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The effect of isotonic drink on heart rates recovery after pencak silat activity: a study on female students in an islamic boarding school

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Abstract: The aim of this study was to examine the effect of isotonic drinks on students' heart rates. This experimental research relied on a randomized pretest–posttest control group design; it consisted of one control group (t1) and one treatment group (t2). All participants were treated with the same exercise protocol including endurance training specifically for the branches of pencak silat (exercise straight kick techniques, scythe while hitting). The control group consumed mineral water, while the treatment group was provided with an isotonic drink after exercise. Following the treatment phase was the calculation of participants' heart rates for one minute; this process was replicated three times: before the exercise (T1), 60 to 90 minutes after the exercises (T2), and 10 minutes after the exercise interval (T3). All data were analyzed using a T-test. The results revealed that the initial heart rates of the control and treatment groups were 72.6 ± 10.36 and 66.3 ± 8.60, respectively. In other words, there were no differences between the two groups. The initial heart rates of the control group control and treatment group after the exercise was 159.2 ± 10.48 and 149.0 ± 8.59, respectively. According to the t-test results, there was a difference ($p < 0.05$) in the heart rates of the control group and treatment group after the exercises. The initial heart rates of the control group control and treatment group after the exercise interval was 76.2 ± 11.0 and 65.9 ± 8.62, respectively. The t-test results reported a difference ($p < 0.05$) in the heart rates of the control group and treatment group after the exercise interval of 10 minutes. Isotonic drinks significantly to heart rates recovery after pencak silat exercise of female students.
Keywords: *mineral water, heart, exercise, isotonic drink.*

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INTRODUCTION

Chief among the approaches to practicing a healthy lifestyle is making physical exercises habitual. Physical exercises or sports aim to maintain body health, leading to better life expectancy amidst a deteriorating environment in the globalized world. Such a condition has urged many people to spend more time doing physical exercises to stay fit and healthy. People should pay attention to the fact that exercise will increase heart rates due to reduced oxygen consumption. The heart's performance is automatically enhanced during the exercises to maintain the stability of blood flow to supply oxygen and fuel energy to the muscles. From the above discussion, the increase in heart rate is influenced by the heart's performance when exercising.

The number of ventricular contractions per unit of time is represented by heart rate (HR), which varies significantly depending on the level of systemic oxygen demand. Monitoring the resting heart rate (RHR) is an easy, non-invasive clinical technique for determining future health. It is important to research this topic and uncover factors that contribute to high RHR, such as elements of physical fitness that are related to one's health, given the data indicating the adverse health impacts linked to higher RHR in adolescents. Since it is possible to identify modifiable factors in the adolescent population using low-cost, easily administered instruments and to suggest strategies with the aim of preventing health problems associated with high RHR, it is crucial to confirm the relationship between health-related physical fitness components and RHR.(Silva et al., 2018).

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The athlete's heart rate reveals how hard they train in order to reach their peak performance. There are two ways to express cardiac chronotropic. Since heart rate can be easily measured by simply palpating an artery, representing cardiac chronotropic by heart rate (HR) as beats per minute (bpm) has a long history. Nevertheless, HR offers a normalized time estimate (i.e., 60 s)(Draghici & Taylor, 2016). In order to maximize both physical and academic performance, intense physical activities and sports need for unique dietary considerations that are sufficient in delivering sufficient energy intake, and macro & micro-nutrients to meet the energy demands and sustain physical and mental fitness. Micronutrients play a crucial role in maintaining a healthy metabolism and supplying the body with the energy it needs. As a result, they are also crucial for maintaining bone strength, repairing damaged tissue, recovering from traumas, and minimizing oxidative stress. By exercising, the body's stored energy sources, such as fat or carbs, are transformed into energy, water, and carbon dioxide (CO2)(Rupasinghe et al., 2023). The energy generated from the burned calory sources can then be divided into two forms: work and heat. Eighty percent of the total energy produced from the metabolism process is energy referred to as heat, and the rest is work. An example of work can be seen in various body movements during sports such as Pencak Silat, a traditional martial art of Indonesia.

