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The Rate of Postprandial Blood Glucose Decrease, After Mild Interval Physical Exercise

Akhmad Fathoni[1]

[1]Jurusan Keperawatan, Poltekkes Kemenkes Mataram, Indonesia

Abstract

Physical exercise with a lower intensity is known to lower blood glucose levels. However, interval physical exercise (which is almost close to the situation in everyday society) is still rarely done. The purpose of this study was to determine the difference in the decrease in blood glucose in moderate intensity physical exercise at intervals of 2:3 minutes and 4:6 minutes postprandial. This research is cross-sectional experimental research with the pretest posttest research design. The research sample consisted of 20 high school students, which were divided into 10 people in the 2:3 interval training group and 10 people in the 4:6 interval training group. Samples were selected using purposive sampling. Samples were given exercise in the form of a treadmill in the active phase and leisurely walking in the resting phase. The data collected were blood glucose before exercise (pretest) and after exercise (posttest) in the 22nd minute and 42nd minute. The results of the ANOVA test for changes in blood glucose pre and posttest in the two treatment groups in the 22nd minute showed a value of p=0.001 (p <0.05), while in the 42nd minute p=0.176 (p>0.05). This means that there was a significant difference between the pre- and post-test blood glucose of the two treatment groups at 22 minutes, but there was no significant difference after exercise at 42 minutes.

Keywords: postprandial; interval physical training; blood glucose; sports

INTRODUCTION

Blood glucose levels must be maintained within normal limits, abnormal blood glucose levels, for example blood glucose levels that are chronically higher than normal (hyperglycemia) can have consequences including blindness, kidney failure, cardiovascular disease, and neuropathy (Shepherd, 1999). Control of normal blood glucose levels is influenced by the balance of glucose production by the liver and the use of blood glucose by body cells, especially skeletal muscle cells (Ganong, 2001; Marliss, 2002). Many factors affect blood glucose levels, which can be endogenous and exogenous. Endogenous factors include the hormone insulin which lowers blood glucose levels, while the hormones glucagon and epinephrine can increase blood glucose levels (Ganong, 2001); exogenous factors include nutrition and physical activity or physical exercise (Shepherd, 1999; Zierath, 2000).

It is known that intense physical exercise (> 80% Vo2max) can increase blood glucose levels after exercise, while physical exercise with lower intensity is known to reduce blood glucose levels (Kreisman 2000; Marliss, 2002). The research that is mostly done is continuous intensive and moderate

intensity physical exercise, while about the effect of interval physical exercise (which is almost close to the situation in everyday society) it is still rarely done, even though this is relatively easy to do, because in reality there are still many researchers in their observations. who are reluctant or do not want to carry out physical activities or sports because they think that sports are strenuous physical activities.

Considering that the character of the community varies greatly, interval physical exercise with the duration of the ratio is not necessarily suitable for all members of the community, a varied method of interval training is needed so that the scope of its application can be wider. The mechanism behind physical exercise can increase glucose uptake is because during physical exercise it is known that the use of glucose increases because the translocation of glucose transporters especially GLUT-4 which is in skeletal muscle cells increases, thereby increasing glucose uptake by skeletal muscle cells. Skeletal muscle cells are known to be the main site of insulin-stimulated glucose uptake, but it is also known that physical exercise can induce GLUT-4 translocation that is different from that mediated by insulin (Shepherd, 1999). When physical exercise is known to increase GLUT-4 translocation by mechanisms that are not insulin dependent, among others, through an increase in calcium ions during skeletal muscle contraction and the metabolic stress generated during contraction. During physical exercise it is also known that insulin concentrations decrease but insulin delivery to the skeletal muscles increases because blood flow to the skeletal muscles increases during contraction, so that glucose uptake during physical exercise increases (Wojtaszewski, 2002). Therefore, to widen the variation of interval physical exercise, it is necessary to conduct research to determine the effect of moderate intensity physical exercise at intervals of 2 minutes: 3 minutes and 4 minutes: 6 minutes on decreasing postprandial blood glucose levels.

Kadar glukosa darah harus dipertahankan dalam batas normal, ketidaknormalan kadar glukosa darah misalnya kadar glukosa darah yang lebih tinggi dari normal (hiperglikemia) yang kronis dapat memberikan akibat antara lain kebutaan, gagal ginjal, penyakit kardiovaskular, dan *neuropathy* (Shepherd, 1999). Pengendalian kadar glukosa darah yang normal dipengaruhi oleh keseimbangan produksi glukosa oleh hepar dan penggunaan glukosa darah oleh sel-sel tubuh terutama sel otot skelet (Ganong, 2001; Marliss, 2002). Banyak faktor yang mempengaruhi kadar glukosa darah, yang dapat bersifat endogen dan eksogen. Faktor endogen antara lain hormon insulin yang menurunkan kadar glukosa darah, sedangkan hormon glukagon dan epinefrin dapat meningkatkan kadar glukosa darah (Ganong, 2001); faktor eksogen antara lain nutrisi dan aktifitas fisik atau latihan fisik (Shepherd, 1999; Zierath, 2000).

