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# Consume the electrolyte solution 20 minutes before physical exercise reduce systolic blood pressure and pulse rate

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## Abstract

Physical exercise can increase systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (FR), and body temperature (BT) exercise. The increase in the body's vital signs can be overcome by consuming electrolyte solutions before exercise. The purpose of this study was to determine the effect of consuming 500 mL of electrolyte solution orally 20 minutes before exercise. The intensity of exercise is 70% of the maximum pulse rate with a duration of 30 minutes, the effect of which is to decrease the SBP, DBP, PR, and exercise BT. This experimental study used a pre and post test control group design, in which 18 subjects were divided into two groups and given different treatments, namely Klp-1 was given mineral water and Klp-2 was given electrolyte solution with the same volume. Differences in treatment results were analyzed using the T-Independent test at the significance of < 0.05. The difference in mean SBP, DBP, PR, and BT between groups after exercise was p = 0.005, p = 0.320, p = 0.000, and p = 0.100. So giving 500 mL of electrolyte solution 20 minutes before physical exercise can reduce SBP and PR ($p<0.05$) but can't reduce DBP and BT ($p>0.05$). Therefore, it is recommended to consume 500 mL of electrolyte solution 20 minutes before physical exercise.

**Keywords:** Electrolyte solution; Systolic blood pressure; Diastolic blood pressure; Pulse rate

## 1. Introduction

Sport is a planned, structured physical activity that is performed repetitively. The goal of the sport is to improve or maintain physical fitness. Therefore, exercise is an important thing that must be done continuously for a long time.

Exercise has many benefits for the human body, such as making the body fit and stamina is always maintained. In addition, exercise can also burn body fat when done for a long duration [1]. Sports or physical activity has the potential to increase PR if the activity load is increased. This happens because the increased physical activity of the body, the more blood flow to supply nutrients and oxygen to active tissues, so that the heart contracts faster and stronger. This increase also causes an increase in PR [2].

It is also stated that dynamic physical exercise involving large muscles will have an effect on increasing cardiovascular function, namely SBP, DBP, and PR, as well as increasing cardiac output [3]. In addition, every physical exercise the body always produces heat which depends on the intensity and duration of the exercise. The higher the activity, the higher the body weight produced and the longer the duration of the exercise, the higher the body temperature [4].

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Without realizing it, after doing activities for a long time, the body loses a lot of fluids. This fluid loss makes you feel thirsty and if not replaced immediately, will lead to dehydration. Dehydration is a decrease in body fluids due to sweating without being replaced with fluids through drinking in moderation [5]. Excretion of body fluids by means of sweating aims to release body heat due to increased activity. The release of body heat aims to stabilize the body's core temperature. The ultimate goal is to minimize the risk of heat injury [6].

The human body is made up of mostly fluids. Water and electrolytes contained in body fluids are needed for the continued effectiveness of nerves and muscles. Heavy and prolonged physical exercise results in a buildup of lactic acid and an increase in body fluid expenditure through sweat. During physical activity, body fluids are needed to maintain balance and the body's metabolic processes. If fluid intake is lower than expenditure, the body will experience a fluid balance disorder called dehydration. Electrolytes are chemical compounds in solution that dissociate into positively or negatively charged particles. Most of the metabolism requires and is influenced by electrolytes. The major contents of electrolytes in body fluids that are needed by the body are sodium ($Na^+$), potassium ($K^+$), chloride ($Cl^-$), and bicarbonate ($HCO3^-$) [7].

## 2. Material and methods

This research is an experimental study using a pre and post-test control group design. The research was carried out at Ngurah Rai Bali Sports Center in the morning at 07.00-09.00. The number of samples in this study were 18 students who had met the inclusion criteria, namely aged 16-18 years, were willing to participate as research subjects and filled out informed consent. The exclusion criteria were if the participant was sick based on a doctor's examination. Participants will be excluded from the study if they withdraw without a reason. Sample selection and sample allocation were carried out using a simple random sampling technique, so that each group consisted of 9 people.

Physical exercise was carried out for 30 minutes on the control group and the treatment group on different days. Before starting the exercise, blood pressure, pulse frequency, and body temperature were measured before treatment, and after that warm-up was done. Body weight and height were also measured to determine body mass index before treatment. The control group was given 500 mL of mineral water and the treatment group was given the same amount of electrolyte fluid, 20 minutes before the start of the exercise. Immediately after the exercise is complete, blood pressure, pulse frequency, and body temperature will be measured again. After that, the body mass index was measured again after treatment.

