

## THE PHYSIOLOGICAL EFFECTS OF WATER vs. GATORADE DURING PROLONGED EXERCISE

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### ABSTRACT

Danielson , A.R., Morris, L., Neiderhauser, L., Stanek, K., Wolter, J. The Physiological effects of water vs. Gatorade during prolonged exercise. *J. Undergrad. Kin. Res.* 2006; 1(1):15-22. The purpose of this study was to investigate the physiological effects of water vs. Gatorade during prolonged exercise. Subjects consisted of 10 recreationally active females between the ages 19 and 22. Each participant was asked to perform two 90 minutes exercise sessions of inclined treadmill walking. One session consisted of drinking 32 ounces of Gatorade during exercise and the other drinking 32 ounces of water. There were significant differences ( $p < 0.05$ ) in peak rating of perceived exertion (RPE) and weight change. The data suggests that drinking Gatorade during prolonged treadmill walking under heat stress elicits lower RPE values than drinking water, (Gatorade mean peak RPE = 4.0, water mean peak RPE = 4.9)  $p = .010$ . In addition, weight change also shows a significant difference (Gatorade mean weight change = .134 kg, Water mean weight change = -.363 kg)  $p = .018$ . The findings in our study are important to exercise physiology as it suggests lower physiological stress when consuming water vs. Gatorade during prolonged activity.

**Key Words:** Hydration, Dehydration, Heat, Fluid Replacement, Gatorade, endurance performance, body temperature, collegian athletes, fatigue.

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### INTRODUCTION

The result of prolonged physical activity in warm temperatures can severely affect water loss and dehydration in any individual. By definition, dehydration is the excessive loss of water from the body or from an organ, or from fluid deprivation or prolonged exercise in hot and or humid environments. According to Gatorade Sports Science Institute, “fluid losses of as little as two percent of body weight can impair performance by increasing fatigue(1).” Benefits to fluid ingestion during prolonged exercise include reduced hyperthermia and reduced cardiovascular stress, which in themselves improve performance. Carbohydrate ingestion during exercise lasting longer than one hour maintains sufficient concentration of blood glucose and sustains a high rate of energy production (2). In our study, performance will be defined by means of extended sub maximal treadmill exercise during heat stress. This necessitates the need for fluid replacement because dehydration is a risk factor for reduced performance and heat stress. Studies including (*Military Medicine, American Physiological Study and Nutrition*

*Reviews,*) have demonstrated the importance of proper hydration before, during, and after exercise to compensate for sweat loss.

Both the ACSM and NATA recommend fluid replacement before, during, and after exercise(3). These organizations recommend drinking 17 to 20 fluid ounces two to three hours before competition followed by an additional 7 to 10 fluid ounces twenty to thirty minutes prior to competition (4). The inclusion of sodium and carbohydrates in sports drinks for events lasting longer than one hour to aid athletes in staying hydrated is also recommended to help maintain optimal endurance performance (5). Another study, conducted at the Defense Medical and Environmental Research Institute in the Republic of Singapore showed that during three hours of intermittent loaded treadmill walking under heat stress, carbohydrate fluid elevated blood glucose, reduced perceived exertion, and increased task completion (6). In addition to carbohydrate beverages, water has also shown significance regarding hydration before, during and after exercise. A study conducted in the Human Performance Laboratory at the University of Austin Texas suggests that water ingestion during prolonged exercise improves endurance performance by preventing progressive increases in heart rate, core temperature, perceived effort and progressive declines in blood volume, stroke volume, and cardiac output (7).

Through critiques of relevant literature, the consideration of sports drinks versus water raises a question. The purpose of this study is to investigate the physiological effects of water versus gatorade during prolonged sub maximal treadmill exercise. We hypothesize that there will be no difference on the physiological effects of consuming water vs. gatorade during prolonged exercise.