Pencak silat is a combination of several elements of movement that support each other. The elements of motion in the sport of pencak silat contain artistic value, as well as show the beauty of movement. Regular practice is needed to achieve superior performance in pencak silat. Exercise is a process to improve one's physical appearance (Hadiana et al., 2022). At the time of carrying out the exercise, an athlete trains optimally in a certain time, without realizing this causes the muscles to experience fatigue. Fatigue in muscle tissue and blood this will lead to an accumulation of lactic acid. This muscle fatigue will result decrease in the quality of movement of athletes. One sign of muscle fatigue is muscle spasms (cramps), which is caused by the non-smooth process of resynthesis of lactic acid into ATP back in in muscles (Wan et al., 2017). According to the American College of Sports Medicine (ACSM) 2008, physical fitness is the heart, blood vessels, lungs, and muscles' ability to work optimally. Physical fitness is also related to the ability to carry out moderate to heavy physical activities without abnormal fatigue and the lifelong ability to maintain these activities. Physical fitness allows the human body to adjust to physical loads, thus preventing excessive fatigue. In other words, the physical condition is an interconnected series of the components of the body's physic. The basics principles of pencak silat are self defense in which there are values of attack and defense (Iswana & Siswantoyo, 2013). Pencak Silat's physical requirements include stamina, strength, quickness, coordination, and flexibility. (Patah et al., 2021). A person's level of physical fitness is determined by a number of traits they possess or acquire that have to do with their capacity to engage in physical activity. The elements of body composition, cardiorespiratory fitness, muscular strength, muscular endurance, flexibility, agility, balance, coordination, power, response time, and speed are examples of these measurable traits (Farley et al., 2020).

Exercise increases metabolic rate and heat generation, which causes electrolyte and water loss as well as liver and muscle glycogen depletion. Dehydration brought on by the lack of essential nutrients can damage health and physical performance. When replacing fluids with an isotonic solution, many metabolic, cardiovascular, thermoregulatory, and performance disturbances may be lessened or avoided. Sports beverages free of caffeine can support the preservation of physiological balance (Moreno et al., 2013).

Water, a good heat conductor, will remove excess body heat through sweat that carries macro-electrolytes to the body, especially sodium (Na+), potassium (K+), and chloride (Cl-). The balance of water and electrolytes is essential for the function of all body organs, thus maintaining one's health (Parrilla et al., 2019). Water and electrolytes are lost during exercise as a result of thermoregulatory sweating. Sweat losses can be sufficient in some circumstances, particularly when exercise is protracted, intense, and/or taking place in a warm climate, leading to severe water/electrolyte imbalances and affecting performance(Baker, 2017). After 45 minutes of cycling in the exercise practice without any water intake, there was a progressive rise in Na+ concentration that could indicate the patient was dehydrated (Parrilla et al., 2019).

On that ground, it is necessary to consume isotonic drinks to replace lost fluids and electrolytes. As the main cation in extracellular fluid, sodium plays the most critical role in regulating fluid balance. When replacing lost fluids with an isotonic solution, many metabolic, cardiovascular, thermoregulatory, and performance disturbances may be lessened or avoided. Failure of the cardiovascular system is

another risk factor associated with exercise, particularly for professionals who exercise seldom. Systemic metabolic disorders (electrolyte imbalance, hypoxia), hemodynamic or neurophysiological disorders (fluctuations in the activity of the autonomic nervous system), as well as hemodynamic or neurophysiological disorders appear to play an important role in lethal arrhythmias. It is known that reduced cardiac parasympathetic regulation associated with increased sympathetic activation may trigger malignant ventricular arrhythmias. In addition, when exercise is combined with dehydration, the physiological overload put on the body is increased (Moreno et al., 2013).

During rise in cardiac stroke volume and heart rate with exercise rise mean arterial blood pressure by increasing cardiac output and briefly increasing systemic vascular resistance. (Nystoriak & Bhatnagar, 2018). Heart rate is increased by physical effort, hence the harder the effort, the greater the heart rate (Putri, 2019). This is seen from assessments of participants' heart rates following 2 km of jogging; the findings indicate that the heart rate was dramatically altered (Efendi, 2019).

The increase in heart rate is determined by the intensity of the activities performed and the noise level. In noise exposure, the rise in heart ranges from 76.64 x/minute and 86.91 x/minute (Adriyani, 2017). Another factor that affects the heart is the hot temperature in the workplace Exercise with a maximum heart rate affects positive exercise results (Dinata, 2019). Different exercise intensities also affect the increase in heart rate(Elyasa et al., 2019). One example of exercise contributing to heart rates is taichi (Stefanie et al., 2019). The practice of bench step-ups are also significant to the heart rate changes; this is based on heart measurement before and after exercise (Putra & Basyar, 2015). High-intensity exercises affect basal heart rates (Brastangkara & Jatmiko, 2019). In conclusion, heart rates increase during physical activities, e.g., movements or work.

Heart rate can be used to measure the intensity of work and the condition of a person's condition in an area. For example, the heart rates of people living in the lowlands are higher than those in the highlands (Kasenda et al., 2014). It turns out that VO_2Max is correlated with heart recovery (Hutama & Yuliastrid, 2017; Yuniana et al., 2023), signifying that physical fitness correlates with heart rates (Kusuma, 2020). The above discussion proves that physiologically, changes in heart rates are subject to the environment or training intensity. In other words, the heavier the intensity of the activity, the higher the heart rates will be. The rate will lower when resting after doing high-intensity activities. The purpose of this study was to determine the effect of isotonic drinks on the pulse rate of female students after pencak silat exercise.