The data obtained were analyzed using the Saphiro Wilk test to test for normality, the Levene Test to test the homogeneity of the data, and the Independent T-Test to determine the difference in treatment results between groups.

## 3. Results

The research data concerns the characteristics of research subjects, data on the research environment, and research results.

**Table 1** Physical Characteristics of Research Subjects

| Variable | Control Group | | | Treatment Group | | |
|---|---|---|---|---|---|---|
| | **Minimum** | **Maximum** | **Mean** | **Minimum** | **Maximum** | **Mean** |
| Age (years) | 17.0 | 18.0 | 17.4 | 17.0 | 17.0 | 17.0 |
| Weight (kg) | 54.1 | 70.3 | 61.6 | 51.2 | 74.0 | 64.9 |
| Height (cm) | 166.0 | 178.0 | 170.2 | 159.0 | 176.0 | 169.8 |
| Body Mass Index ($kg/m^2$) | 18.6 | 23.5 | 21.2 | 18.6 | 24.8 | 22.5 |

The characteristic data of the research results taken before and after treatment are presented as in Table 3. The data measured were systolic blood pressure, diastolic blood pressure, pulse frequency and body temperature.

Before determining the statistical test used, the normality and homogeneity of the data were first tested. The data tested were TDS, TDD, FDN, and BT both before and after treatment (Table 4).

**Table 2** Characteristics of the Research Environment

| Variable | Minimum | Maximum | Mean |
|---|---|---|---|
| Ambient Temperature before Treatment | 28.2 | 28.8 | 28.5 |
| Ambient Temperature after Treatment | 31.0 | 31.4 | 31.2 |
| Relative Humidity before Treatment | 56.0 | 59.0 | 57.5 |
| Relative Humidity after Treatment | 45.0 | 47.0 | 46.0 |

**Table 3** Characteristics of Research Results

| Variable | Control Group | | | Treatment Group | | |
|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Minimum | Maximum | Mean |
| **Before Treatment** | | | | | | |
| SBP (mmHg) | 112.0 | 138.0 | 127.1 | 106.0 | 128.0 | 115.9 |
| DBP (mmHg) | 65.0 | 87.0 | 75.7 | 63.0 | 82.0 | 74.6 |
| PR (beats/minute) | 73.0 | 97.0 | 82.7 | 63.0 | 76.0 | 70.4 |
| BT ($^oC$) | 36.5 | 37.5 | 36.9 | 36.3 | 37.1 | 36.6 |
| **After Treatment** | | | | | | |
| SBP (mmHg) | 134.0 | 158.0 | 145.2 | 130.0 | 142.0 | 135.6 |
| DBP (mmHg) | 88.0 | 99.0 | 93.4 | 85.0 | 96.0 | 89.4 |
| PR (beats/minute) | 110.0 | 134.0 | 121.8 | 96.0 | 105.0 | 100.4 |
| BT ($^oC$) | 37.1 | 37.8 | 37.4 | 36.5 | 37.6 | 36.9 |

Information: SBP = systolic blood pressure, DBP = diastolic blood pressure, PR = pulse rate, BT = body temperature

**Table 4** Normality and Data Homogeneity Test Results

| Variable | p-Value Normality (Saphiro Wilk) | | p-Value Homogeneity (Levene Test) |
|---|---|---|---|
| | Control Group | Treatment Group | |
| SBP before Treatment | 0.510 | 0.483 | 0.621 |
| SBP after Treatment | 0.888 | 0.992 | 0.123 |
| DBP before Treatment | 0.612 | 0.215 | 0.819 |
| DBP after Treatment | 0.731 | 0.172 | 0.378 |
| PR before Treatment | 0.405 | 0.685 | 0.092 |
| PR after Treatment | 0.908 | 0.555 | 0.052 |
| BT before Treatment | 0.828 | 0.231 | 0.649 |
| BT after Treatment | 0.477 | 0.634 | 0.178 |

Information: SBP = systolic blood pressure, DBP = diastolic blood pressure, PR = pulse rate, BT = body temperature

SBP, DBP, PR, and BT before and after treatment were normally distributed (P>0.05). The data variance between groups both before and after treatment was homogeneous (P > 0.05). Because the variable data being compared were normally

distributed and homogeneous, the mean difference in the data after treatment was analyzed using the Independent T-Test.

