67±0.61	15.67±0.72	0.93*
BMI	30.49±3.32	29.96±4.35	0.18$
6MWT	5.36±0.53	5.30±0.58	0.59*
Cortisol	107.49±51.86	84.97±32.1	**0.27***

* uji mann whitney

$ independent t test

There was no significant difference in cortisol levels before and after treatment in both groups based on statistical tests (table 2).

Table 2. Cortisol levels in group 1 and group 2

Cortisol	Mean±SD		*p* [a)]
	Group 1 (*n*=15)	Group 2 (*n*=15)	
• Pre	107.49±51.86	84.97±32.1	0.27*
• Post	86.77±38.45	82.02±69.24	0.30*
p [b)]	0.173#	0.125#	
• Delta (post-pre)	-17.69±48.06	-20.67±66.46	0.97*

*mann whitney test
wilcoxon test

The number of male partispant in this study was more than women (table 1). The range of age between 15-18 years old with the age average was 15.67 years old. The mean of BMI in group 1 was 30.49 ± 3.32, while the mean of BMI in group 2 was 29.96 ± 4.35 (table 1). The classification of obesity in this study according to the WHO's obesity criteria for Asian populations is ≥25 kg / m2. Blood collection for serum cortisol examination was conducted at 08.30-09.00 am. The timing is due to cortisol levels influenced by the circadian rhythm of the body, [16]. The cortisol levels will decrease and increase along with body circadian rhythm, so to reduce variation in basal cortisol levels due to different sampling times, we limit the time of blood sampling for cortisol examination.The mean cortisol levels in both groups measured by ELISA cortisol DRG were within the normal range. The normal range of serum cortisol levels at 08.00-10.00 am is 50ng / mg - 230 ng / mg.

DISCUSSION

Levels of Cortisol Group 1 and Group 2

Based on Table 2, there was a significant decrease in serum cortisol levels after light intensity aerobic exercise (p = 0.17) as well as in the group performing moderate intensity exercise (p = 0.12). The slightly higher levels of cortisol before treatment in both groups may be due to blood sampling by needle-sharing for participants was a daunting condition, which can trigger an acute stress response that results in elevated levels of cortisol in both blood and saliva.[19] The results of this study were consistent with the results of previous studies which suggest that no significant difference in cortisol levels immediately after light and moderate intensity aerobic exercise.[20] Jacks et al., In his study of the effects of aerobic exercise with three different intensity levels also suggest, that light and moderate intensity aerobic exercise did not cause significant differences in cortisol levels before and after exercise, only exercise with severe intensity and long duration could lead to increased cortisol levels.[21] This is because HPA axis will only respond to cortisol release at exercise with intensity at least 60% VO2max (vigorous intensity exercise), or if the exercise is done in a long duration of about 90 minutes even though below the 60% VO2 max threshold. In obese individuals with predominant central obesity, aerobic exercise below the 60% VO2max threshold may lead to increased cortisol release due to HPA axis hypersensitivity causing excessive stimulation of HPA axis,[14,24] but different results are obtained in this study, which in both groups there is no significant difference of cortisol level after exercise. The factors that may contributed to this result may be due to selection of obese participants, in this study obese participants were selected based on WHO criteria for Asian populations with cut point for obesity is BMI ≥25 kg/m2, whereas in previous studies the selection of obese participants were based on WHO criteria in general with a cut of point for obesity is an individual with BMI ≥ 30 kg/m2. This led to differences in the characteristics of the study subjects, where in this study, the paricipants were mostly grade 1 obese based on the WHO criteria for Asian populations, whereas in the previous the study participants were grade 2 obese based on WHO for Asian populations.

Obesity is defined as a condition characterized by excessive accumulation of fat in the body, while the 11ßHSD1 enzyme responsible for converting inactivated cortisol (cortisone) to cortisol, has the highest levels in adipose tissue, hepatic tissue and brain tissue.[22] This leads to obesity with excessive visceral fat accumulation can be found increased levels of local cortisol in adipose tissue. Increased accumulation of visceral fat is also a consequence of the onset of HPA axis hypersenstivity.[23,24] The more obese a person with higher visceral fat accumulation may also have higher local cortisol levels in adipose tissue as a consequence of HPA axis hypersensitivity. The difference in the degree of obesity with previous research is what may

cause the difference in outcomes. Another possible reason is the subject of this study despite individuals with obesity but they have a fairly good fitness level based on fitness test results with 6MWT, where the fitness level also affects the release of cortisol during exercise.[13,25] A study conducted by Webb et al comparing the cortisol response to exercise and psychic challenges in individuals with high levels of fitness and individuals with low fitness levels indicate that in individuals with low fitness levels showed significantly higher cortisol levels than individuals with high levels of fitness. This is due to well trained individuals and who have a good level of fitness can develop adaptation mechanisms such as decreased sensitivity to cortisol to protect muscles against excessive secretion of cortisol, through these adaptation mechanisms, HPA axis can overcome recurrent stimuli that allow on the one hand the ability of the organism to respond to repetitive stimulation adequately and, on the other, to protect glucocorticoid-sensitive tissues from high cortisol levels.[13] At the cellular level, Duclos et al., have reported that in vitro plasticity, monocyte sensitivity to glucocorticoids in well trained subjects, adjusted for changes in systemic cortisol concentrations.[13]

Another factor causing the difference results in this study was the limitation of cortisol reagent causing exercise only done one time so that finally only got result from one exercise not from mean value from several times result of acute effect of exercise. In this study, blood sampling for cortisol examination was not performed in one day because patients refused to be taken blood twice a day, but nevertheless we tried to reduce the limitations by equating the participants condition in the second blood sampling with first blood sampling, such as patients do not drink coffee, do not drink alcoholic beverages and do not take medication 8 hours before the test and do not stay out late the night before. The aforementioned factors are possible factors that may cause the difference of this research result with previous research.

