08. THE SIMILAR CHANGES OF GLUCOSE LEVELS BEFORE AND AFTER MODERATE

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THE SIMILAR CHANGES OF GLUCOSE LEVELS BEFORE AND AFTER MODERATE INTENSITY EXERCISE ACUTELY IN THE MORNING AND NIGHT

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ABSTRACT

Background: *There is a lot of research on the importance of exercise but studies on the effective time of exercise regarding regulation of blood glucose levels are not clearly known.* ***Objective:*** *This study aims to determine the comparison of changes in blood glucose levels before and after moderate intensity physical exercise in the morning and night.* ***Material and method:*** *Healthy men (n=34), Age between 17-22 years, Body Mass Index (BMI) between 18.5-22.9 kg/m^2 (normal Asia Pacific), participating in the morning group (8.00 am) or the night group (20.00 pm) are asked to do moderate intensity physical exercise (55-70% of maximum heart rate) using ergocycle for a total of 40 minutes. Blood glucose levels 2 hours post prandial capillaries are taken before exercise and blood glucose levels after exercise are taken acutely.* ***Result:*** *The mean decrease in blood glucose levels in the morning group was –8.353±9.16 mg/dL and in the night group was –6.294±10.10 mg/dL. Blood glucose levels decreased significantly for the morning group (p=0.002) and the night group (p=0.021). The comparison of changes in blood glucose levels between the morning and night groups was not significant (p=0.538).* ***Conclusion:*** *There is no difference between morning or night exercise related to changes in blood glucose levels.*

Keywords: *Circadian rhythms, exercise, glucose, moderate intensity, morning, night*

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Background

Exercise is a physical activity that is planned, structured, repeated, directed and aimed to improve the fitness of one's body (WHO, 2018). Often forgotten, lack of physical activity has been identified as the fourth risk factor for global deaths, which is 6% of global deaths or around 3.2 million deaths in the world (WHO, 2018). Determining the right time to exercise is considered as a controversial thing in society due to daily activities that is inconvenient in regards to the time for exercising.

Several studies have discussed the difference between morning-to-night physical exercise. A research was conducted by Shiotani et al. (2009) stated that participants who carried out an aerobic exercise in the morning for 2 months have shown a significant decrease in heart rate compared to the afternoon. Conducting exercises during night time can intensify heart rate especially in the first 3 hours approaching bedtime (Myllymaki et al., 2011) and there is a strong correlation between circadian rhythms with physical activity on the heart (Wang, 2017). The sleep quality is improved if it is done in the morning than in the night (Andriana & Ashadi, 2019). Therefore, there needs to be a study done in determining the effective time to exercise.

Circadian rhythm is a change of physical, mental, and behavioral which follows a daily cycle (day-night), including the production of cortisol, melatonin, corticotropin-releasing-factor (CRF) and adrenocorticotropic hormone (ACTH). Suprachiasmatic Nucleus (SCN) or the body's master clock located in the brain can control certain production of hormone and substance in the body through the light (day-night) that enters the eyes then through the optic nerve and finally transfers it to a part of the brain called hypothalamus (NIGMS, 2017). The existence of this day-night cycle makes a high level of CRF, ACTH and cortisol secretion in the morning and low level at night.

Cortisol contribute in regulating carbohydrates, including the process of glucose formation through gluconeogenesis, reducing the use of glucose by cells, affect the transportation of fatty acids in the body (Guyton & Hall, 2015) and eventually increase plasma glucose levels (Qaid & Abdelrahman, 2016). Apart from improving body condition, exercise can also affect the metabolism of blood glucose regulation. If it is not controlled, glucose could be a leading factor in the emergence of several diseases including obesity, diabetes mellitus, and even cardiovascular disease. Through several steps, exercise is a way to regulate blood glucose levels by muscle contraction (Lieberman & Marks, 2012). Exercise affects patients with type 2 diabetes mellitus (Soegondo, 2009) and type 1 (Colberg et al., 2010) in reducing blood glucose acutely.

Due to the fact that there is still a lack of data regarding the effective time to exercise and zero study reveal the difference in the effect of exercise in the morning and night time acutely on blood glucose levels, thus, this study aims to analyze the comparison of changes in blood glucose levels before and after moderate intensity exercise in morning and night.