METHOD

This research is an experimental cross-sectional study with the pretest posttest research design. The research subjects were high school students who were determined by the inclusion criteria: male, aged 17-20 years, healthy, and had no contraindications for doing physical exercise. The total sample

was 20 people, divided into two treatment groups, namely the group given moderate physical exercise at intervals of 2 minutes: 3 minutes and the group given physical exercise at intervals of 4 minutes: 6 minutes.

Samples were given moderate intensity physical exercise at intervals of 2 minutes: 3 minutes with intensities ranging from 60-70% maximum heart rate (70% Vo2max) for a total time of 42 minutes with a work: rest ratio of 2 minutes: 3 minutes. Moderate intensity physical exercise with intervals of 4 minutes: 6 minutes is carried out with an intensity ranging from 60-70% maximum heart rate (equivalent to 70% Vo2max) for a total time of 42 minutes with a ratio of work: rest, namely 4 minutes: 6 minutes. In both exercise groups, the working phase was carried out by riding a treadmill while the rest phase was carried out by walking in place at a rate of 30 times per minute. Data on blood glucose levels collected were postprandial blood glucose levels before exercise (pre-test data) and postprandial blood glucose levels taken after physical exercise (post-test data), namely at the 22nd and 42nd minutes. 30 minutes before doing physical exercise, research subjects were given 300-350 calories of food after previously being asked to fast for 8 hours from 24.00 to 08.00 in the morning. In addition to blood glucose data, data on sample characteristics including age, height and weight were also collected and analyzed descriptively. Statistical tests to assess blood glucose reduction were carried out using the ANOVA test.

RESULTS

The results of data collection on sample characteristics data showed that the average age of the sample was 17 years, with an average height of 163 cm and an average weight of 56 kg. The average value of blood sugar at 1 hour postprandial (pretest), at 22 minutes after exercise (posttest 1) and at 42 minutes after exercise (posttest 2) in the group given 2:3 interval training can be seen in table 1 .

Table 1. Mean Value of Blood Sugar and SD of the 2:3 Interval Exercise group variable

Training Interval 2:3		BG1PP (pretest)	BG22 (Posttest 1)	BG42 (Posttest 2)
N	Valid	9	9	9
	Missing	0	0	0
Mean		129.0000	118.2222	112.8889
Std. Deviation		18.28251	9.56266	16.22070

Table 1 shows the average value of blood glucose 1 hour PP of 129.00, blood sugar in the 22nd minute after exercise was 118.22 and blood sugar in the 42nd minute after exercise was 112.88. The average value of blood sugar at 1 hour postprandial (pretest), at 22 minutes after exercise (post test 1) and at 42 minutes after exercise (post test 2) in the group given 4:6 interval training can be seen in table 2.

Table 2. Mean Value of Blood Sugar and SD of the 4:6 Interval Exercise group variable

Training Interval 4:6		BG1PP	BG22	BG42
N	Valid	9	9	9
	Missing	1	1	1
Mean		119.4444	103.7778	102.8889
Std. Deviation		18.55472	6.01618	8.55050

Table 2 shows the average value of blood glucose 1 hour PP of 119.44, blood sugar in the 22nd minute after exercise of 103.77 and blood sugar in the 42nd minute after exercise of 102.88. Anova test for differences in blood sugar 1 hour postprandial (pretest), blood sugar 22 minutes after exercise (post test 1) and 42 minutes after exercise (post test 2) in both treatment groups, can be seen in table 3 and table 4.

Table 3. Results of the Anova test on blood glucose levels at 1 hour postprandial (pretest) and at 22 minutes after exercise (posttest 1) 2:3 interval and 4:6 interval exercise

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1679.630	2	839.815	9.427	.001
Within Groups	2138.000	24	89.083		
Total	3817.630	26			

Table 3 shows a significant value of 0.001 ($p < 0.05$) this means that there is a significant difference in the change in blood glucose reduction in the treatment group in the 22nd minute.

Table 4. Results of the Anova test on blood glucose levels at 1 hour postprandial (pretest) and at 42 minutes after exercise (posttest 1) 2:3 interval and 4:6 interval exercise

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	574.519	2	287.259	1.870	.176
Within Groups	3685.778	24	153.574		
Total	4260.296	26			

Table 4 shows a significant value of 0.176 ($p > 0.05$) this means that there was no significant difference in the change in blood glucose reduction in the treatment group at 42 minutes.

