Effect of Moderate-Intensity Acute Physical Activity on Decreasing Cortisol Levels in Obese Female

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Abstract

Background: Obesity is an excessive fat accumulation within adipose tissue, which may caused by stress. The uncontrolled stress can increase cortisol hormone levels, thus increases appetite through ghrelin stimulation to cause obesity. Physical activity becomes a stressor, which depends on physical activity performed.

Methods: This study was a true experiment with randomized pretest-posttest control group design. The study was conducted on 16 obese female which were divided into two groups, G_1(n=8, control group) and G_2 (n=8, moderate-intensity physical activity group). The subjects chosen by consercutive sampling technique. Moderate-intensity physical activity done by treadmill on 60-70% HRmax, and continuously performed for 30 minutes. Serum cortisol levels wasmeasured using enzyme-linked immunosorbent assay (ELISA) kit method.

Results: The levels of cortisol on control group pretest (310.18±246.55) ng/mL and posttest (309.03±204.97) ng/mL were not significant different (P value: 0.992). Cortisol levels on moderate-intensity physical activity group pretest was 305.50±145.94 ng/mL dan posttest was 157.25±34.16 ng/mL, (P value: 0.058). Delta (Δ) cortisol levels on control group between pretest and posttest (–1.15±65.83) ng/mL, while on moderate-intensity physical activity (–148.25±156.45) ng/mL, (P value: 0.028).

Conclusion: There is an acute effect of moderate-intensity physical exercise on cortisol level in obese female.

Key word: *moderate-intensity physical activity, cortisol levels,obese female*

Introduction

Obesity is an excessive accumulation of fat within adipose tissue, which cause some health problems[1]. Obesity prevalence is increasingin both developed and developing country[2]. According to RISKESDAS 2013, obesity in Indonesia continue to increase by the time. The number of obese female (32.9%) was more than obese male (19.7%)[3]. Other fact obtained from RISKESDAS 2018 showed that obesity prevalence in adult aged 18 years old increased from 2007 (10.5%), 2013 (14.8%), and 2018 reached 21.8% from Indonesian population[4].

Obesity causes some chronic disease, such as diabetes, cardiovascular disease, and cancer[5]. Obesity also relates to morbidity and mortality. World Health Organization (WHO) has classified obesity as the fifth risk factor for death, which is 7% from global death[6]. Obesity may caused by stress. The uncontrolled stressraises cortisol levels, so that increases appetite through ghrelin stimulation on hunger control. Therefore, it has an impact on obesity[7]. According to WHO (2009), principle factor of obesity are low physical activity and poor dietary. In addition, lack of sleep and stress lead to inadekuat physical activity, thusbecome somecauses of weight gain[8]. Having enough physical activity needed to burn excessive energy. If physical activity is low,then the excessive energy will changed into fat and then stored in adipose tissue[9]. Obesity prevention with physical activity intervention performed by moderate intensity activity for minimally 150-250 minutes every week. Additionally, it also needs to limit the excessive food intake, do some rest (6-8 hours for adults) and

reduce stresses[10]. A regular moderate intensity physical activity may reduce obesity risk factor due to a balance of energy expenditure and energy intake[11].

Stress is a new dynamic of the body. Stress has not only negative effects, but also positive effects[12]. Hans Selye in Cox (2002) reports that stressor which has positive impacts called by eustress, while other stress that has negative impacts called by distress. A distress occurs when the body system does notperform adequate recovery[13]. Conversly, eustress happens if the stress itself can improve functions, both physically and mentally aspects[14]. Stress causes some physiological changes to maintain homeostasis[15]. Physical activity provokes stress, and the stress experienced depend on physical activity performed. Stress mechanism due to physical activity, activates hipotalamus-pituitari-adrenal axis (HPA) axis andsympathoadrenal medullary (SAM) axis[16]. SAM-axis is a short-term stress mechanism (acute stress) marked by an increase of catecholamine. A physical stress also stimulates HPA-axis, which is a long-term stress mechanism (chronic stress) marked by an increase of cortisol secretion[12], until 20 fold[17].

