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FREKUENSI DENYUT JANTUNG INDIVIDU AKTIF LEBIH RENDAH DIBANDING INDIVIDU SEDENTER SAAT AKTIVITAS FISIK ANAEROBIK (STUDI PADA LAKI-LAKI USIA 18-24 TAHUN)

THE HEART RATE FREQUENCY OF ACTIVE INDIVIDUALS IS LOWER THAN SEDENTARY INDIVIDUALS DURING ANAEROBIC PHYSICAL ACTIVITY (STUDY ON MALES 18-24 YEARS OLD)

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Abstrak

Saat ini, dalam bidang olahraga dan kesehatan diyakini bahwa individu yang aktif beraktivitas fisik atau rutin berolahraga memiliki frekuensi denyut jantung yang lebih rendah dibandingkan dengan individu sedenter, baik ketika istirahat maupun ketika beraktivitas fisik. Frekuensi denyut jantung mencerminkan intensitas aktivitas fisik yang dilakukan seseorang. Penelitian ini bertujuan untuk membuktikan perbedaan frekuensi denyut jantung pada individu aktif dan individu sedenter ketika melakukan aktivitas fisik anaerobik. Subyek penelitian ini adalah 16 orang laki-laki aktif dan 16 orang laki-laki sedenter berusia 18-24 tahun. Penelitian ini menggunakan metode eksperimen dengan perlakuan berupa aktivitas fisik anaerobik yaitu push-up, sit-up dan squat secara berurutan serta dilakukan pemantauan frekuensi denyut jantung yang dicatat setiap 10 detik. Hasil menunjukkan bahwa kelompok aktif memiliki frekuensi denyut jantung lebih rendah dibandingkan dengan kelompok sedenter ketika beraktivitas fisik anaerobik. Kesimpulan dari penelitian ini adalah bahwa ketika melakukan aktivitas fisik anaerobik yang sama, bagi individu aktif kenaikan intensitas aktivitas fisik yang terjadi tidak sebesar yang dialami oleh individu sedenter.
Kata Kunci: anaerobik, denyut jantung, frekuensi, intensitas, sedenter

Abstract

Currently, in the field of sports and health it is believed that individuals who are active in physical activity or exercise regularly have a lower heart rate compared to sedentary individuals, both at rest and during physical activity. The heart rate reflects the intensity of a person's physical activity. This study aims to prove differences in heart rate frequency in active individuals and sedentary individuals when performing anaerobic physical activities. The subjects of this study were 16 active men and 16 sedentary men aged 18-24 years. This study used an experimental method with treatment in the form of anaerobic physical activity, namely push-ups, sit-ups and squats sequentially and monitoring the heart rate was recorded every 10 seconds. The results showed that the active group had a lower heart rate compared to the sedentary group when doing anaerobic physical activity. The conclusion of this study is that when doing the same anaerobic physical activity, for active individuals the increase in physical activity intensity that occurs is not as great as that experienced by sedentary individuals.
Keywords*: anaerobic, heart rate, frequency, intensity, sedentary*

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INTRODUCTION

The human body needs energy for activities, especially muscle cells which function as the body's main mover. In cells, energy is produced from the oxidation of metabolic fuels such as carbohydrates, lipids and proteins. The oxidation process produces free energy products that can be stored in high-energy bonds such as Adenosine Triphosphate (ATP). ATP is a high-energy compound needed by myosin to attract actin in the process of muscle contraction (Nath, 2006; Matarneh et al., 2023; Guyton & Hall, 2016; Sherwood, 2015). The higher the intensity of the activity carried out by the body, it can be assumed that the more muscle cells are involved in contraction work and/or the more intense the contractions carried out by the muscle cells. The high activity of muscle contractions has an impact on the need for ATP which also increases.