METHOD

This research was conducted in Moosalamati, an Islamic boarding school for female students in Gorontalo, in September 2022. Isotonic drink and mineral water were the research material. Twenty young female volunteers (13-19 y.o) were investigated. All were active attend pencak silat exercise according questionnaire. Those taking medications that might affect cardiac autonomic activity were not included in the study, nor were drinkers, people with known endocrine, metabolic, or cardiovascular diseases, or anyone who led sedentary, excessively, or too active lifestyles. Throughout the experiment, there were no volunteers who were turned away. Each participant completed a consent form and was made aware of the study's methods and goals.

This experimental research relied on randomized pretest – posttest control group design; it consisted of one control group (t1) and one treatment group (t2). All participant were treated with same exercise protocol includes endurance training specifically for the branches of pencak silat (exercise straight kick techniques, scythe while hitting). Volunteers were allowed to rest in the supine position for 10 min, followed by 90 min of exercise and 60 min of recovery. The control group consumed mineral water, while the treatment group was provided with isotonic drink after exercise. Following the treatment phase was the calculation of participants' heart rates for one minute; this process was replicated three times: before the exercise (T1), 60 to 90 minutes after the exercises (T2), and 10 minutes after the exercise interval (T3). All data were analyzed using a t-test, with a significance of 0.05, to identify the difference between the control and treatment groups.

Volunteers were told to refrain from consuming caffeine 24 hours prior to the procedures, eat a light fruit-based meal two hours prior to the tests, get 7-8 hours of sleep, avoid doing any strenuous physical activity the day of the test, and wear appropriate athletic attire (shorts, shirt, shoes, and socks) for physical activity.

RESULTS AND DISCUSSION

Result

The respondent involved 20 female students of Moosalamati Islamic boarding school (from seventh to twelfth grade); their ages ranged from 13 to 19. Provided in Table 1 below are the respondent characteristic.

Table 1. Characteristics of the Respondents

Respondents' Category	Description	F(n)	%
Age	13	2	10
	14	2	10
	15	6	30
	16	3	15
	17	5	25
	18	1	5
	19	1	5
Total		**20**	**100**
BMI	Underweight	3	15
	Normal	17	85
	Overweight	0	0
	Obese	0	0
Total		**20**	**100**
Daily isotonic consumption	Never	16	80
	1-2 bottle	4	20
Total	3-4 bottle	0	0
		20	**100**
Daily mineral water consumption	Never	0	0
	1-2 glasses	2	10
	3-4 glasses	1	5
	5-6 glasses	13	60
	7-8 glasses	2	10
	>8 glasses	3	15
Total		**20**	**100**

The age disparity is because the respondents were from two different levels of education (junior high and senior high). All respondents were pencak silat athletes participating in pencak silat exercises once to twice a week.

The initial heart rate refers to the respondent's heart before the exercise (Table 2). The t-test results indicated no difference ($p > 0.05$) in the heart rates of the control group and treatment group before the exercises, meaning that both groups had normal heart rates. The heart rate will remain constant to fulfill oxygen supplies during growth. A person's age significantly impacts heart rate; the maximum heart rate in the elder aged 80 years dramatically declined (a 50% decrease from the age of teenagers). This condition is caused by reduced muscle mass and power. The resting heart rate in children aged five years is between 96-100 beats per minute. The rate gradually increases at the age of 10 years (80-90 beats per minute) and in adulthood (60-100 beats per minute) (Sandi, 2013).

Table 2. Initial Heart rates

Treatment	Initial Heart rates Mean ±SD	Max.	Min.
Control group	72.6 ± 10.36	90 beats/minute	61 beats/minute
Isotonic group	66.3 ± 8.60	85 beats/minute	60 beats/minute

During physical exercise, the heart rate is primarily controlled by the balance between inhibition by the vagus nerve and the cardiac sympathetic nerves stimulation. The sympathetic nerve has a more dominant influence than the vagus nerve in resting conditions. If the autonomic nerves to the heart are blocked, the resting heart rate from an average of 70 beats per minute will increase to 100 beats per minute (Guyton, 2012). The results are depicted in the following Table 3.

Table 3. Post-exercise Heart Rate

Treatment	Initial Heart rates Mean ±SD	Max.	Min.
Control group	159.2 ± 10.48	180 beats/minute	144 beats/minute
Isotonic group	149.0 ± 8.59	165 beats/minute	135 beats/minute

There was an increase in the respondent's heart rates after the exercise. The increase in heart rate after exercise in the control and treatment groups was 45.60% and 44.50%, respectively. Acoording (Sebayang et al., 2022), the mean (average) recovery time of the pre-test Heart Rate is 21.80 minutes while the average value of the post-test Heart Rate recovery time is 9.20 minutes with a sig- p value = 0.000 ($p<0.05$). This means that there is a significant decrease in the recovery time of the Heart Rate after administration of isotonic fluids ($p = 0.000 < 0.05$).