Cortisol is a main glucocorticoid and defined as a stress hormone that plays a role in carbohydrate, protein and lipid metabolism[18]. Glucocorticoid functions as mediatormetabolism on gluconeogenesis andprotector of internal environtment[19]. Secretion rate of corticotropin-releasing hormone (CRH), adrenocorticotropic hormone (ACTH), and kortisol are high in the morning. About 75% of cortisole synthesis occurs between 4 am until 10 am, but it seems to get low between 5 pm until 1 am. The highest plasma cortisol level is about 20 µg/dL, an hour before sunrise and the lowest is about 5 µg/dL around midnight. This effect is resulted from signal cycle change of hypothalamus over 24 hours, which lead to cortisol secretion difference[17].Cortisol levels increases during long duration of physical activity due to increased stress accumulation. It related to cortisol function as an anti inflamation and anti imunosupresif. Long-term physical activity decreases glycogen reserve in muscle, thus stimulates an increase of cortisol secretion, because cortisol has a role in maintaining blood glucose levels [20].

According to WHO, physical activity that recommended for obese is moderate-intensity physical activity. Moderate intensity for obese people that performed in 20-45 minutes and three until five times every week shows normal cortisol levels. Moderate-intensity physical activity, which is maintaining 60% HRTmax, increases cortisol levels in 120 minutes duration of intervention[21]. An exhaust exercise has higher cortisol levels than moderate exercise[22]. Twelve weeks of physical activity lead to decrease in cortisol levels significantly on obese children[23]. However, effect of moderate-intensity acute physical activity on decreasing cortisol levels in obese female still unclear. This study aims to prove the effect of moderate-intensity acute physical activity on serum cortisol levels in obese female.

Materials and Methods

Experimental design

The present study was a true experiment with randomized pretest-posttest control group design. The experiment was conducted in Surabaya in 2020. The subjects were 16 Indonesian obese female in Surabaya aged 19-24 years old, body mass index (BMI) 25.5-32 kg/m^2, fasting blood glucose (FBG) < 100 mg/dL, normal hemoglobin (Hb), normal resting heart rate, and normal blood pressure. They were randomly divided into two groups, which were G1 (n=8, control group without intervention), G2 (n=8, moderate-intensity acute physical activity). All procedures of the present study approved by the Ethical Committee Faculty of Medicine Airlangga University, Surabaya, JawaTimur, Indonesia no. 84/EC/KEPK/FKUA/2020.

Physical Activity Protocol

Intervention of moderate intensity physical activity was done by treadmill running with intensity 60-70% HRmaxfor 30 minutes continuously. This intervention was performed at 7.00 until 9.00 am (Western Indonesian Time) using treadmill (Richter Treadmill Semi-Commercial Evolution (4.0 Hp DC)). Polar heart rate monitor (Polar H10 Heart Rate Sensor, USA, Inc) used to monitor the intensity.

Blood Collection and Analysis

Three mililiters of blood takenfrom cubital vein, and then centrifuged for 15 minutes by 3000 rpm of speed. Blood serum was separated and stored at (-80°C) for cortisol levels analysis the following day. Blood

sampling was conducted at 6.30 until 9.30 am (Western Indonesian Time). The blood taken twice (pre-physical activity and 10 minues post-physical activity). Blood collection for FBG and Hb measurement was carried out on the finger capillaries. Measurement of cortisol was performed by using Enzyme-Linked Immunosorbent Assay (ELISA) kit method (Cat.No E-EL-0157; Elabscience Biotechnology Co. Ltd., China, 2018) with standard curve range 6.25-400 ng/mL and sensitivity level of cortisol 2.92 ng/mL. FBG levels was evaluated by using ACCU-CHEK (ACCU-CHEK® Performa, Mannheim, Germany) with concentration unit mg/dL, while Hb level was checked by Mission Hemoglobin (Mission® Hb Test Strips (Whole Blood), ACON Laboratories, Inc. 10125 Mesa Rim Road, San Diego, CA 92121, USA).