ATP can be produced from glucose metabolism both aerobically and anaerobically, where to obtain ATP aerobically, glucose and oxygen are needed in the mitochondria. Meanwhile, anaerobic ATP production is obtained from anaerobic glycolysis, the process does not require oxygen and can be carried out outside the mitochondria (Chandel, 2021). The higher the intensity of activity carried out by the body, the greater the need for ATP for muscle contraction so that metabolism increases to meet the high demand for ATP, especially by muscle cells. If metabolism increases, the need for oxygen and glucose will also increase because oxygen and glucose are the materials needed to produce ATP. The high demand for oxygen and glucose needs to be balanced with an adequate supply or transport speed. To increase the speed of oxygen and glucose supply, the heart beats faster (Casey & Joyner, 2012). Therefore, an increase in heart rate can be an indicator of increased metabolism in the body.

The predominant energy system during physical activity depends on the type of activity carried out. The dominant use of the aerobic energy system occurs in light intensity physical activity that requires a longer duration of activity, such as when walking leisurely or swimming frog style. Meanwhile, the use of predominantly anaerobic energy systems occurs in physical activities that require large amounts of energy in a short time, such as lifting weights, push-ups, sit-ups, squats and short distance running (sprints) (McArdle et al., 2009).

The energy released during physical activity can be estimated using the estimation method, namely MET (Metabolic Equivalent of Task). MET can be used to predict energy output when the body is undergoing physical activity. 1 MET is 1 kilocalorie (kcal) of energy used by 1 kilogram of body weight in 1 hour or the equivalent of 3.5 ml O2 per kg of body weight in 1 minute (Mendes de Almeida et al., 2018; Mortazavi et al., 2013) in resting condition. MET is the ratio of the energy expended when carrying out an activity to the energy level expended at rest. MET can be used to provide general limits or guidelines for the intensity of physical activity for a population (Nelson et al., 2007).

Heart rate is a manifestation of the performance and performance of the heart. The heart rate is in line with the pulse, so the pulse can be an indicator of heart rate. So, to find out the heart rate frequency, you can also measure the pulse rate, which is the propagation of the heart rate. Beats are calculated per minute by counting repetitions of beats per minute or beats per minute (bpm). Counting heart rate can be done by palpation or pressing on body parts such as the wrists and lower side of the neck for 1 minute. The heart rate when the body is at rest is called the Resting Heart Rate (RHR). RHR is measured when the body is at rest. The resting heart rate in normal adults is 60-80 beats per minute (Amanuloh et al., 2017; Hermawan et al., 2012).

The maximum frequency of beats that the heart can make is called the maximum heart rate (MHR). MHR can be estimated in several ways. According to Tanaka, MHR = 208 - (0.7 x age) (Tanaka et al., 2001). According to Gulati MHR = 206 - (0.88 x age) for women (Gulati et al., 2010). In general in Indonesia, the formula used to predict MHR is 220 – age (Robergs &

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Landwehr, 2002). When the body is active, the heart rate is between the RHR and MHR frequencies. The position between the RHR and MHR is called the Heart Rate Reserve (HRreserve) (Karvonen & Vuorimaa, 1988). HRreserve is often used to measure exercise intensity by knowing the target heart rate or Target Heart Rate (THR) during physical activity. To find out THR, you can use the carvonen formula, namely THR=((MHR-RHR)x%intensity)+RHR (Putra, 2020).

A person's heart rate varies when resting and doing activities. There are many factors that influence differences in heart rate frequency, such as gender, geopictureic location of residence and intensity of physical activity. The resting heart rate in men is lower than in women because the size of the female heart is smaller than the male heart. So a smaller heart requires a higher and faster beating frequency to pump blood throughout the body. Studies prove that the geopictureic location of residence also influences heart rate, where individuals who live in the highlands have a lower heart rate than individuals who live in the lowlands (Kasenda et al., 2014).

