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Adapun penelitian tersebut layak dilakukan dan menghasilkan output yang sangat baik, meskipun belum ada *Uji Ethical Clearance* karena merupakan penelitian observasional.

Demikian surat keterangan ini kami buat untuk dapat dipergunakan sebagai persyaratan pengusulan Jabatan Fungsional Guru Besar.

Sabaya, 24 April 2023



Dr. Sani Martini, dr. M.Kes
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Comparison of Results of Measurement Hand Dynamometer with Lactat Acid Blood Plasma for Muscle Fatigue Level Indicator Hand Computer Operator

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Abstract

Fatigue is a protective mechanism of the body to avoid further damage resulting in the recovery after the break. Fatigue usually indicates that the situation is different in each individual, but it all boils down to loss of efficiency and a reduction in work capacity and endurance. Fatigue can be shown on the measurement results using a hand dynamometer and blood plasma lactic acid levels. This study aimed to compare the level of muscle fatigue hand computer operator based on the measurement method of blood plasma lactic acid by the method of hand dynamometer. This study was designed to use observational research in the field using cross sectional design. The study population was computer operator males aged 20-30 years. The research sample computer operators who meet the inclusion criteria that had no history of specific diseases such as diabetes mellitus, musculoskeletal disorders, cardiac disorders, kidney and has worked as a computer operator at least 1 year, totaling 20 subjects.

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Results of research on paired t-test is obtained a significant difference ($P < 0.05$) to the level of fatigue on the measurement of hand dynamometer (79.25 ± 12.40 and 71.45 ± 12.65) and lactic acid levels of blood plasma (2.93 ± 0.29 and 4.67 ± 0.57) before and after work typing on the computer for 4 hours. While at Pearson test the muscle fatigue level respondents hands after treatment between groups showed no significant differences $p = 0.893$ ($p > 0.05$). Conclusion of research is no significant difference between the measurement results of hand dynamometer with blood plasma lactic acid levels as an indicator of muscle fatigue respondents hands after working on the computer for 4 hours.

Key words: hand dynamometer; blood plasma lactic acid; muscle fatigue hand.

1. Introduction

The use of computers is becoming more popular in the community in line with advances in telecommunications and information. Ranging from private companies, governments, students and other non-commercial users are already familiar with the use of computers. This situation is getting easier for people to use computers, either for work purposes or to just play. The use of computers today is not only academic community, but the general public has also been widely used in the computer data entry as in the office.

Fatigue is a protective mechanism of the body to the body avoids further damage resulting in the recovery after the break. The term fatigue is showing different conditions in each individual, but it all boils down to loss of efficiency and a reduction in work capacity and endurance. Fatigue is classified into two types, namely muscle fatigue and general fatigue. Muscle fatigue (muscular fatigue) is indicated by symptoms tremendous pain such as muscle tension and tension around the joint [1-3].

Muscle fatigue is a tremor in the muscles or feeling pain in the muscles, while general fatigue are usually characterized by reduced willingness to work is caused by the monotony, intensity and duration of physical work, the environment, because of mental, health status and nutritional state [3,4]. Muscle fatigue can be divided into two parts, namely local fatigue and general fatigue. Local fatigue is reduced muscle response to respond repeatedly seen in the reduction of motor unit potential amplitude. General fatigue (general fatigue) can be seen in the emergence of a number of complaints in the form of feeling sluggish and aversion to activity [5,6].

Some of the factors that caused the complaint skeletal muscle, that muscle stretching excessive, repetitive activities, work attitude is not natural factors secondary causes such as pressure, vibration, microclimate and the contributing factors combinations such as age, sex, smoking habits, physical health, strength physical and body size or anthropometry [7]. The risk of skeletal muscle discomfort increased with the use of the computer an hour a day and risk of injury to the skeletal muscle increased 9 times greater for a person who worked with computers for four hours compared with 1 hour of computer users per day [8]. On the complaints of the computer operator will eventually cause health problems such as repetitive strain injury (RSI) and cumulative trauma disorder (CTD) thus causing carpal tunnel syndrome, tendinitis and muscle pain [9]. The study of subjective complaints of a computer operator at the Technical Implementation Unit of Art and Technology Development of Ceramics

and Porcelain Bali shows the difference of fatigue before and after work, with an increase of 37.29% fatigue [10]. Results of research on the computer operator fatigue showed a marked increase in lactic acid concentration of 4.3 mg / ml of blood, where the minimum increase in lactic acid concentration was 3.5 mg / ml of blood and the highest was 5.5 mg / ml of blood [11].