Measurement of Body Composition and physiological Conditions

Measurement of body height used stadiometer (SECA, Chino, CA). Measurement of body composition, which consisted of body weight, BMI, and PBF used TANITA (Body Composition Analyzer DC3607601(2)-1604 FA, TANITA Corporation of America, Inc., USA). Measurement of resting heart rate used Pulse Oximeter (PO 30 Pulse Oximeter, Beurer, Germany). Blood pressure wasmeasured using digital tensimeter OMRON (OMRON Model HEM-7130 L, Omron Co. JAPAN).

Statistical Analysis

Data were analyzed using software Statistic Package for Social Science (SPSS) version 17 (Chicago, IL, USA). Normality test used Shapiro-Wilk. Comparation test used Independent Samples T Test and Paired Sample T-Test. All data expressed as the mean±SD. The level of statistical significance is $p<0.05$.

Result

The result of descriptive analysis subjects of each group can bee seen on Table 1.

Table 1. Descriptive analysis subjects of each group

Variable	Group		Independent Samples T Test p-value
	G1 (n=8)	G2 (n=8)	
Age (year)	21.14±1.91	21.00±0.89	0.861
Body weight (kg)	75.21±6.15	73.13±7.29	0.573
Body height (m)	1.58±0.04	1.57±0.05	0.793
BMI (kg/m2)	29.94±1.48	29.28±1.15	0.372
PBF (%)	46.34±3.70	44.56±2.41	0.306
FBG (mg/dL)	92.71±4.99	88.14±6.79	0.177

Cont... **Table 1. Descriptive analysis subjects of each group**

Hb (g/dL)	15.60±1.97	14.41±1.06	0.186
RHR (bpm)	78.14±11.35	80.00±7.66	0.726
SBP (mmHg)	114.28±5.34	111.43±3.78	0.271
DBP (mmHg)	77.14±4.88	75.71±5.34	0.611

Note: BMI: Body Mass Index; PBF: Percetage Body Fat; FBG: Fasting Blood Glucose; Hb: Hemoglobin; RHR: Resting Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SD: Standard Deviation; G1: Control group; G2: Moderate-Intensty Acute Physical Activity

Based on table 1, the result of independent sample t test showed that there was no significant difference the mean of subject characteristics (p>0.05). The analysis result of cortisol levels between pre-physical activity and 10 minutes post-physical activity each group presented on figure 1

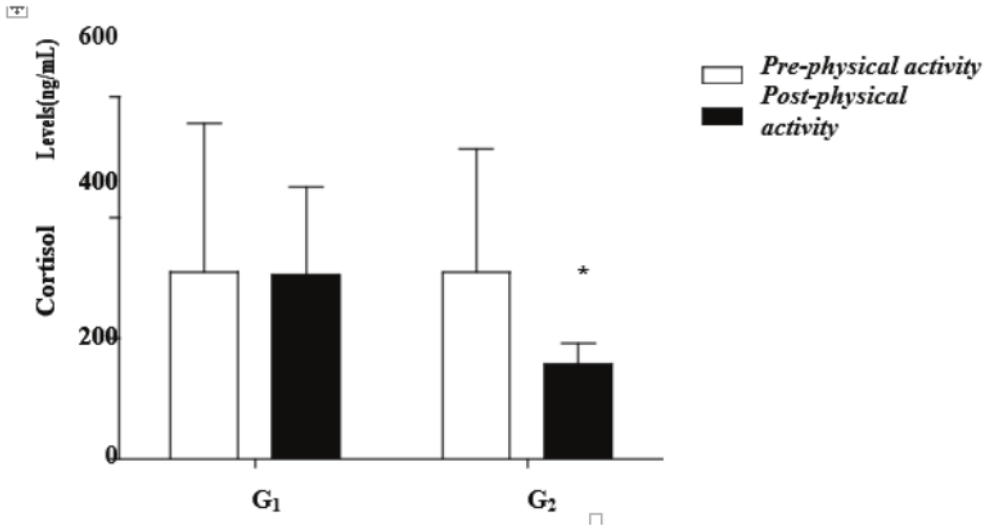

Figure 1. The mean of cortisol levels between pre-physical activity and 10 minutes post-physical activity on each group. *significant result on pre-physical activity group G_2 (p<0.05).