The intensity of physical activity greatly affects heart rate. The intensity level of physical activity is divided into five, namely sedentary, light, moderate, high (vigorous) and very high (Norton et al., 2010). Sedentary is very light activity that usually involves a lot of sitting or lying down and has little additional movement and low energy requirements. Sedentary activity has an equivalent metabolic rate of less than 1.6 MET, so little energy is expended each day. In contrast to the intensity of light activity which is equivalent to a metabolic rate between 1.6 MET to 3 MET. Light activities such as washing dishes, eating, ironing, cooking and walking. Often sedentary individuals are categorized into light intensity physical activity, but the two actually have differences, but further studies are needed to study the differences between these two categories.

Moderate intensity activities include walking for 10 minutes, brisk walking, carrying light loads, cycling regularly, playing tennis regularly and other physical activities that involve constant movement and/or regular light loads for a longer duration. The duration or duration of moderate activity is around 10 to 30 minutes per day. The metabolic rate of moderate intensity activity is estimated to be between 3 and 6 METs.

High activity (vigorous) is physical activity that makes the body breathe more intensely and pant, such as cycling, jogging, tennis matches, soccer matches. Vigorous activity metabolism is 6 to 9 METs. High intensity activity involves strong contractions and/or long contraction duration. Meanwhile, very high intensity activities have an intensity level that reaches at least 90% of the MHR and a metabolic rate of more than 9 METs (Mendes de Almeida et al., 2018). Very high intensity involves very strong contractions, long duration of contractions and/or repetition of intense strong contractions over a short period of time. Very high intensity physical activity is rare in daily life. These very high intensities may be common among elite athletes and military personnel whose training programs can significantly increase VO_2max within 3 months (Putra & Haridito, 2013).

In the world of sports and health, it is believed that individuals who are physically active or exercise diligently have a lower heart rate intensity compared to sedentary individuals. However, there is still little research that discusses the differences in heart rate intensity between sedentary and active individuals, especially when both groups are doing anaerobic physical activity. The aim of this research is to prove the difference between the heart rate of sedentary individuals and active individuals when doing anaerobic physical activity. The heart rate intensity studied in this research is the heart rate intensity when performing anaerobic physical activity in the form of push-ups, sit-ups and squats. It is hoped that the results of this research can be a reference in preparing exercise programs or physical activity models both for the purpose of improving performance and for the purpose of improving the quality of health.

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METHOD

This research is an experimental study using a Pre Test - Post Test design and implementing 3 treatments sequentially. There were 2 groups in this study who were then given the same treatment, namely the group that had a sedentary level of physical activity (sedentary group) and the group that was active in physical activity (active group). The treatment given to both groups was the same, namely anaerobic physical activity in the form of 20 repetitions of push-ups, 20 repetitions of sit-ups and 30 repetitions of squats and was carried out sequentially with rest breaks between treatments. The rest pause is carried out until the heart rate no longer decreases and stabilizes within a maximum range of 5 bpm for 30 seconds, before continuing with the next treatment. The heart rate sensor and monitoring process continues from start to finish, so that the pause time will be recorded and can be calculated, and no part will be missed during the recording period.

The experimental design applied to the two groups was as follows:

RHR measurement → warmup → Push-up → Rest → Sit-up → Rest → squat → Rest
O1 → X1 → O2 → X2 → O3 → X3 → O4

O1: Resting Heart Rate (RHR) Recording
O2: Recording of the highest frequency of Heart Rate after 20 repetitions of push-ups
O3: Recording the highest frequency of Heart Rate after 20 repetitions of sit-ups
O4: Recording of the highest frequency of Heart Rate after 30 repetitions of squats
X1: Treatment 1 – Push-ups 20 reps
X2: Treatment 2 – Sit-ups 20 reps
X3: Treatment 3 – Squats 30 reps

In the first observation (O1) as a Pre-Test, the resting heart rate (RHR) will be recorded. Heart rate frequency was recorded every 10 seconds from the first observation (O1/ pre-test), then the highest achievement was recorded during the second observation (O2/ post-test 1), namely immediately after 20 repetitions of push-ups, the highest achievement was recorded during the third observation (O3 / post-test 2), namely immediately after 20 repetitions of sit-ups and the highest achievement was recorded during the fourth observation (O4 / post-test 3), namely immediately after 30 repetitions of squats.