CONCLUSION

The results of this study suggest that moderate and mild intensity aerobic exercise in obese participants showed no significant difference in cortisol levels as well as individuals with normal weight.

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REFERENCES

1. **Raj M, Kumar RK**. Obesity in Children and Adolescents. *Indian Journal of Medical Research*. 2010;132(5):598-607.
2. **Ramachandran A, Snehalatha C.** Rising Burden of Obesity in Asia. Journal of Obesity. 2010:1-8.
3. **Trihono.** Riset Kesehatan Dasar Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI. 2013:5-10.
4. **McKinney L.** Diagnosis and Management of Obesity. www.aafp.org. Published 2013. Updated 15 January 2015.
5. **Shenbagavalli A, Mary R**. Effect of Aerobic Training on Body Mass Index on Sedentary Obese Men. Journal of Exercise Science and Physiotherapy. 2008;4(2):125-128.
6. **Ho SS, Dhaliwal SS, Hills AP, Pal S**. The Effect of 12 Weeksof Aerobic, Resistance or Combination Exercise Training on Cardiovascular Risk Factors in the Overweight and Obese in a Randomized Trial. BMC Public Health. 2012;12(704):1-10.
7. **Guyton AC, Hall JE**. Hormon Adrenokortikal. Buku Ajar Fisiologi Kedokteran. Singapore: Elsevier Ltd; 2008. p. 992-1009.
8. **Butcher SK, Killampalli V, Lascelles D, Wang K, Alpar EK, Lord JM**. Raised cortisol: DHEAS ratios in the elderly after injury: potential impact upon neutrophil function and immunity. Aging Cell. 2005;4(6):319-324.
9. **Manenschijn L**. Cortisol exposure and sensitivity in health and disease: Erasmus MC: University Medical Center Rotterdam; 2013.
10. **Altindag O, Altindag A, Asoglu M, Gunes M, Soran N, Deveci Z**. Relation of cortisol levels and bone mineral density among premenopausal women with major depression. International journal of clinical practice. 2007;61(3):416-420.
11. **Redinger RN**. The pathophysiology of obesity and its clinical manifestations. Gastroenterology & hepatology. 2007;3(11):856.
12. **Duclos M, Corcuff J-B, Rashedi M, Fougere V, Manier G**. Trained versus untrained men: different immediate post-exercise responses of pituitary adrenal axis.

European journal of applied physiology and occupational physiology. 1997;75(4):343-350.
13. **Duclos M, Tabarin A.** Exercise, training, and the hypothalamo–pituitary–adrenal axis. Hormone Use and Abuse by Athletes: Springer; 2011. p. 9-15.
14. **Azizi M, Rahmani-Nia F, Mohebbi H**. Cortisol Responses and Energy Expenditure at Different Times of Day in Obese Vs. Lean Men. World Journal of Sport Sciences. 2012;6(3):314-320.
15. **Hill E, Zack E, Battaglini C, Viru M, Viru A, Hackney A**. Exercise and circulating cortisol levels: the intensity threshold effect. Journal of endocrinological investigation. 2008;31(7):587-591.
16. **Azarbayjani M, Vaezepor F, Rasaee M, Tojaril F, Pournemati P, Jourkesh M, et al**. Daily timing of salivary cortisol responses and aerobic performance in lean and obese active females. Bratislavske lekarske listy. 2010;112(4):213-217.
17. **Stewart PM, Boulton A, Kumar S, Clark PMS, Shackleton CHL**. Cortisol metabolism in human obesity: impaired cortisone—cortisol conversion in subjects with central adiposity. J Clin Endocrinol Metab 1999;84:1022-1027
18. **ACSM**. Preparticipation Health Screening and Risk Stratification. Dalam: Thompson WR, Gordon NF, Pescatello LS, penyunting. ACSM's Guidelines for Exercise Testing and Prescription: Lippincot william and wilkins; 2013. p. 19-22
19. **Morgan KA**. Salivary testosterone and cortisol measurements in profesional elite rugby union players. 2009.
20. **Domes G, Heinrichs M, Rimmele U, Reichwald U, Hautzinger M**. Acute stress impairs recognition for positive words-association with stress-induced cortisol secretion. Stress: The International Journal on the Biology of Stress. 2004;7(3):173-181.
21. **Kent B, Weekes S, Zhou S, Davie AJ**. The acute effect of specific exercise intensities on plasma testosterone and cortisol concentrations. School of Health and Human Sciences Papers. 1997:552.
22. **Jacks DE, Sowash J, Anning J, McGloughlin T, Andres F**. Effect of exercise at three exercise intensities on salivary cortisol. The Journal of Strength & Conditioning Research. 2002;16(2):286-289.
23. **Talbott SM, Kraemer WJ**. The cortisol connection: why stress makes you fat and ruins your health-and what you can do about it: Hunter House; 2007.
24. **Björntorp P**. The regulation of adipose tissue distribution in humans. International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity. 1996;20(4):291-302.
25. **Björntorp P**. Obesity and the adipocyte. Neuroendocrine factors in obesity. J Endocrinol. 1997;155:193-195.
26. **Webb HE, Rosalky DS, Tangsilsat SE, McLeod KA, Acevedo EO, Wax B**. Aerobic fitness affects cortisol responses to concurrent challenges. Med Sci Sports Exerc. 2013;45(2):379-386