The result of paired t test on figure 1 presented that there was no significant difference mean of cortisol levels between pre-physical activity and 10 minutes post-physical activity G_1 (p>0.05), while G_2showed a significant difference mean of cortisol levels between pre-physical activity and 10 minutes post-physical activity (p<0.05). Delta (Δ) of cortisol levels between pre-physical activity and 10 minutes post-physical activity both groups presented on figure 2.

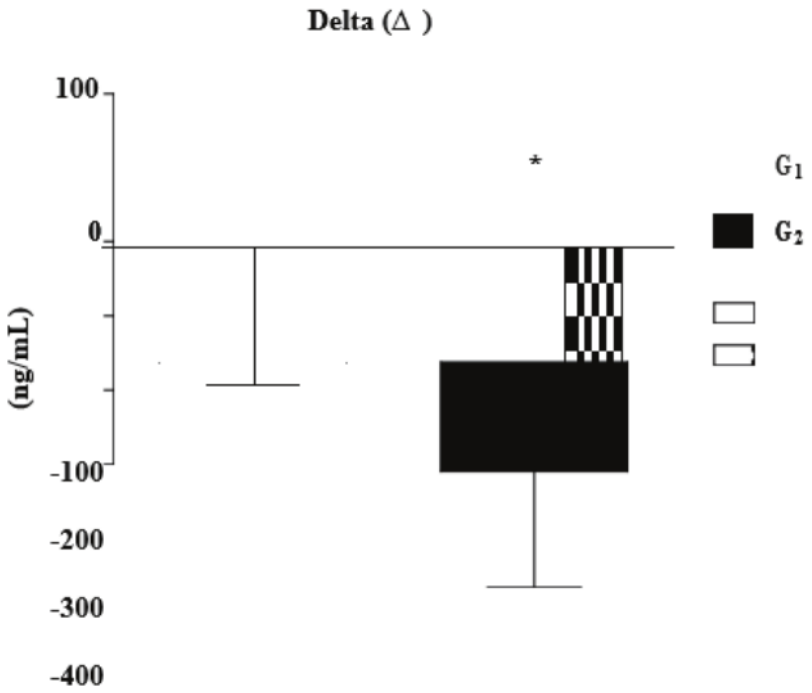

Figure 2. Mean delta (Δ) cortisol levels pre-physical activity and 10 minutes post-physical activity
***significant result on control group (G_1) (p<0.05)**

Independent samples t test was applied and the mean delta (Δ) cortisol levels between pre-physical activity and 10 minutes post-physical activity was found to be statistically significant (p<0.05).

Discussion

A decrease of cortisol levels was higher on G_2 group. In line with a previous study where physical activity in 12 weeks decreased cortisol levels significantly in obese children, while control group showed very slight decrease of cortisol levels[23]. It supported by this study result, that no significant difference cortisol levels found between pre-physical activity and 10 minutes post-physiscal activity in G_1(p>0.05). It may caused by there was no physical activity intervention in G_1, so it tend to be inactive (lack of movement), while G_2performed physical activity and more active so resulting in a high dercrease of cortisol.

The lack movement disturbs metabolic process, so causes some health problems and even exacerbates obesity[24]. Moderate-intensity physical activity for obesity is useful to improve the condition of obesity itself[25]. Bhavsaret al. (2014) has explained that inactive habitual also induces psychological stress. If inactive habitual is unchanged by an obese, so stress that experienced is absolutely more increase and worsening the condition[26].

Other result of present study showed that there were significant difference cortisol levels between pre-physical activity and 10 minutes post-physical activity on G_2 (p<0.05). Additionally, delta (Δ) mean of cortisol levels between pre-physical activity and 10 minutes post-physical activity on G_2 was lower than G_1. Not only that, delta (Δ) mean of cortisol levels between pre-physical activity and 10 minutes post-physical activity also found significantly different. These results were similar to previous research conducted by Fauzi (2015), who found thatcortisol levels decreases due to moderate exercise. A moderate-intensity physical activity performed in G_2 may cause muscle contraction, which is a form of stressor. However, stressor from moderate-intensity physical activity can cause coping[22]. Rushall&

Pyke in Sugiharto (2012)have argued that the body tries to develop "coping" mechanism against pressure, so that it gradually adapts to stress and can feel comfortable in facing shock, then occurs higher adaptation by activating SAM-axis. SAM-axis is a short-term stress mechanism (acute stress) marked by elevated levels of catecolamine and endorphine, thus causes comfort and rilex[12]. Therefore, G_2can decrease cortisol secretion.