The instrument used to measure heart rate in this research was a Polar H10 sensor connected to the Polar Beat application on the researcher's smartphone. RHR is recorded first by looking at the lowest heart rate recorded in the polar beat. Next, warm up for 2 minutes. After warming up for 2 minutes, the subjects were asked to do 20 repetitions of push-ups. Next, the subject was asked to rest so that the heart rate fell. The heart rate frequency was recorded based on the highest frequency achieved after doing the push-ups. In the second treatment, subjects were asked to do sit-ups for 20 repetitions. Immediately after completion, the highest achieved heart rate was recorded again and the subject was asked to rest so that the heart rate decreased. In the third treatment, subjects were asked to do 30 repetitions of squat movements, after completion the subjects were asked to rest and the highest achieved heart rate was recorded.

Determining the number of subjects uses the purposive sampling method or taking subjects using predetermined criteria. The number of subjects required for this study was 32 people, consisting of 16 sedentary individuals (sedentary group) and 16 physically active individuals (active group). The active group comes from individuals who regularly carry out physical activities in their daily lives, such as regularly jogging or cycling 2-3 times a week,

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and/or similar activities. The sedentary group comes from individuals whose daily activities are dominated by sitting, lying down, walking slowly, with a load of less than 1.6 MET (Norton et al., 2010).

The criteria for subjects included in this study (inclusion criteria) are men aged 18 to 24 years, do not have cardiovascular diseases such as arrhythmia, coronary heart disease, heart failure, stroke or do not have a history of lung diseases such as bronchitis, asthma, tuberculosis, pneumonia. Do not consume coffee, tea or other substances containing caffeine or epinephrine before the observation is carried out, have a regular sleep pattern before carrying out the test, and are willing to be a research subject as proven by filling out informed consent. Those who are not criteria for this study are women, under 18 or over 24 years old, have cardiovascular disease or are currently receiving treatment for cardiovascular disease, have physical limitations (physical disabilities) or are currently experiencing an injury. The subject's age range will not be a confounder in this study, because heart rate analysis is carried out in percent (%) after being converted using the carvonen formula. Age range will be a confounder if the analysis is carried out in beats per minute (bpm).

The instrument used to monitor heart rate frequency in this study was the Polar H10. Polar H10 can detect the heart's electrical activity at a certain time. To find out your heart rate using the Polar H10, you must pair the H10 sensor with the Polar Beat application on an Android or iOS device via a Bluetooth connection. Polar H10 is widely used in research to monitor heart rate, predict the number of calories expended during activity and is used as a comparison tool for new devices that are almost the same as Polar H10 (Gilgen-Ammann et al., 2019; Müller et al., 2019). So far, the Polar sensor is still a product that is trusted for use in research.

How to use Polar H10 is, first wet the electrode area on the strap, then tie the strap with the Polar H10 sensor attached around the torso at diaphragm level and adjust the strap so that it is not loose or too tight. After that, turn on Bluetooth on the Android or iOS device, then open the Polar Beat application on the Android or iOS device, then go to the application settings section and find the heart rate sensor according to the serial number of the sensor being used. When the sensor is found, tap pair.

The flow of data collection in this research is to fill out a consent form to become a research subject (informed consent), then fill in a form containing name, gender, place, date of birth, age, weight (kg), height (cm) and medical history. After filling in the form, a pre-test was carried out and then given treatment in the form of 20 repetitions of push-ups, 20 repetitions of sit-ups and 30 repetitions of squats. The highest heart rate achieved was recorded immediately after each treatment. Heart rate recording is carried out continuously every 10 seconds from the first observation (O1) to the last observation (O4) so that researchers have a recording of heart rate fluctuations during the treatment & observation process.

The data taken is the heart rate frequency in beats per minute (bpm) then converted into heart rate intensity in percent (%) based on the carvonen formula (Putra, 2020). Data were analyzed descriptively by comparing the actual results of heart rate intensity (%) between the sedentary group and the active group. The data for each treatment is calculated as the average for each group.

