CRP as a mediator for the innate immunity system and blood glucose levels in football trained adolescents

PCR como mediador del sistema de inmunidad innata y de los niveles de glucosa en sangre en adolescentes entrenados en fútbol

Huldani[1]* Department of Physiology, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: huldani@gmail.com. https://orcid.org/0000-0003-1362-4763
Nur Qomariah[2] Department of Otorhinolaryngology, Head and Neck Surgery, Ulin General Hospital, Banjarmasin, South Kalimantan, Indonesia. Email: nur.qamariah@ulm.ac.id. https://orcid.org/0000-0001-8218-3952
Agung Biworo[3] Department of Pharmacology, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: agung_biworo@yahoo.com. https://orcid.org/0000-0002-9089-0806
Wafa Ahdiya[4] Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: wafaahdiya2000@gmail.com. https://orcid.org/0000-0003-3674-6835
Muhammad Hasan Ridhoni[5] Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: hasanridhoni@gmail.com. https://orcid.org/0000-0002-7146-91433.
San Gunma[6] Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: sangunma6@gmail.com. https://orcid.org/0000-0002-3675-8724
Ihyar[7] Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia Email: ihyarm70122@gmail.com. https://orcid.org/0009-0000-9547-5022
Naimah[8] Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: naimahsh07@gmail.com. https://orcid.org/0000-0001-7696-3338
Nurkhaliza Rizky Amaliea9 Medical Student, Faculty of Medicine, Lambung Mangkurat University, Banjarmasin, South Kalimantan, Indonesia. Email: 2210911320030@mhs.ulm.ac.id. https://orcid.org/0000-0002-9149-3335
Corresponding author: huldani@gmail.com
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Abstract

Regular exercise such as soccer players will gradually adapt and compensate the body so that physical activity in the form of running for 30 minutes does not cause an inflammatory response and does not increase inflammatory biomarkers. An inflammatory biomarker that is easy to measure when compared to other inflammatory markers is C-Reactive Protein (CRP). The objective of this study was to explain the differences in CRP and blood glucose levels in adolescents after 30 minutes of running which was an exercise immunology study. The study used a quasi-experimental model pre and posttest with a purposive sampling method on each of 30 soccer-trained youth and not, according to the inclusion criteria. The results showed significant differences between the trained and untrained groups in the levels of CRP and blood glucose after running 30 minutes. In the trained group, blood glucose levels differed significantly before and after 30 minutes of running (P 0.05) based on a paired t-test. Before and after 20 minutes of running, the untrained group had significantly lower blood glucose levels as measured by the Wilcoxon test (P<0.05). The conclusion is that there are differences in CRP and blood glucose levels in trained adolescents and not after 30 minutes of running.

Keywords: aerobic, blood glucose, CRP, exercise immunology, trained

Resumen

El ejercicio regular, como el de los futbolistas, adaptará y compensará gradualmente el cuerpo para que la actividad física en forma de correr durante 30 minutos no provoque una respuesta inflamatoria y no aumente los biomarcadores inflamatorios. Un biomarcador inflamatorio que es fácil de medir en comparación con otros marcadores inflamatorios es la proteína C reactiva (PCR). El objetivo de este estudio fue explicar las diferencias en los niveles de PCR y glucosa en sangre en adolescentes después de 30 minutos de carrera, que fue un estudio de inmunología del ejercicio. El estudio utilizó un modelo cuasiexperimental pre y postest con un método de muestreo intencional en cada uno de 30 jóvenes entrenados y no entrenados en fútbol, según los criterios de inclusión. Los resultados mostraron diferencias significativas entre los grupos entrenados y no entrenados en los niveles de PCR y glucosa en sangre después de correr 30 minutos. En el grupo entrenado, los niveles de glucosa en sangre difirieron significativamente antes y después de 30 minutos de carrera (P 0,05) según una prueba t pareada. Antes y después de 20 minutos de carrera, el grupo no entrenado tenía niveles de glucosa en sangre significativamente más bajos, medidos por la prueba de Wilcoxon (P<0,05). La conclusión es que existen diferencias en los niveles de PCR y glucosa en sangre en adolescentes entrenados y no después de 30 minutos de carrera.