Cortisol levels will increase when physical activity performed due to increased stress accumulation[19]. The present study showed that G_2 in acute female obese were resulting a decrease of stress. Stress due to G_2 is responed by hypothalamus, which can secreting corticotrophin realising hormone (CRH) and sending signal to anterior pituitary. The pituitary then releases adrenocorticotrophin hormone (ACTH) that functions to activate or influence adrenal cortex, a place which cortisol hormone secreted. Cortisolgets into the blood circulation and increases body metabolism[27]. It has a major impact on immune system[28] by giving a marker or signal when the stress is experienced[29]. As a result, moderate-intensity acute physical activity in obese lead to decrease stress.

The difference in delta (Δ) cortisol between pre-physical activity and 10 minutes post-physical activity caused by physical activity performed (G_2). Hence, it brings positive impact in G_2 group by resulting a decreased cortisol response. The intensity of physical activity below 60% HRTmax in 60 minutes decreases cortisol levels. Physical activity in obese can increase capability of cell to respond similar load[30], as in aerobic intervention (increases myoglobin and improve carbohydrate and lipid metabolism) and anaerobic activity (increases enzim that involved in ATP-PC, and increases glycolysis capacity)[31]. For example, catecholamine (epinephrine) can cause liver glycogen and tryglyseridbreakdown, and inhibit blood glucose from being synthesized into glycogen[30]. When Growth Hormone Releasing Hormone (GhRH) secreted by hypothalamus, it stimulates Growth Hormone (GH) secretion and Insulin-Like Growth Factor (IGF-1) synthesis[32]. By the time synthesis of IGF-1, so protein metabolism is not as an energy source, but it plays a role in bone and new protein formation, and also has function decreases stress in obese subjects.

Stress due to obesity can bereduced by appropriate physical activity[33], thus G_2 can reduce stress by converting distress into eustress. G_2 gets the body response to reach coping mechanism that changes stressor into a beneficial stimulator. It caused by body adaptation to the physical activity dose was good and could reduce some pressures at the level of neuroendocrine, thus decrease cortisol secretion. Low level of cortisol does not affect energy burning using muscle glycogen and does not change protein composition of the body[12]. Therefore, stress in obese people with G_2 intervention causes physiological change to maintain homeostasis[15].

Obese condition causes stress that cannot be controlled by the body. It marked by elevated levels of cortisol. Cortisol hormone in obese increases appetite due to ghrelin stimulation, thus can affect the condition of obesity itself[7]. Stress in obesity belongs to a chronic stress that can activates HPA-axis[16]. HPA-axis is a long-term stress mechanism (chronic stress) marked by an increase of cortisol secretion[12]. Stress will activate HPA-axis, then increases stimulation on limbic hipotalamuspuititutary adrenal axis (LHPA-axis), thus stimulates hypothalamus and causes CRH secretion. CRH provokes hypothalamus to secrete ACTH, which plays a role in cortisol secretion[34]. Elevated levels of cortisol causes obesity. However, moderate physical activity can inhibit or improve obesity. Catecholamine and endorphine secretion due to moderate-intensity physical activity be able to inhibit HPA-axis. Inhibition of HPA-axis and secretion of cortisol aims to form an adaptation mechanism to the stress experienced[12], so cortisol secretion is low[35]. The present study suggesteddoing moderate-intensity acute physical activity (60-70% HRmax) in 30 minutes every session in order to decrease stress levels with cortisol levels parameter in obese female.

Conclusion

The study concluded that moderate-intensity acute physical activity that performed 30 minutes significantly decreases serum cortisol levels compare to control groups.

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Conflict of Interest -The authors declare that they have no potential conflict of interest.

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GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8