RESULT

Table 1. Subject Characteristics

Sedentary Group (Average)		**Active Group (Average)**	
Number of Subjects	16 people	Number of Subjects	16 people
Age	21 years	Age	21 years
Weight	58,5 kg	Weight	59,79 kg
Height	165,31 cm	Height	165,18 cm

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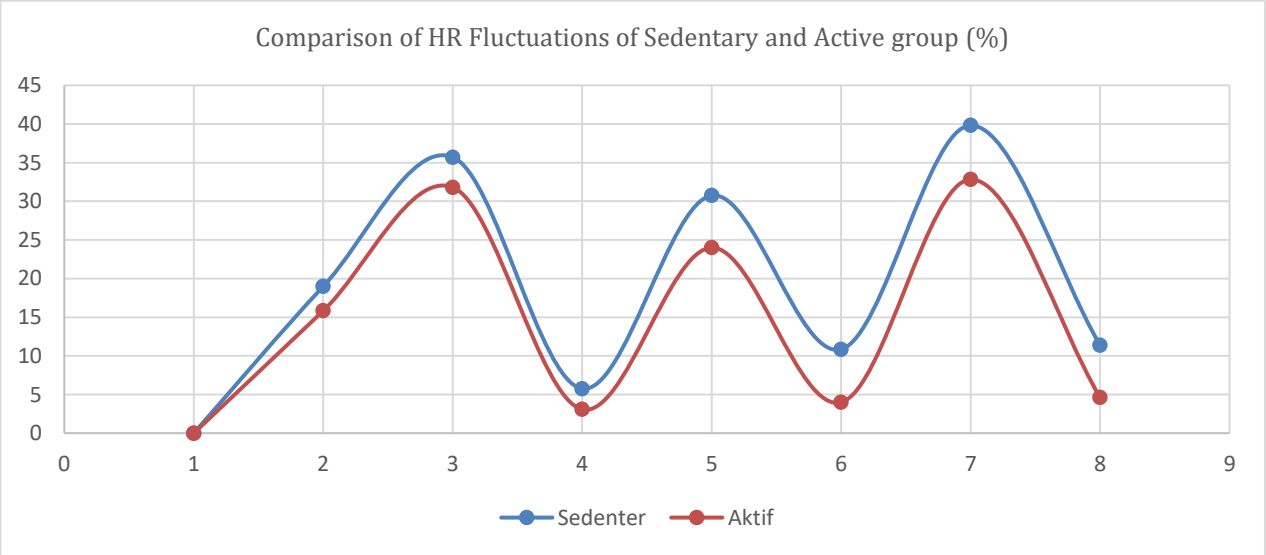
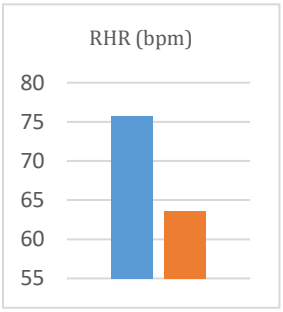
The data in table 1 for the sedentary group and active group each have a sample size of 16 people. The average age of the sedentary group was 21 years, average body weight 58.5 kg, average height 165.31 cm. The active group has an average age of 21 years, average body weight 59.75 kg, average height 165.18 cm.

Table 2. Average results of achievement and increase in heart rate for the sedentary group and active group

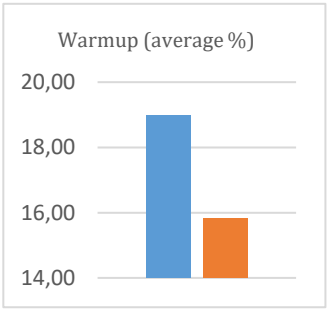
Sedentary Group				Active Group			
Achievements		**Enhancement**		**Achievements**		**Enhancement**	
Warmup	18,99%	Warmup - *Push-Up*	16,72%	Warmup	15,83%	Warmup - *Push-Up*	15,97%
Push-Up	35,71%			*Push-Up*	31,81%		
Rest 1	5,76%	Rest -*Sit-Up*	24,98%	Rest 1	3,08%	Rest -*Sit-Up*	20,92%
Sit-Up	30,74%			*Sit-Up*	24%		
Rest 2	10,85%	Rest 2- *Squat*	28,96%	Rest 2	3,99%	Rest 2- *Squat*	28,83%
Squat	39,81%			*Squat*	32,82%		
Rest 3	11,39%			Istirahat 3	4,63%		