Because the data before treatment between groups was homogeneous, it can be stated that the initial state of the data came from the same source, so that the difference in SBP, DBP, PR, and BT after treatment was due to differences in the treatment given. To determine the effect of treatment on SBP, DBP, PR, and BT after treatment, it is presented in Table 5.

**Table 5** Results of the Mean Difference between Groups After Treatment

| Variable | Mean of Control Group | Mean of Treatment Group | Mean Difference | p-Value |
|---|---|---|---|---|
| SBP | 145.2 | 135.6 | 9.6 | 0.005 |
| DBP | 93.4 | 89.4 | 4.0 | 0.320 |
| PR | 121.8 | 100.4 | 21.4 | 0.000 |
| BT | 37.4 | 36.9 | 0.5 | 0.100 |

Information: SBP = systolic blood pressure, DBP = diastolic blood pressure, PR = pulse rate, BT = body temperature

The difference in mean SBP and PR between groups after treatment was significantly different with a value of $p<0.05$, while the mean difference between DBP and BT after treatment was not significantly different with a value of $p>0.05$.

## 4. Discussion

Table 1 shows that the mean age in the two groups is almost the same age, which is between 17-18 years. This is in accordance with the age of high school students, which ranges from 16-18 years. The effect of age on resting pulse rate can be seen from the resting pulse rate in adults as much as 60-90 beats per minute [8]. The results of previous research on 33 students of SMKN-5 Denpasar, it was found that there was a significant relationship between age and resting pulse rate with $p = 0.007$ ($p <0.05$) [9].

Body weight and height are used to determine body mass index. Based on the characteristics of body mass index, it shows that the minimum value in the control group is 18.6 kg/m$^2$ and the treatment group is 18.6 kg/m$^2$. The maximum value in the control group was 23.5 kg/m$^2$ and the treatment group was 24.8 kg/m$^2$. The mean in the control group was 21.2 kg/m$^2$ and the treatment group was 22.5 kg/m$^2$. Judging from the subject's body mass index, this value is within the normal limits of WHO standards [10]. So based on the body mass index, the nutritional status of the subject was within normal limits, thus the subject was not overweight or obese.

Table 2 shows that the environmental characteristics of the control group and the treatment group consisted of ambient temperature and relative humidity of the air. The minimum value of the ambient temperature of the two groups before treatment was 28.2$^o$C and the maximum was 28.8$^o$C, while the mean value was 28.5$^o$C. The minimum value of the environmental temperature of the two groups after treatment was 31.0$^o$C and the maximum value was 31.4$^o$C, while the mean value was 31.2$^o$C. The relative humidity of the air before treatment showed that the minimum value for both groups was 56.0% and the maximum value was 59.0%, while the average was 57.5%. The minimum value for both groups after treatment was 45.0% and the maximum value was 47.0%, while the mean value was 46.0%. The results of previous studies showed that 40% relative humidity is better than 50% and 60% humidity because it can inhibit the increase in pulse rate, body temperature and exercise blood lactic acid [11]. This value indicates that the relative humidity is within normal limits. So that the subject can perform physical activity comfortably. The WBGT Index (Wet Bulb Globe Temperature Index) is used to assess the level of environmental comfort that combines the impact of solar radiation, ambient temperature, humidity and wind speed. In various sports the WBGT index is recommended to reach 25$^o$C, and exercise is considered unsafe if the WBGT index reaches more than 28$^o$C for those who are not trained or have not acclimatized. This value is in the normal to high limit [12].

According to Table 3, the mean SBP before treatment in the control group was 127.1 mmHg and the treatment group was 115.9 mmHg. The mean DBP of the control group was 75.7 mmHg and the treatment group was 74.6 mmHg. The normal state of resting SBP is in the range of 110.0-120.0 mmHg while DBP is between 70.0-80.0 mmHg. So that the SBP of subjects in the control group slightly increased and the treatment group was within normal limits, while the SBP of subjects in the control group and the treatment group was within normal limits.