Objective

The purpose of this study is to prove and find out the comparison of changes in blood glucose levels before and after moderate intensity exercise in morning and night. However, there are specific objectives of this study, which are to determine the blood glucose levels before and after moderate intensity exercise acutely and to find out the comparison of changes in blood glucose levels before and after a moderate intensity exercise in morning and night.

Material and Method

The study design, methods and procedures have been approved (No.224/EC/KEPK/FKUA/2018) by the Medical Research Ethic Committee of Faculty of Medicine, Universitas Airlangga.

This is an Experimental Pretest-Posttest Group design research with 2 experimental groups, morning and night groups. This research was conducted in January 2019 - June 2019 in the Laboratory/Department of Physiology Faculty of Medicine, Universitas Airlangga, Surabaya, East Java.

Thirty-four healthy men were divided into 2 groups, morning (n=17) and night (n=17). The sampling technique that were used was purposive sampling technique, which have criteria of Age of 17-22 years old, Body Mass

Index of 18.5-22.9 kg/m^2 (normal Asia Pacific), willing, and taking into account that the subjects have no symptoms of heart disease, disorders of the bone and joints, and not taking any medications for blood pressure or heart problems that can affect the ability to participate in the research. Subjects will draw a lottery to determine the group whether they are in the morning group (8:00 in the morning) or in the night group (20:00 at night). There will be 17 subjects that will do moderate intensity exercise in the morning and 17 subjects that will do moderate intensity exercise at night.

In the morning group, subjects were asked to fast and can only drink water from 23:00 at night and in the night group, subjects were asked to fast from 12:00 at noon. All of the subject will drink a glass of tea with 2½ teaspoon of sugar 2 hours before doing moderate intensity exercise. Capillary blood will be taken from both group before doing the exercise to determine the 2 hour blood glucose post prandial pre-test using Easy Touch Point of Care Testing. Subjects will perform moderate intensity exercise using Ergocycle at 55-70% of the maximum heart rate limit, measured using Polar Heart Rate, with a total duration of 40 minutes (30 minutes + 10 minutes warming up and cooling down). After exercising, capillary blood from both group will be taken again to determine the post-test blood glucose level immediately after exercise or acutely. Furthermore, all the data were statistically analyzed and interpreted using statistical program.

Result

All data are shown in mean±standard deviation. Based on the Independent T Test results in Table 1 below it can be seen that the mean age of the morning group was 19.53±1.23 years and the mean age of the night group was 18.94±1.43 years. This shows that the mean age of the morning group was 0.59 years higher than the mean age of the night group, but there was no significant difference (p=0.209). The mean BMI of the morning group was 20.6±1.15 kg/m^2 and the mean BMI of the night group was 20.1±1.09 kg/m^2. There was no significant difference (p=0.220) between the two groups. The results stated that the subjects BMI did not affect the results of the study and were all in the normal category of BMI Asia Pacific.

Table 1. Characteristics of Subjects

Variable	Group	N	Mean	*p*
Age	Morning	17	19.53 ± 1.23	0.209
	Night	17	18.94±1.435	
BMI	Morning	17	20.6746±1.15327	0.211
	Night	17	20.1825±1.09251	

BMI: Body Mass Index

p>0.05 = not significant

Shapiro-Wilk normality test for both group (morning and night) on the variable of blood glucose levels before and after moderate intensity exercise and the decrease in blood glucose levels had normal distribution (p> 0.05).

Based on Table 2 below it can be seen that the mean blood glucose levels before exercise in the morning group was 86.24±7.72 mg/dL and the mean blood glucose level immediately after exercise was 77.88±9.49 mg/dL. In the night group it was shown that the mean blood glucose levels before exercise was 85.94±6.81 mg/dL and the mean blood glucose levels immediately after exercise was 79.65±9.99 mg/dL. There were significant differences between before and immediately after exercise in both morning group (p=0.002) and night group (p=0.021) based on the results of the Paired T Test.

Table 2. Blood glucose levels before and after exercise in morning and night.

Group	Variable	Mean	*p*
Morning	Pre	86.24±7.62	0.002*
	Post	77.88±9.49	
Night	Pre	85.94±6.81	0.021*
	Post	79.65±9.29	

*p<0.05 = significant Post = Acutely after exercise

Pre = Before exercise

Based on Table 3 below it can be concluded by the results of the Independent T Test that there was no significant difference (p=0.538) between changes in blood glucose levels before and after moderate intensity exercise in the morning and night group. The mean decrease in the morning group was −8.35±9.165 mg/dL while in the night group was −6.29±10.104 mg/dL. This shows that the decrease in blood glucose levels in the morning group was 2.06 mg/dL higher than in the night group, although it did not differ significantly.