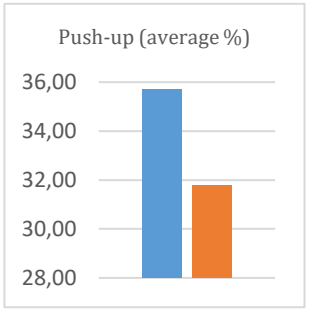
Picture 1. Heart rate achievements between the sedentary group and the active group



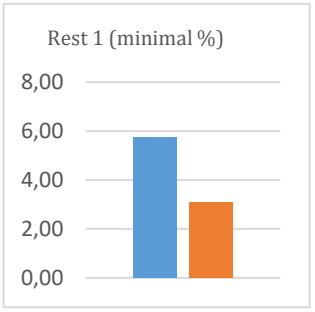
Picture 2. Average resting heart rate



Picture 3. Average heart rate achieved during warm-up



Picture 4. Average heart rate achieved during push-ups



Picture 5. Average decrease in heart rate at rest 1

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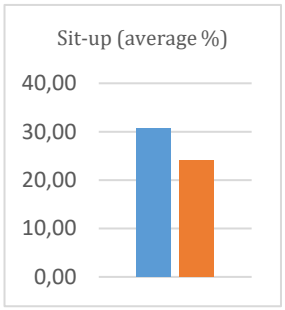
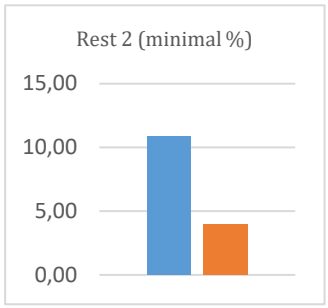
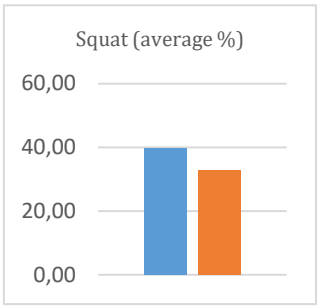


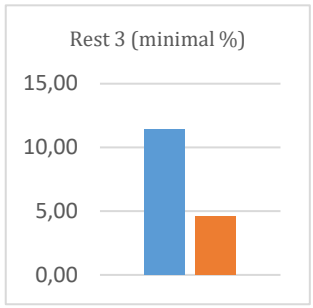
Picture 6. Average heart rate achieved during sit-ups



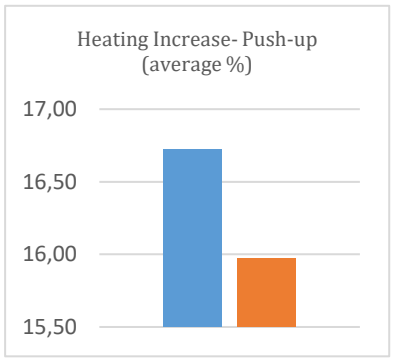
Picture 7. Average decrease in heart rate at rest 2



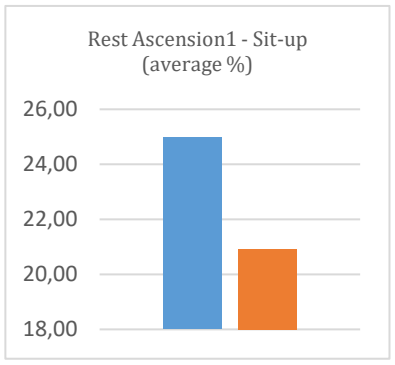
Picture 8. Average heart rate achieved when squatting