## **METHODS**

### ***Subjects***

Participants were chosen based upon several factors; physical activity level, age, and gender. Ten recreationally active females between the ages of 19-22 volunteered to take part in this study. The subject demographics are presented in Table 1. These ten participants were a convenience sample based upon their interest and collegiate involvement in recreational activities. Each female involved had given their informed consent to participate in the research of this study. This study was approved by the University of Human Subjects Institutional Review Board. Prior to the experiment, participants were asked to fill out questionnaire regarding health history.

|                    | Mean Weight<br>(Kg) | Mean Height<br>(Cm) | Mean Age<br>(Yrs) | Resting Heart Rate<br>(BPM) |
|--------------------|---------------------|---------------------|-------------------|-----------------------------|
| Mean               | 68.0                | 171.97              | 21.10             | 68.50                       |
| Standard Deviation | 10.14780            | 9.11715             | .99443            | 11.80361                    |

Table 1. Demographics

### ***Instrumentation***

Baseline, exercise, and post exercise measurements were taken using a scale (Detecto balance beam scale), stadimeter (Seca stadimeter), bioelectrical impedance analysis (Tanita body composition analyzer), blood pressure cuff and gauge sphygmomanometer

(American Diagnostic Corporation, 1993), heart rate monitors (Monark and Polar heart rate monitors), and a 1-10 rate of perceived exertion scale. Subjects performed the exercise portion on treadmills (Woodway DESMO-S-LED-120V, Trackmaster Full Vision TMX-425-CP, Trackmaster Silver Series 215 AC) in a controlled exercise physiology lab. To conserve body heat and elicit perspiration, each subject wore a cotton t-shirt, hooded sweatshirt, and sweatpants. The same type of clothing was worn for both trials. To determine exercise intensities, the Karvonen formula was used to find target heart rates.

$$\begin{aligned} \text{Target HR} &= [(\text{Max HR} - \text{Resting HR}) * \text{Exercise intensity}\%] + \text{RHR} \\ \text{Maximum HR} &= 220 - \text{age} \end{aligned}$$

### ***Procedure***

Prior to attendance, each subject was asked to eat a balanced meal with an adequate amount of calories and to come normally hydrated. Baseline measurements were taken for each subject including resting heart rate, resting blood pressure, height, weight, and body composition using a BIA scale. Target heart rates were determined using the *Karvonen* formula. Each participant walked with exercise intensity between 40 and 50 percent of heart rate reserve. Termination of the test was set at 85 percent of heart rate reserve.

The treadmill walk began at an incline grade of 5 percent and speed was adjusted to reach target heart rate range. Each subject completed two separate, 90-minute treadmill, walking bouts. One session was dedicated to water consumption and while the other was dedicated to Gatorade consumption using a randomized order. Throughout the 90-minute bout, 32 fluid ounces of Gatorade or water were consumed. Exercise heart rate, blood pressure, and RPE was taken every 15 minutes during the treadmill walking. Body mass and BIA were the post-exercise measurements recorded to determine fluid gained or lost from pre to post exercise.

### ***Statistical Analyses***

Using a paired t-test, our study compared the physiological differences between consumption of Gatorade and water that were elicited during a 90-minute exercise bout. The data utilized in this comparison was heart rate, blood pressure, body composition, rate of perceived exertion, and body mass. Our statistical significance was set at  $p < .05$ .

**Independent Variable:** The independent variable for this research study was water or Gatorade consumption

**Dependent Variables:** The dependent variable for this research study was the physiological effects during and after performance. These effects include the following:

- Change in body mass
- Change in blood pressure
- Heart rate drift
- Changes in BIA measurements
- RPE changes

## **RESULTS**

We found there to be a significant difference ( $p < 0.05$ ) in the Gatorade-consuming group's peak rate of perceived exertion (4) and the water-consuming group's (4.9),  $t(9) =$