2. Materials and Methods

2.1 Research Locations

This research was conducted in the community that is at the office of PT. Putra Pusoro Makassar.

2.2 Research Design

This type of research is observational research in a field that is based on techniques of data collection is a kind of cross-sectional study. In research carried out measurements of muscle fatigue hands of the subject (computer operator) with a hand dynamometer and blood plasma lactic acid levels before work and shortly after working for 4 hours. This design aims to compare the measurement results with a hand dynamometer blood lactic acid as an indicator of their arm muscle fatigue [12].

2.3 Population and Sample

The population used in this study is a computer operator males aged 20-30 years. The sample was selected by using non-random sampling, namely by using purposive sampling, where samples were taken on the basis of certain considerations which made the researchers themselves, which does not have a history of specific diseases such as diabetes mellitus, cardiac disorders, kidney as evidenced by the results of medical records from doctors, free of chronic musculoskeletal disorders, has worked as a computer operator of at least one year so that the total sample of 20 subjects.

2.4 Data Collection Methods

Data obtained from the measurement of the ability of muscle contraction hands of the subject (computer operator) using a hand dynamometer and lactic acid levels in the blood. Both types of measurements performed on the same subject just before work and after working with computers for four hours.

2.5 Data Analysis

To analyze the level of fatigue before and after working with a computer for 4 hours used paired t-test analysis and to compare the results of measurements of hand dynamometer with blood lactic acid as an indicator of muscle fatigue hand computer operator used pearson analysis test.

3. Results

3.1 Analysis of Research Variables

Table 1 showed research subjects were obtained between the ages of 20-30 years. The subject is a computer

operator who all male sex.

Most subjects aged between 20-25 years as many as 17 people (85%) and subjects aged 26-30 years as many as 3 people (15%).

Table 1: Distribution of Subjects According to Age at PT. Son Pusoro Makassar 2015

Age	n	%
20 – 25	17	85
26 – 30	3	15
Amount	20	100

Table 2 shows the comparison of muscle fatigue with the ability of muscle contraction subject hands before and after working on the computer for 4 hours. This measurement is performed to determine that the method of hand dynamometer (handgrip) can reveal the presence of fatigue in hand muscles after working in computer subjects for 4 hours.

Table 2: Comparison of the Ability of Muscle Contraction Subject Hands Before and After Working 4 Hours on the Computer

Variable	Hand Dynamometer		The difference in mean	t	p		
	before	after					
	Mean	SD	mean	SD			
Value capabilities hand muscle contraction	79.25	12.40	71.45	12.65	7.80 ± 3.93	8.88	0.000

Results of paired samples t-test to measure the average ability of muscle contraction subject hands before and after working on the computer for four hours showed a significant difference ($p < 0.05$), that is 79.25 ± 12.40 kg before work and 71.45 ± 12.65 after working on the computer for 4 hours with a mean difference of $7.80 + 3.93$. It can be concluded that there are differences in the measurement capabilities of muscle contraction hands before and after working on the computer for 4 hours.

Table 3 shows the comparison of muscle fatigue lactic acid levels of blood plasma subjects before and after working on the computer for 4 hours. This measurement is performed to determine that the method of lactic acid blood plasma can be aware of any fatigue in hand muscles after working in computer subjects for 4 hours.

Results of paired samples t-test to measure average blood plasma lactic acid levels subject muscles before and after working on the computer for four hours showed a significant difference ($p < 0.05$), which is 2.93 ± 0.29 mg / ml before work and 4.67 ± 0.57 mg / ml after working with the average difference of 1.75 ± 0.48 mg / ml.

It can be concluded that there are differences in blood plasma lactic acid levels before and after working on the computer for 4 hours.