Palabras clave: aeróbico, glucosa en sangre, PCR, inmunología del ejercicio, entrenado.

Introduction

Physical activity involves movement produced by skeletal muscles and requires energy expenditure. A sport is a planned, structured, and repetitive physical activity that maintains physical fitness Optimal physical fitness will help maintain the health of the heart, lungs, muscles, and blood circulation system. Physical fitness is closely related to sports because sports require good body abilities to run effectively so that good physical fitness will be obtained[1,2].

Physical activity as the result of skeletal muscle contractions will cause some energy expenditure from the body[3]. Lack of physical activity can affect an increase in blood sugar levels which has the potential to cause some metabolic disorders. The incidence of non-communicable diseases is increasing every year, one of the reasons is the sedentary lifestyle or lack of physical activity which can increase the risk factors for degenerative diseases. The Ministry of Health of the Republic of Indonesia (2018) recommends that people do light to moderate physical activity for at least 10-30 minutes a day[4,5].

Physical activity such as running for 30 minutes without stopping can trigger an inflammatory response. In someone who regularly does sports such as a soccer player, there will be gradual adaptation and compensation of the body so that physical activity in the form of a 30-minute run will not cause an inflammatory response, so no increase in inflammatory biomarkers is obtained[6,7]. An inflammatory biomarker that is easy to measure when compared to other inflammatory markers is C-Reactive Protein (CRP)[8]. CRP is a plasma protein produced by the liver and is produced in large quantities when inflammation occurs. CRP levels will increase if there is trauma, bacterial infection, and inflammation[9,10]. One way to prevent inflammation after physical activity is to exercise regularly. People who regularly do sports has lower CRP serum[6].

The simplest way to increase immunity is to do physical exercise and get enough rest and sleep. Low-intensity physical exercise is also able to activate the work of white blood cells which are the main component of the body's immunity in blood circulation, as long as the exercise is carried out with sufficient duration and routinely, for example, aerobic exercise for 12 to 30 minutes five times a week. Ideally, aerobic exercise is carried out for 30 minutes to achieve optimal physical fitness. Running for 30 minutes can be a form of physical activity that has benefits in controlling blood glucose levels[11,12], and cause the different immune responses (inflammatory or not) depending on the immune system of the individual

who performs it[6,7]. Through this study glucose levels and pro-inflammatory responses (CRP levels) will be measured in trained adolescents (soccer players) and untrained adolescents after 30 minutes of moderate-intensity running.

Materials and methods

This study used a quasi-experimental model of pre and post-tests on 30 football-trained and 30 untrained adolescents according to the inclusion criteria to be a research subject: male, age between 16-22 years, physically healthy, cooperative, not smoking, not drinking alcohol, not currently taking drugs that affect CRP and glucose levels at least one day before taking CRP and glucose levels on the study day, have a normal body mass index (BMI), members of the Banjarmasin Football Club, and regularly play soccer at least 4 days a week. The sample selection technique uses a purposive sampling method. CRP and blood glucose levels were measured before and after 30 minutes of running.

Data analysis used paired T-tests for trained and untrained pre and post-test, and unpaired T-tests to compare the changes of CRP and glucose levels in trained and untrained adolescent groups (difference before and after running). Normality test was carried out using the Kolmogorov-Smirnov test. If the data is not normally distributed, then the data is transformed with log 10. If the results are normally distributed, then paired and unpaired T-tests are performed, but if not normally distributed, Wilcoxon and Mann-Whitney tests will be performed as the alternative tests.

Results

Statistical tests with paired t-tests showed that there has been a substantial difference in blood glucose levels of the trained group before and after running 30 minutes (Sig 2-tailed <0.05). And the Wilcoxon test showed that there was a substantial difference in blood glucose levels in the untrained group between before and after running 30 minutes (Asymp. Sig. (2-tailed) <0.05). The Mann-Whitney test showed that there was a significant difference in mean blood glucose between the trained and untrained groups (Asymp. Sig. (2-tailed) <0.05) (Table 1).