3.250,  $p=0.01$  (Figure 1). From pre- to post-exercise, there was a significant difference ( $p<0.05$ ) in the Gatorade-consuming group's weight change (.1340 kg) and the water-consuming group's (-.3630 kg),  $t(9) = -2.898$ ,  $p= 0.018$  (Figure 2). The figures below demonstrate the significant findings. From pre- to post-exercise, there was no significant difference ( $p>0.05$ ) between the Gatorade-consuming group's heart rate change (2.4 bpm) and the water-consuming group's (5.5 bpm),  $t(9) = 1.358$ ,  $p=.207$  (Figure 3). There was no significant difference ( $p>0.05$ ) in the Gatorade-consuming group's systolic blood pressure change (5.2 mmHg) from pre- to post-exercise and the water-consuming group's (2.6 mmHg),  $t(9) = -.517$ ,  $p=.618$ . There was no significant difference ( $p>0.05$ ) between the Gatorade-consuming group's change in body composition using the bioelectrical analysis method (.07%) from pre- to post-exercise and the water-consuming group's (-1.42%),  $t(9) = -1.633$ ,  $p=.137$ .

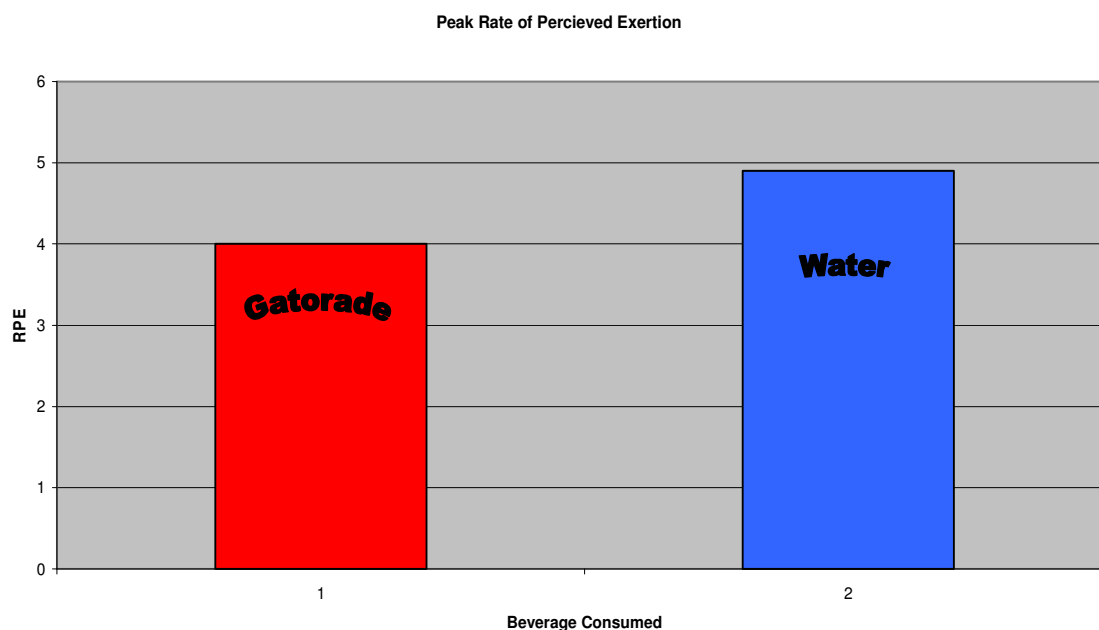


Figure 1. Peak Rate of Perceived Exertion-Gatorade vs. Water Group

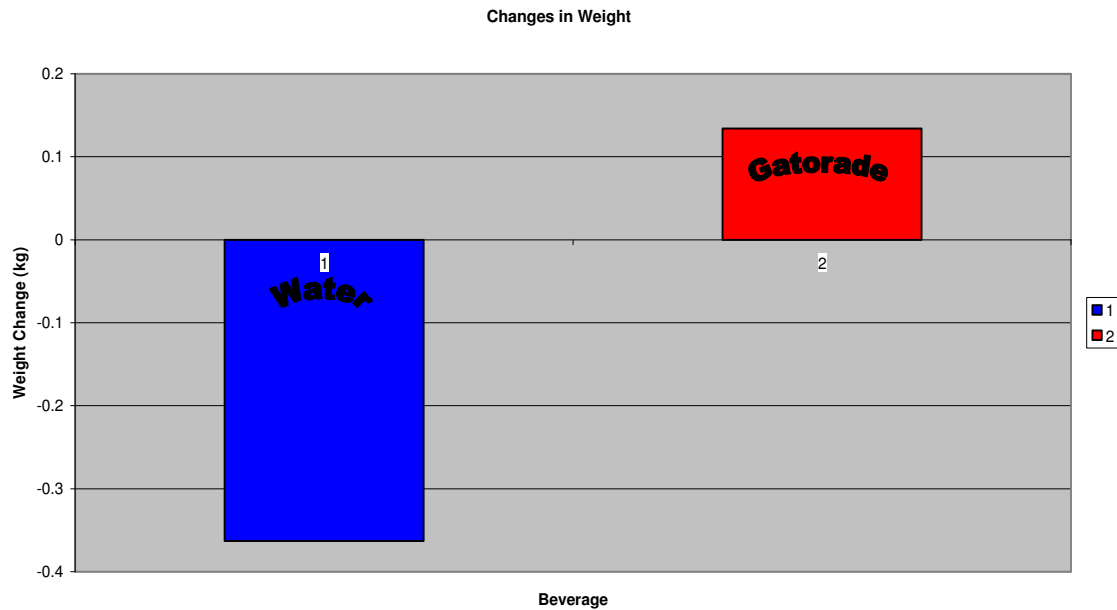


Figure 2. Weight changes- Gatorade vs. Water Group

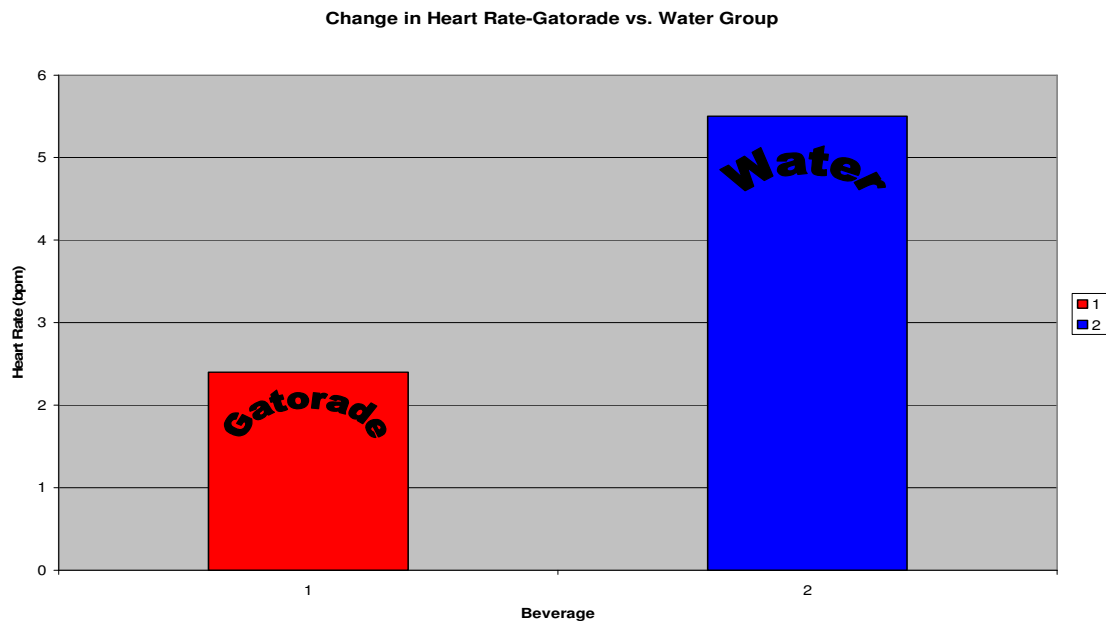


Figure 3. Change in Heart Rate- Gatorade vs. Water Group

## DISCUSSION

The results of our study lead us to reject the research hypothesis. There *were* significant differences on the physiological effects of consuming water vs. Gatorade during