Table 3: Comparison of Blood Plasma Lactic Acid Levels Subjects Before and After Working 4 Hours on the Computer

Variable	Lactic Acid Blood Plasma				The difference in mean	t	p
	before		after				
	mean	SD	Mean	SD			
Value Lactic acid levels in the blood	2.93	0.29	4.67	0.57	1.75 ± 0.48	-15.79	0.000

Table 4 shows a comparison of measurement results between a hand dynamometer with lactic acid blood plasma as an indicator of their arm muscle fatigue after working at the computer for 4 hours. The results of the measurement of the ability of muscle contraction after working on the computer for 4 hours with a hand dynamometer obtained a value of 71.45 ± 12.65 kg, while the blood plasma levels of lactic acid obtained a value of 4.67 ± 0.57 mg / ml.

Table 4: Comparison of the Results of Measurements of Hand Dynamometer With Lactic Acid Blood Plasma as an Indicator of Hand Muscle Fatigue After Working on the Computer for 4 Hours

Variable	methods of measurement	mean	SD	p
Value Fatigue	Hand Dynamometer	71.45	12.65	0.893
	Lactic Acid Blood Plasma	4.67	0.57	

Pearson test results on a hand dynamometer measurement and blood lactic acid levels of the muscle fatigue level subject hands after working on the computer for four hours showed no significant difference with $p = 0.893$ ($p > 0.05$). It can be concluded that there was no difference in the measurement results of hand dynamometer with blood plasma lactic acid levels as an indicator of muscle fatigue your hands after working on the computer for 4 hours.

4. Discussion

Analysis of the 20 subjects (computer operator) men have a productive lifespan. Lifespan of subjects in accordance with the optimal physical to do the job. Age influence the physical work ability or the a person's muscle strength. Age is one factor that is prone to fatigue because it will affect the capacity of soft tissue, resistance to stress as well as muscle strength declines with age [13]. Physical ability to achieve the maximum a person between the ages of 25-39 years and will continue to decline with age [4]. Ages 25 to 40 years is

physiologically mature age, where the physiological functions of the body is still able to work optimally and have not decreased significantly function and will be decreased ability when approaching the age of 50 years. Categories of age > 40 years began working capacity is reduced so that a 80-60% compared with a working capacity of workers aged 25 years [14,15]. Changes in age-related mechanical properties of elastin and connective tissue that controls the power [16]. On the basis of the description, then all operators are the subject of research can be said to have optimal working capacity so that the effect of age will determine the level of exhaustion.

To ensure that the ability of the subject's arm muscles (computer operator) can be used as a parameter to the impact of work typing on the computer for 4 hours, then before working typing on the computer for 4 hours to do the measurement value of the ability of the arm muscles. Then the operator works with typing on the computer for 4 hours and shortly after working for 4 hours to judge the value of the ability of the arm muscles using a hand dynamometer. It is to know the difference of the value of the subject's ability arm muscles before and after work in the form of typing on the computer for 4 hours. The test results showed differences in the ability of muscle contraction value of the subject's arm before and after working for 4 hours. The test results can be concluded that the work of typing on the computer for four hours have an influence on the decreased ability of muscle contraction computer operator arm. The decrease in the ability of muscle contraction shown in hand dynamometer indicates fatigue in hand muscles computer operator. This happens because their static muscle contraction continuously so that the muscles are experiencing pain and tremor resulting in decreased function [1, 4]. Fatigue can occur due to repetitive movement in a long time or a repetitive motion performed continuously with a specific purpose, at least for 1 hour to do with cycles that are similar to one another [17].

Fatigue that occurs can also be influenced by how quickly a muscle to contract. The faster the contraction, the faster the muscle is experiencing fatigue. Computer operator at the time of typing work, the muscles in the neck and back, shoulder girdle muscles and upper arm muscle contraction everything statically, while the muscles of the fingers and hands to work with the dynamic and repetitive contractions. The faster the contraction, the faster exhaustion [18]. Static and dynamic muscle contraction repeatedly for a long time will affect the muscle cells or limitations on the circulation so that muscle fatigue [19]. It can be concluded that the measurement of hand dynamometer can be used as one measure to determine their fatigue in hand muscles computer operator.