Statistical tests with Wilcoxon showed that there was a significant difference in CRP levels before and after running 30 minutes in both the trained and untrained groups (Asymp. Sig. (2-tailed) <0.05). The Mann-Whitney test showed that there was a significant difference in the mean CRP levels between the trained and untrained groups (Asymp. Sig. (2-tailed) <0.05) (Table 2).

Table 1. Results of statistical test regarding blood glucose levels

Groups	Blood Glucose	Mean		Median	Asymp. Sig. (2-tailed)
		Statistics	Std. Error		
Trained	Pre-test	108.3000	3.28149	109.5000	
	Post-test	84.1000	2.27599	84.0000	
Paired T-test					.000
Untrained	Pre-test	78.5333	2.35949	83.0000	
	Post-test	81.2333	2.26248	85.0000	
Wilcoxon					.043
Mann-Whitney					.000

Table 2. Results of statistical test regarding CRP

Groups	CRP	Mean		Median	Asymp. Sig. (2-tailed)
		Statistics	Std. Error		
Trained	Pre-test	4.2600	.31461	3.8500	
	Post-test	5.3567	.36229	4.8000	
Wilcoxon					.000
Untrained	Pre-test	2.6800	.17697	2.8000	
	Post-test	4.8400	.14563	4.6000	
Wilcoxon					.000
Mann-Whitney					.016

C-Reactive Protein (CRP) was discovered by William S. Tillett (1892-1974) and Thomas Francis, Jr. (1900-1969) in 1930 in the laboratory of Oswald T. Avery (1877-1955). A non-specific inflammatory mediator, CRP is a sensitive indicator of bacterial infection, inflammation, and tissue damage[11-14]. CRP is a plasma protein originating from the liver, belonging to the pentraxin family, and forms the main component of any inflammatory reaction[15,16]. CRP synthesis in the liver is modulated by cytokines, Interleukin-1b (IL-1b), Interleukin-6 (IL-6), and TNF-α which are very important regulators of CRP synthesis[17-19]. Determination of CRP is used to help establish the diagnosis of the disease state concerned with the process of inflammation and tissue necrosis, also monitor the results of treatment (effectiveness of therapy) of several diseases with acute inflammation or tissue damage, as well as markers of inflammation in cardiovascular disease to see the possibility of coronary heart disease[20].

CRP levels in the blood should not exceed 0.1 mg/dL or 1 mg/L. The expression of CRP increases during inflammatory conditions such as rheumatoid arthritis, cardiovascular disease, and infection. The plasma concentration of CRP during inflammatory conditions deviates by at least 25% [21,22]. After inflammation process, CRP formation will increase within 4 to 6 hours, the amount even doubles within 8 hours after inflammation. Peak concentrations will be reached in 36 hours to 50 hours after inflammation. CRP levels will continue to increase along with the inflammatory process which will result in tissue damage. If healing occurs there will be a rapid decrease in CRP levels because CRP has a half-life of 4 to 7 hours[23]. Meier-Ewert et al.[24] evaluate the type of moderate exercise and showed an increase in CRP 30 minutes after exercise with a greater increase 28 hours later. As a result of severe tissue damage, such as trauma and progressive cancer, CRP levels increase from about 1 g/mL to more than 500 g/mL in 24-72 hours. As well as amplifying the effect of IL-6, IL-1 also increases the expression of CRP. Many factors can change the CRP baseline; namely age, sex, smoking status, body weight, and lipid levels. The average CRP level in healthy people is around 0.8 mg/L, but this level can vary widely between individuals due to other factors including CRP gene polymorphisms[21,25].