The mean PR of the control group was 82.7 beats/minute and the treatment group was 70.4 beats/minute. So that the resting pulse frequency of the research subjects was within normal limits. The effect of age on the resting pulse rate can be seen from the resting pulse rate in adults as much as 60-80 beats/minute. This statement is in accordance with the results of research on 33 students of SMKN-5 Denpasar, it was found that there was a significant relationship between age and resting pulse frequency with $p = 0.007$ ($p < 0.05$) [9].

The mean ST in the control group was 36.9$^{o}$C and the treatment group was 36.6oC. Normal body temperature is in the range of 36.3$^{o}$C-37.1$^{o}$C. So that the ST research subjects are in normal limits.

The mean SBP after treatment in the control group was 145.2 mmHg and the treatment group was 135.6 mmHg. Systolic blood pressure at rest 120 mmHg will increase to 140-250 mmHg during maximum intensity exercise. This is possible because most of the skeletal muscles contract which forces the blood vessels. The increased pressure only lasts a few minutes, and the pressure will slowly return to normal. This increase was also followed by DBP, but the increase was not too high [4]. So that the increase in SBP after treatment of the subject was within normal limits.

The mean PR after treatment in the control group was 121.8 beats/minute and the treatment group was 100.4 beats/minute. Exercise PR will increase up to 185 beats / min, where the increase reaches 270% which will increase cardiac output [13]. The increase in exercise PR in research subjects is within normal limits. It is also stated that physical activity causes acute changes in respiratory rate and PR [14].

The mean ST after treatment in the control group was 37.4oC and the treatment group was 36.9oC. During physical activity, ST will increase up to 40oC [13]. So that the increase in ST in this research subject is still within normal limits.

Table 5 shows that there was a significant difference in SBP and PR exercise between the control group compared to the treatment group, where SBP and PR exercise in the control group were higher than the treatment group. This difference was caused by differences in the treatment given, namely before the treatment the control group was only given drinking water while the control group was given drinking electrolyte fluids.

Drinking water is recommended for someone who is active for a relatively short period of time (<75 minutes), but electrolyte drinks containing carbohydrates are highly recommended and are the average choice for athletes [15]. The research subjects were given 500 ml of electrolyte fluid in the form of Pocari Sweat with a total fat content of 0 g, cholesterol 0 g, sodium 125 mg, total carbohydrates 15 g, and protein 0 g. Administration of electrolyte-carbohydrate fluids can reduce the level of dehydration and reduce the effect of fluid loss on cardiovascular function [16].

The purpose of providing electrolyte-carbohydrate fluids is to stimulate the rate of fluid absorption, supply of carbohydrates and other nutrients as a substrate for physical activity, increase rehydration, decrease physiological stress and recovery after exercise. Maintaining fluid levels of carbohydrates is very important, 1% of fluid is lost from sweat which will eventually result in decreased exercise performance. According to the research results of Hornsby [17], electrolyte-carbohydrate drinks can reduce pulse frequency, systolic blood pressure and diastolic blood pressure.

Water is an essential ingredient in every life, which is the main key to survival, namely by preventing dehydration. Without water humans can only survive for a few days. When dehydration occurs, water is a temporary way to replace the lost fluids. Subsequent replacement is with electrolyte fluids for moderate to severe dehydration [18].

So, because the drinks consumed by the subjects in the treatment group were electrolyte fluids with a total fat content of 0 g, cholesterol 0 g, sodium 125 mg, total carbohydrates 15 g, protein 0 g, the electrolyte fluid used in this study could reduce SBP and PR. according to the results of previous research.

## 5. Conclusion

Consuming 500 mL of electrolyte solution 20 minutes before exercise with an intensity of 70% maximum pulse rate can reduce exercise SBP by 6.6% and exercise PR by 17.6% ($p<0.05$). Besides that, it can also reduce DBP by 4.3% and exercise BT by 1.3%, but the decrease is not significantly different ($p>0.05$). Consuming 500 mL of electrolyte solution before physical exercise can't significantly reduce diastolic blood pressure and exercise body temperature, therefore it is necessary to re-examine why it occurs.

## Compliance with ethical standards

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For the sake of the smooth running of the publication, we as the authors agree to provide flexibility to the correspondent writers as the main authors to arrange the writing format and regulate the publishing costs in accordance with the publisher's provisions.

*Statement of informed consent.*

No informed consent.

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