To ensure that the blood plasma levels of lactic acid can be used as a parameter to the impact of work typing on the computer for 4 hours, then before working typing on the computer for 4 hours to do the measurement value of the blood plasma levels of lactic acid. Then the subject of works by typing on the computer for 4 hours and shortly after working for 4 hours is measured on levels of lactic acid in the blood plasma of the subject (computer operator). It is to know the difference of the value of the blood plasma lactic acid levels subjects before and after work in the form of typing on the computer for 4 hours. The test results can be concluded that the work of typing on the computer for four hours has an effect on increased levels of lactic acid blood plasma of the subject. The occurrence of elevated levels of lactic acid in the blood plasma showed fatigue in hand muscles subject. This can occur because of the imposition of excessive muscle will cause a damming of blood flow to the extremities so that supply blood that contains nutrients and O₂ are not optimal, as a result of lactic acid (buildup during contraction) cannot be converted back into a source of energy, causing fatigue. Fatigue can

also occur due to excessive workload on the systems of the body (muscle, blood vessels and bones) will lead to the loss of work efficiency in the organ thus causing reduction in energy reserves and increasing metabolic system as a precipitating factor of fatigue. Muscular work can be influenced by physiological and biomechanical factors that lead load increases muscle to ease fatigue. On the hand does not have a warning system oxygen sensor so that the arms buildup can occur in the arm muscle metabolism so that there may be noise elasticity [20,21].

Continuous muscle contraction will lead to an increase in lactic acid pata muscle tissue. Lactic acid is unstable and is converted into lactate and hydrogen ions (H^+). H^+ will affect the contraction process in the form of inhibition of phosphofructokinase (rate-limiting enzyme of glycolysis), inhibition of transformation phosphorylase (which reduces glycogen is converted into glucose), reduced muscle strength by inhibiting myosin ATPase as well as reduce the excitability of muscle fiber membranes. Muscle fatigue can also occur due to proton (H^+) redundant as a byproduct of glycolysis and if the rate of production of pyruvate (glycolysis) exceeds the level of oxidized via the tricarboxylic acid cycle, the excess pyruvate is converted into lactic acid [22,23]. Increasing exercise load will also increase lactic acid levels in the blood and muscles. High-intensity exercise (exercise using anaerobic energy systems) will be increased levels of lactic acid heap, so the maximal exercise for 30-120 seconds, lactic acid levels can reach 15-25 mM as measured after the exercise for 3-8 minutes. This indicates an increase in lactic acid ischemia and hypoxia [24, 25]. It can be concluded that the measurement of blood plasma levels of lactic acid can be used as one measure to determine their fatigue in hand muscles subjects (computer operator).

Measurement of muscle fatigue after working for 4 hours at a computer to do one. The measurement is carried out using a hand dynamometer and blood plasma lactic acid levels. The test results showed no correlation hand dynamometer measurement results with blood plasma lactic acid on the incidence of fatigue in hand muscles after a computer operator working for 4 hours. Both methods such measurements indicate a significant change in the measurement result after working for 4 hours. The occurrence of fatigue in both of these measurements depends on the type of factors that cause fatigue. This is consistent with the opinion William MH (1991) which states that the lactic acid increased after muscle work anaerobically, resulting in muscle contraction lactic acid will increase significantly when the muscles are contracted with a large load. Similarly, the opinion Santoso which states that the work with heavy loads are done continuously will cause a lack of oxygen resulting in anaerobic metabolism that produce lactic acid as a cause of fatigue. A large workload will lead to fatigue more quickly because the subject try hardest to resist the applied load. While the measurement with a hand dynamometer, muscle fatigue can be demonstrated by a decrease in the ability of muscles to contract. This can occur due to muscle fatigue caused by factors other than workload can also be caused due to muscle histology concerned. which states that the white muscle fibers have a fast reaction to stimuli but rapidly exhausted, whereas red muscle fibers have slow reaction to stimuli but slow fatigue. It can be concluded that there is a relationship between the results of measurements using a hand dynamometer with measurement results of blood plasma levels of lactic acid in muscle fatigue computer operator's hands after working 4 hours using a computer.

5. Conclusion

The fact that there is a significant difference measurement results of blood plasma levels of lactic acid and muscle fatigue hand dynamometer at the finger and forearm computer operator before and after working four hours by using a computer. There was no significant difference between the measurement of blood plasma levels of lactic acid and hand dynamometer measurement against muscle fatigue finger and forearm computer operator after working 4 hours using a computer.

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