Physical exercise can lead to the generation of a short-term inflammatory response followed by leukocytosis, particularly the number of systemic neutrophils, muscle and internal organ damage, and immune suppression[6,7]. As well as triggering a rise in oxidative stress, a rise in serum cortisol and plasma CRP levels[13,17]. Regular exercise will reduce CRP, IL-6, and TNF alpha and increase anti-inflammatory substances such as IL-4 and IL-10. In healthy young people, a 12-week program of high-intensity aerobic exercise will decrease cytokine and monocyte release. Physical activities carried out during free time, such as leisurely jogging, walking, or running, can also decrease high-sensitivity CRP concentrations with graded levels[8]. This theory was proven in this study where there were significant differences in CRP levels after and before exercise in both the trained and untrained groups.

Blood glucose is one of the energy reserves in the form of sugar which is formed from carbohydrates in food and is contained in the blood. Blood sugar as the main metabolic substrate of carbohydrates functions as the energy used for activities. Glycogenolysis refers to the breakdown of glycogen stored in the liver in the form of carbohydrates, while gluconeogenesis refers to the production of glucose from non-carbohydrate sources such as lactate, alanine, and glycerol. The breakdown of blood glucose in the body functions to provide energy to tissues and cells which can be stored as energy reserves in the body. Glycogen after being broken down can be released into the blood in the form of glucose, then taken up by the muscles as a source of energy[20,25].

The main product of carbohydrates digestion in the blood circulation is glucose. After glucose enters the cell, glucose will undergo phosphorylation to form glucose 6-phosphate. The enzyme that catalyzes this reaction is hexokinase. Glucose 6-phosphate then undergoes polymerization into glycogen. Glycogen is a storage form of glucose that is found in most body tissues, especially in the liver and skeletal muscles[13,18].

Blood circulation in it there is a lot of glucose and there are still small amounts of fructose and galactose. After absorption from the digestive tract, fructose and almost all of the galactose is converted to glucose in the liver. Glucose metabolized after a meal is partly dispersed and taken up by the skeletal muscles, the process of transporting glucose into the muscles is considered a limiting step for glucose disposal. Glucose transport occurs through Glucose Transporter (GLUT) diffusion, the hormone insulin will regulate blood glucose primarily through GLUT4 translocation from the intracellular compartment to the plasma membrane and transverse tubules[11,12].

Blood glucose level is a tightly regulated blood sugar level in the body. Blood sugar concentration is regulated in the body with normal limits throughout the day, namely 70-150 mg/dL[22]. There are several types of measurement of blood sugar levels, namely fasting blood sugar examination by measuring blood sugar levels after at least 8 hours of fasting, postprandial blood sugar examination by measuring blood sugar levels 2 hours after eating, and examination of free blood sugar levels without estimating the time of collection[1,16]. According to the Indonesian Ministry of Health, blood sugar levels at any time in a person are categorized as normal if <200 mg/dL, categorized as low if the sugar level is <70 mg/dL, and categorized as high if >200 mg/dL[17]. Blood sugar levels can change due to several factors, include physical activity. Physical activity has a close relationship

with blood glucose levels, because physical activity can improve glucose mechanism control[3,7,10].

Muscle contraction directly induces the release of IL-6 which is part of the chemokines and plays a role in and regulates muscle growth. IL-6 has a positive effect on glucose absorption and fat oxidation. Muscle contraction can also stimulate the entry of glucose transporter-4 (GLUT 4) into the plasma membrane of active muscle cells even in the absence of insulin. GLUT 4 is an amino acid compound that is very abundant in tissues and will absorb glucose from the blood. The effects of this physical exercise will last for 24-72 hours, therefore regular exercise is important to increase long-term insulin sensitivity[4,17]. The effects of physical exercise are not always the same for each individual decreasing blood glucose levels, depending on the intensity, duration, type, and frequency of exercise[9].

These theories are consistent with the results of this study which shows an effect of physical exercise on blood glucose levels as evidenced by the finding of significant differences in glucose levels before and after a 30-minute run in the trained and untrained groups.

Conclusions

The conclusion is that there are differences in CRP and blood glucose levels in trained adolescents and not after 30 minutes of running. Regular exercise has been shown to improve long-term insulin sensitivity and compensation of the body gradually so that routine physical activity will not cause an inflammatory response including CRP levels.

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