Recovery heart rate is the time required to reach a normal heart rate after a person has finished exercising. Measurement of resting heart rates aims to observe the ability to recover after strenuous activity (Hausswirth, 2013). The results are depicted in the following Table 4.

Table 4. Post-interval Exercise Heart rates

Treatment	Initial Heart rates Mean ±SD	Max.	Min.
Control group	76.2 ± 11.0	94 beats/minute	65 beats/minute
Isotonic group	65.9 ± 8.62	84 beats/minute	60 beats/minute

Discussion

Heart rate is one of the most basic and frequently measured human vital signs. Heart rate can be measured using electrocardiography, pulse oximetry or other monitoring methods. However, the simplest and most commonly used method is counting by radial palpation. In principle, the number of pulses measured by radial palpation should correspond to the number of heartbeats measured using electrocardiography. Heart rate is generally expressed as the number of beats per minute (bpm). Thus, if the pulse is measured for one full minute, the number of beats should be identical to the pulse rate. If measurement is performed for 60 s, the resulting number must be multiplied by 4 or 2 to convert it into bpm. Because the pulse rate obtained using the above method is multiple of an integer, pulse-counting for shorter time periods introduces the possibility of an error. Thus, pulse rate accuracy relates to the duration of measurement (Kobayashi, 2013). The normal limits of heart rate on the basis of the results obtained in a population of subjects aged 50 to 80 years. By the addition of 2 SD to the mean heart rate value, found upper normal limits of 93 bpm for resting heart rate in the men and of 95 bpm in the women (Palatini, 2022). Therefore the initial heart rate in this study was includes in normal category for adolescents.

The t-test results reported a difference ($p < 0.05$) in the heart rates of the control and treatment groups after the exercise interval of 10 minutes. The heart rate of the treatment group was lower than that of the control group. Such a finding proves that isotonic drinks impact heart rates after recovery. Physical exercise that is performed aerobically for a long time and continuously will cause an increase in the size of the heart (atrial and ventricular chambers, especially in the left ventricle). Practice preparing is notable to advance gainful variations in the cardiovascular framework which can change as per type, force, and term of activity. Systemic benefits to metabolism control, skeletal muscle, cognitive function, and cardiovascular function are significantly induced by exercise training. The group of changes that are induced in the myocardium is referred to collectively as the "athlete's heart," and it includes increased cardiac mass, the formation of new blood vessels, and a decrease in the amount of collagen (Fernandes et al., 2015)

During recovery, hydrating with an isotonic solution led to significant changes in cardiac autonomic modulation and helped linear HRV indices recover faster (Moreno et al., 2013). Isotonic beverages aid in the replenishment of sweat-lost fluids and electrolytes. Because of their low osmolarity and the presence of electrolytes, isotonic drinks help the body replace lost fluids quickly. Positive and

negative ions make up the electrolytes in isotonic drinks, which are similar to fluids in the body. Isotonic drinks contain electrolytes and water: sugar, citrus extract, sodium citrate, sodium chloride, potassium chloride, potassium lactate, magnesium, carbonate, and citrus flavors. The solution concentration in isotonic is balanced with the blood fluid concentration. Electrolytes improve performance by reducing the risk of dehydration and hypothermia, and sports drinks are designed to balance blood glucose concentration before, during, and after exercise. While the carbohydrates in sports drinks contribute to energy balance, electrolytes improve performance by reducing the risk of dehydration (Suna & Türkay, 2020). These drinks are becoming popular because many manufacturers have claimed them to be better alternatives to mineral water. Therefore, studies on isotonic drinks are essential to solid proof of the advertised drinks' advantages. Such studies are also significant in educating the public and students majoring in sports departments to be smart consumers who are not quickly captivated by marketing claims.

CONCLUSION

The average initial heart rates of the control and treatment groups were 72.6 ± 10.36 and 66.3 ± 8.60, respectively. Such a result indicates no differences between the two groups. After the exercise, the average initial heart rates of the control and treatment group were 159.2 ± 10.48 and 149.0 ± 8.59, respectively. Based on the t-test results, there was a difference ($p < 0.05$) in the heart rates of the control group and treatment group after the exercises. The initial heart rates of the control group control and treatment group after the exercise interval were 76.2 ± 11.0 and 65.9 ± 8.62, respectively. The t-test results reported a difference ($p < 0.05$) in the heart rates of the control and treatment groups after the exercise interval of 10 minutes. Isotonic drinks significantly to heart rates recovery after pencak silat exercise of female student.

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