Table 3. Mean decrease in blood glucose levels before and after exercise in the morning and night groups

Variable	Group	Mean	*p*
deltaglucose	Morning	−8.35±9.165	0.538
	Night	−6.29±10.104	

p>0.05 = not significant

Discussion

Cortisol hormone is regulated by excitation of the hypothalamus through different types of stress. Stress activates the body to cause a rapid release of cortisol, then it initiates a series of metabolic effects aimed at reducing the harmful effect of the stressful state. CRF, ACTH, and cortisol secretion levels are high in the morning but low at night, plasma cortisol levels range between 20 µg/dL per hour before morning time and low about 5 µg/dL around midnight. This is the result of the 24 hour day cycle causing changes to cortisol secretion from the hypothalamus throughout the day.

Metabolic effects of cortisol and glucocorticoids are the formation of carbohydrates from protein and other substances by the liver and can increase the rate of gluconeogenesis 6 to 10 times. Cortisol increase enzymes needed to convert amino acids into glucose in liver cells, as well as being an antagonist of the effects of insulin by increasing gluconeogenesis in the liver. One effect of cortisol is reducing GLUT 4 translocation into cell membranes, especially in skeletal muscle cells, which causes the body to become insulin resistance. High glucocorticoid levels can reduce sensitivity to many tissues, especially skeletal muscles and adipose tissue. A significant increase in blood glucose concentration (50 percent or more above normal) is called adrenal diabetes (Guyton and Hall, 2015). The mean blood glucose level before exercise in the morning group was higher than the night group, but not significantly. According to research conducted by Fernandes et al. (2014) plasma glucose levels at night are higher than in the morning with the hypothesis that an increase in the hormone insulin and decreased concentration of growth hormone (GH) in the morning cause a decrease in plasma glucose levels.

Blood glucose level were significantly decrease between before and after moderate intensity exercise for both morning and night group acutely. It is due to due to increase GLUT-4 muscle mRNA immediately after exercise (Richter & Hargreaves, 2013) and

also exercise causes muscles to be more active and sensitive to insulin, thus muscles can utilize more glucose which then lead to a decrease in glucose level (Nayak, Maiya & Hande, 2005). In line with a research done by Savikj et al. (2018) which shows that high intensity interval training in the afternoon is more effective in improving (reducing) blood glucose levels than in the morning. This can be due to the strength of the human skeletal muscle and mitochondrial function peaks in the afternoon, showing the circadian rhythm of oxidative metabolism.

Conversely, Savikj et al. (2018) research stated that some high intensity interval training in the morning has an acute effect of increasing blood glucose level after exercise. Supported by Gomez et al. (2015) where there are fewer hypoglycemic events if exercise performed in the morning. Exercising in the morning increases metabolic control the for next day and keeps patients in the euglycemic range for longer periods. This could be due to higher norepinephrine levels after exercise, so glucose levels after exercise in the morning are higher when compared to the night (Fernandes et al., 2014).

Comparison of changes in blood glucose level before and after moderate intensity exercise between morning and night group showed that there was no significant difference. Similar to the result, in a study done by Fernandes et al. (2014) proved that the difference of time in exercise was not significant.

Factors that affect blood glucose levels during exercise include last meal time, duration and intensity of the exercise. Time of last intake of food or drinks before exercise was proven to affect glucose changes by Colberg et al. (2013), showed that exercising 1 or 2 hours after the last intake decreases more blood glucose levels rather than 30 minutes after the last intake in patients with type 1 diabetes mellitus. Duration of the exercise will reduce more blood glucose level if it is longer in time, showed in patients with type 1 diabetes (Colberg, 2013). Lastly, the exercise intensity will have a different effect on blood glucose with different intensity. In the study conducted by Atsari, Susanto & Argarini (2016), it showed that moderate intensity continuous training reduced glucose levels much more than high intensity continuous training.

Conclusion

Moderate intensity exercise significantly decreases blood glucose levels in the morning and night groups, due to an increase in GLUT-4 contracting muscles. There were no differences concerning the effect on blood glucose changes between performing exercise in the morning or in the night. This can be due to cortisol hormone affecting blood glucose levels in morning and night, but can be stabilize by insulin and norepinephrine in the body. But further research is needed to better understand the underlying mechanisms.

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