DISCUSSION

This study aims to determine changes in postprandial blood glucose levels (after eating) in 2:3 light intensity physical exercise at 22 and 42 minutes and 4:6 minutes light intensity physical exercise at 22 and 42 minutes. This research is a cross-sectional study with the pretest posttest control group design. The pretest data in question is the 1-hour postprandial blood glucose level which is used to determine the initial state before treatment. There are 2 posttest data, namely posttest 1 is data on

postprandial blood glucose levels immediately after moderate exercise 2:3 minutes at 22 minutes and moderate exercise 2:3 minutes at 42 minutes. While posttest data 2 is data on postprandial blood glucose levels immediately after light exercise 4 :6 minutes at 22 minutes and light exercise 4:6 minutes at 42 minutes.

The treatment group consisted of 20 people, aged between 17-20 years, male. Prior to the treatment, they were asked to fast from 24.00 to 08.00 which means fasting for 8 hours. According to (Meyes) fasting for 8-18 hours will result in a little or even depleted liver glycogen, so with the input of carbohydrates or food from outside, the energy used for physical exercise is from blood glucose because the liver glycogen is small and muscle glycogen is only able to meet the needs minutes (Guyton, 2000).

Physical Exercise 2:3 and 4:6 Moderate Intensity.

Based on VO2 maximum, the intensity of physical exercise can be divided into:

1. Light intensity physical exercise: <45 % VO2 max (50 %-60 % HR max),
2. Moderate intensity physical exercise: 50-70 % VO2 max (60 % -70 % HR max)
3. Heavy intensity physical exercise: >80% VO2 max (80%-90% HR max) (Yaspelkis, 1993; Fox, 1999; Cantu, 1982).

The duration of the physical exercise is 2:3 with 3-5 minutes of warm-up so that it is expected that the predominant energy is carbohydrates (Fox, 1993). The type of physical exercise that is done is walking on a treadmill. In the general public, this type of exercise will be able to provide an alternative choice of exercise for people with diabetes, especially in doing physical activity, so that it can be applied more broadly. The physical exercise performed was physical exercise with moderate intensity intervals of 2:3 and 4:6 with a duration of 22 and 42 hours in the postprandial state. This aims to show the magnitude of the decrease in postprandial blood glucose levels with the same training load. Does the same exercise chart show the same decrease in glucose. So that it can be used as an alternative choice of exercise that can regulate postprandial blood glucose levels.

Moderate intensity interval physical training model if we observe it everyday is the most widely practiced exercise model in society. In this exercise, there is an increase in glucose oxidation so that the same process can occur. With an increase in glucose oxidation, glucose uptake from the blood will increase and blood glucose levels will decrease

Mean decrease in blood sugar and different tests for decreasing blood sugar

In moderate intensity interval physical exercise of 2:3 from pretest blood sugar with post test 1 and post test 2, there is an average change in blood glucose of 5-6 mg/dl. Whereas in moderate intensity interval training 4:6 there is an average change in blood glucose of 5-6 mg/dl. This shows that moderate intensity interval training 2:3 and moderate intensity interval training 4:6 can lower blood glucose. This is because physical exercise can cause the binding of GLUT –4 to the cell surface and increase glucose

transport (Zierath, 2000; Sakamoto, 2002). Physical exercise with this interval can increase GLUT-4 translocation in skeletal muscle (Thorel, 1999).

The measurement of blood glucose immediately after exercise shows a significant decrease because glucose enters the muscles, then glucose in the muscles is burned by physical activity for energy so that blood glucose decreases. In the literature it is stated that postprandial blood sugar levels return to normal at 2-3 hours postprandial (Guyton, 2000). These results indicate that the metabolism that occurs during moderate intensity interval physical exercise can be assumed to be the same because the total relative load given is the same.

The results of the ANOVA test on blood glucose levels at 1 hour postprandial (pretest) and at 22 minutes after exercise (posttest 1) 2:3 interval and 4:6 interval exercise show a significant value of 0.001 ($p < 0.05$) this means that there is a real difference in the change in blood glucose reduction in the treatment group in the 22nd minute. While the results of the ANOVA test on blood glucose levels at 1 hour postprandial (pretest) and at 42 minutes after exercise (posttest 2) 2:3 interval and 4:6 interval training show a significant value of 0.176 ($p > 0.05$) this means there was no significant difference in the change in blood glucose reduction in the treatment group in the 42nd minute.