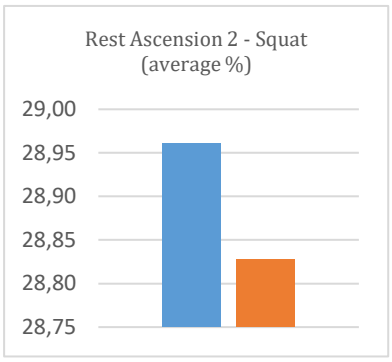
Picture 9. Average decrease in heart rate at rest 3



Picture 10. Average increase in heart rate from warm-up to push-up



Picture 11. Average increase in heart rate from Rest 1 to sit-up



Picture 12. Average increase in heart rate from rest 2 to squat

The data in Table 2 & Picture 1 shows that the sedentary group when warming up reached a heart rate intensity of 18.99%. After doing the push-up activity, the heart rate intensity increased by 16.72% to 35.71%. At the first rest, the heart rate intensity dropped to 5.76%. The next activity was sit-ups which increased heart rate intensity by 24.98% to 30.74%. During the second rest, the heart rate intensity dropped again to 10.85%. Then the last activity was squats with an increase in heart rate intensity of 28.96% to 39.81% and at the third rest the heart rate intensity decreased to 11.39%.

The active group, when warming up, experienced an increase in heart rate intensity of 15.83%. After doing the push-up activity, the increase in heart rate intensity was 15.97% to 31.81%. During the first rest, the heart rate intensity dropped to 3.08%. The next activity was sit-ups which caused an increase in heart rate intensity of 20.92% to 24%. During the second rest, the heart rate intensity dropped again to 3.99%. Then the last activity was squats with an increase in heart rate intensity of 28.83% to 32.82% and at the third rest, heart rate intensity decreased to 4.63%.

In Picture 2, the measurement of resting heart rate frequency in the sedentary and active groups has a difference of 12 bpm. In the sedentary group the average heart rate was 76 bpm, while in the active group it was smaller, namely 64 bpm. During the warm-up (Picture 3) which was carried out for 2 minutes, the average achievement (%) of heart rate intensity in the sedentary group was 18.99%. The active group's average achievement was 15.83% so the difference in intensity achievement was 3.16%.

In Picture 4, the sedentary and active groups did 20 repetitions of push-ups resulting in

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an increase in heart rate intensity. The achievement of heart rate intensity in the sedentary group was 35.71%, while the achievement in the active group was 31.81%. The difference in achievement between the two groups was 3.9%. At the first rest (Picture 5), the heart rate intensity of the sedentary group fell again to 5.76%, while in the active group the heart rate intensity fell to 3.08%. The difference in heart rate intensity between the two groups at rest was 2.68%.

After doing 20 repetitions of sit-ups (Picture 6), the sedentary group's heart rate intensity achievement was 30.74% higher than the active group's average heart rate intensity achievement of 24%. The difference in achievement is 6.74%. During the second break (Picture 7), the sedentary group's heart rate decreased to 10.85%, while the active group's heart rate decreased to 3.99%. The difference in heart rate intensity during the second rest was 6.86%.

In Picture 8, when doing 30 repetitions of squats, the sedentary group's heart rate intensity achievement was 39.81% higher than the active group's average heart rate intensity achievement of 32.82%. The difference in achievement between the two groups was 6.99%. In Picture 9, during the third rest, the heart rate intensity of the sedentary group fell to 11.39%, while in the active group the heart rate intensity fell to 4.63%. The difference in heart rate intensity between the two groups during the third rest was 6.76%.

Picture 10 shows the increase in heart rate intensity from warm-up to push-ups in the sedentary group was 16.72% while in the active group it was 15.97%. The increase difference is 0.75%. Picture 11 shows the increase in heart rate intensity from the first rest to sit-ups. The heart rate intensity in the sedentary group increased by 24.98%, while in the active group it increased by 20.92%. The difference in the increase between the two groups was 4.06%. Picture 12 shows the increase in heart rate intensity from the second rest to the squat. The sedentary group experienced an increase of 28.96%, while the active group increased by 28.83%. The difference in increase in the two groups was 0.13%.