prolonged exercise in the areas of peak RPE and weight change. The results of our study show no significant differences in blood pressure, body composition (using BIA), and heart rate. Although there was no statistical significance in heart rate, we recognize practical significance. By this we mean the p value was significantly greater than 0.05, however it was small enough to exhibit practical significance. Gatorade consumption elicited lower peak RPE values than water consumption. When comparing our results to similar studies, we have found contrasting results. One research study failed to find any significant differences in heart rate or RPE (8). The results of our study show significant differences in RPE and body mass changes regarding water and Gatorade consumption during exercise.

### ***Limitations***

A major limitation of our study is that we did not have a control group for comparison. Another limitation involved our subjects. Our sample size consisted of only 10 subjects who were all the same gender (female). In addition to our population size, the age of our subjects was narrow (19-22), due to our convenience sampling. Another limitation of our study involved our access to technology. In similar studies, instrumentation used included vapor pressure osmometers and Flame Photometers to test osmolarity and electrolyte concentrations in urine samples (8). Having technology such as this would have allowed us to research more physiological effects, therefore making a more accurate prediction within our results.

### ***Interpretation of Findings***

Our study has exhibited lower RPE values and positive weight changes for Gatorade consumers. These RPE values may be due to many factors such as taste of the beverage and electrolyte and carbohydrate concentration. Similar studies have identified sports drinks such as Gatorade to be more appropriate for exercise as it produces more muscle glycogen for greater endurance (9). Also, sodium (Na<sup>+</sup>) plays a role in muscle contraction and the conduction of nerve impulses. Deficiency of Na<sup>+</sup> may impair performance, by causing nausea, headache, appetite loss, and muscular weakness and cramping (9). The increase of body mass during Gatorade consumption may be related to the Na<sup>+</sup> concentration which promotes water retention.

### ***Applications for Findings***

The findings of this study could be applied towards any individual who needs to stay hydrated during any form of moderately intense, prolonged exercise. These results are especially applicable to individuals involved in uphill walking in high temperature environments.

### ***Recommendations***

Our study has demonstrated that Gatorade is slightly better than water at hydrating during a prolonged uphill walking bout. Our findings regarding the variables of RPE and weight change demonstrate this. With this in mind, our recommendation is to consume Gatorade during prolonged exercise. We recognize that water is also beneficial to hydration status during prolonged exercise, as many previous studies have demonstrated this. A study conducted in the Human Performance Laboratory at the University of Austin Texas

suggests that water ingestion during prolonged exercise improves endurance performance by preventing progressive increases in heart rate, core temperature, perceived effort and progressive declines in blood volume, stroke volume, and cardiac output (7). Water consumption during exercise is not discouraged, as the differences between water and Gatorade consumption found in our study were relatively minor. To further investigate the physiological effects of water versus Gatorade, we would recommend that more research be done using different modalities and altering environmental temperatures.

## **CONCLUSION**

After conducting our statistical analysis, we have found that Gatorade was slightly more beneficial than water regarding RPE and weight change during prolonged exercise. With this in mind, we recommend hydrating with Gatorade during prolonged exercise bouts. Individuals who would be interested in this finding include anyone who needs to stay hydrated during any form of moderately intense prolonged exercise. This recommendation may be especially relevant to those participating in uphill walking in a heated environment. Groups that this recommendation may be applicable to include any group involved in athletics or recreational activities that involve proper hydration.

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