Changes in blood glucose levels occur because at the peripheral level, for example in skeletal muscles, light and moderate intensity physical exercise after eating can increase insulin. Because blood glucose levels increase after food input, insulin will cause an increase in glucose uptake into muscle cells (Ganong, 2001). Some of the things that cause a decrease in glucose in moderate intensity interval training are sympathetic stimulation. This sympathetic stimulation occurs when a person does moderate intensity interval physical exercise, causing an increase in epinephrine secretion and an increase in glucose uptake into muscle cells (Nonogaki, 2000). The decrease in glucose in this exercise also occurs because in contracting skeletal muscles, intra-cell calcium ions will increase and this calcium will activate protein kinase C (PKC) which can increase GLUT-4 translocation (Richter, 2001).

Several things that also play a role in reducing blood glucose after exercise are the increase in metabolic stress in terms of the energy system in doing physical exercise. After physical exercise, a condition called metabolic stress occurs, namely the ATP/ADP ratio increases, the CP/Cr ratio decreases, and the glycogen content decreases. This can lead to activation of 5 AMP – activated protein kinase (AMPK) which can increase GLUT –4 translocation (Musi, 2001; Richter, 2001). Furthermore, both light and moderate intensity exercise will cause an increase in AMP (adenosine 5 monophosphate activated phospokhinase) and a decrease in CP (creatin phosphate). Increase in AMP with AMPKK and ZMP (Z monophosphorylated) through several pathways, including: AMPK-OP will phosphorylate to form new proteins, these proteins will activate several targets and affect several other systems in the body; through protein phosphorylation, where GLUT-4 translocation in moderate intensity interval physical exercise can be directly affected through AMPK-OP; and through activating P13-K which is then changed through PDK (phosphoinisted dependent kinase), and then activating PK-B and PK-C which will affect GLUT-4 translocation.

The difference in blood glucose changes in both moderate intensity interval training 2:3 and moderate intensity interval training 4:6 which was not significant with a value of $p = 0.176$ ($p>0.05$), possibly due to exercise conditions, the patient will return to normal at 2-3 hours postprandial (Ganong, 2001).

CONCLUSION

From the results of the study it can be concluded that there was a decrease in blood glucose in the two exercise groups, both 2:3 interval training and 4:6 interval training. There was no significant difference in the decrease in blood glucose between 2:3 interval physical exercise and 4:6 physical exercise at 42 minutes even though there was a decrease in glucose. People can do physical exercise at medium intensity intervals, both 2:3 and 4:6 intervals, both of which can help lower blood glucose.

REFERENCES

Brooks GA, Fahey TD, 1985. Exercise Phisiology Human Bioenergetics and Its Applications. New York: Macmillan Publishing Co, pp 326, 432.

Christmass MA, Dawson B, Arthur PG, 1999. Effect of Work and Recovery Duration on Skeletal Muscle Oxygenation and Fuel Use During Sustained Intermittent Exercise. Eur J Appl Physiol Occup Physiol. Oct; 80 (5) : 435-47. Abstract.

Fox E, Bowers RW, Foss ML, 1993. The Physiologycal Basis for Exercise and Sport, 5th edition. Wisconsin: Brown and Benchmark, pp 514-515.

Fox SI, 1999. Human Physiology. 6th edition. Boston: The Mc Graw-Hill Companies, pp 107-108,139,327,331, 616-620.

Ganong WF, 2001. Review of Medical Physiology, 20th Edition. New York: Lange Medical Books/ McGraw-Hill: pp 278,280-281,334-336,340.

Guyton AC, Hall JE, 2000. Textbook of Medical Physiology, 10th edition. Philadelphia: WB Saunders Company, pp 11-12,43-55,73-79, 772-774, 798-799, 850, 862, 884-887, 962.

Mayes PA, 2000. Harper's Biochemistry, 25th edition. New York: McGraw-Hill, pp 149-159, 173, 177.

Marliss EB, Vranic M, 2002. Intense Exercise Has Unique Effects on Both Insulin Release and Its Roles in Glucoregulation – Implication For Diabetes. Diabetes vol. 51, supplement 1.

Richter EA, Derave W, Wojtaszewski JFP, 2001. Glucose, Exercise, and Insulin: Emerging Concepts. Journal of Physiology (2001), 535.2, pp 313-322.

Shepherd PR, Kahn BB, 1999. Glucose Transporters and Insulin Action. The New England Journal of Medicine 341 (4), p.248-255.

Vander A, Sherman J, Luciano D, 2001. Human Physiology The Mechanisms of Body Function, 8th edition. Boston: The Mc Graw-Hill Companies, pp 42-43,118-129,292-304.

Wojtaszewski JFP, Nielsen JN, Richter EA, 2002. Exercise Effects on Muscle Insulin Signaling and Action Invited Review: Effect of Acute Exercise on Insulin Signaling and Action in Humans. J Appl Physiol 93: 384-392.

Zierath JR, Krook A, Wallberg-Henriksson H, 2000. Insulin action and insulin resistance in human skeletal muscle. Diabetologia 43 : 822-823.