DISCUSSION

The treatments in this study represent each extremity of the body. Extremities are body parts that are extensions of the body. The extremities are divided into 2, namely the upper extremities consisting of the navel to the head, while the lower extremities consist of the navel to the toes (Sherwood, 2015). The treatment given in this study was push-ups representing the upper extremities, sit-ups representing the trunk (core) while squats represented the lower extremities.

The results of the study showed that there were differences in the achievements and increases in heart rate intensity in the sedentary group and the active group. It appears that the sedentary group achieved a higher heart rate intensity compared to the active group in all treatments (push-ups, sit-ups and squats). This answers the general understanding that the heart rate intensity of active individuals is lower than that of sedentary individuals when subjected to physical activity. In fact, active individuals have a lower heart rate intensity when at rest.

The habit of training extremity muscles is thought to cause muscle contractions to work more efficiently, not easily get tired, so it does not cause an increase in heart rate intensity as large as the increase that occurs in sedentary individuals (Pangemanan et al., 2012). This may be because active individuals have better physiological parameters compared to sedentary individuals. For example, active individuals have a larger lung capacity which allows for greater availability of oxygen in the lungs, a larger heart ventricle size which allows for greater cardiac output, and a greater number of red blood cells or hemoglobin available in the blood so that the oxygen transport capacity and greater carbon dioxide elimination as well. However, further studies are needed to prove this. However, in general, the habit of exercising the extremities

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represented by the active individual group shows a difference in heart rate intensity compared to the sedentary group, where the active group who are used to doing extremity activities regularly have a lower heart rate intensity both at rest and during exercise. physical activity. This can be seen from the lower achievement of the active group compared to the sedentary group. So it can be concluded that the habit of exercising extremity muscles in daily life can influence a person's heart rate intensity.

Because sedentary individuals have a higher heart rate intensity when doing activities compared to active individuals, it is recommended that sedentary individuals not undertake high intensity physical activity suddenly or for a long time because their cardiovascular and respiratory systems have not been trained. It is recommended that sedentary individuals do light activity first for several weeks, then increase it to moderate intensity to train the body gradually and minimize any risk of injury and disease.

If someone forces them to do high-intensity activities before their body is trained, they will risk having a negative impact on their heart rate and other organs. If someone who is not trained is forced to do high-intensity activities, their heart rate will increase too high, causing the heart to experience overload, which can result in shortness of breath and increase the risk of heart failure (Hamdani & Hasye, 2019). Apart from that, it is possible to experience fatigue for several days, pain in certain parts of the body and injury. Dizziness, dizziness, nausea and fainting are common symptoms that occur if an untrained person pushes high-intensity activities beyond their capacity. It is best for someone who wants to do physical activity to first understand their physical abilities and physical limitations. To achieve or carry out a certain level of physical activity, regular exercise is also required first.

The limitation of this research is that all the subjects used still came from various regions and various tribes in Indonesia, so genetic factors may have an influence on the research results. Suggestions for future research are that researchers need to consider the ethnic origins of the subjects to create groups that are more homogeneous from a genetic aspect. Anthropometric factors also need to be considered because the mechanical load of the body can influence the strength of muscle contractions which will be related to the amount of ATP consumption, production of lactic acid and carbon dioxide that occurs during treatment.

CONCLUSION

Based on the results of this study, it can be concluded that individuals who are physically active at least 2 to 3 times a week have a lower resting heart rate (RHR) compared to sedentary individuals whose physical activity is dominated by sitting, lying and walking slowly. Active individuals also have a lower heart rate intensity than sedentary individuals when doing anaerobic physical activity. The intensity of the heart rate when resting after doing anaerobic physical activity is also lower for active individuals compared to sedentary individuals.

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