

## The Influence of Gatorade on Sweat Loss During a High Cardiovascular Activity

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### Abstract:

This experiment was undertaken to determine whether Gatorade induces more sweat loss compared to water consumption during a high cardiovascular activity. I conducted a two week study with 14 participants who participated in a one hour, high cardiovascular activity. Before the workout each participant consumed 20 ounces (oz.) of water and then was weighed. They then worked out for one hour. Then were weighed again and the difference in their weight determines the amount of sweat that was lost. This continued for a 5 day period. For the second week the same procedures were taken, however this time each participant would consume 20 oz. of Gatorade. Results reveal that Gatorade consumption yielded more sweat loss compared to water consumption. On average, 14 participants yielded 1.7 pounds of sweat with Gatorade consumption and 1.2 pounds with water consumption. Due to my results, I would have to accept my hypothesis that Gatorade yields more sweat loss during a high cardiovascular activity compared to water consumption.

### Introduction:

Sweat loss is a great indicator of revealing how hard an individual is working out. Be it for sports or personal health benefits, sweat is often a necessary byproduct of cardiovascular exertion. The downside to sweat loss is a reduction in physical performance (mainly cardio performance) due to the loss of electrolytes (electrolytes help control fluid levels in the body, which maintain normal pH levels and ensure the correct electric potential between nerve cells that enables the transmission of nerve signals) from sweat. During prolonged physical performance, an individual may experience a significant loss of water, sodium, and chloride (Maughan and Shirreffs, 2004).

Fluid in the body is mainly held in two compartments, the extracellular and the intracellular fluids. Extracellular fluid is outside the cells, and intracellular fluid is held inside red blood cells (Duvillard *et al.*, 2004). About 60% of an average person's

body weight comes from extracellular fluid, which is made up of interstitial fluid and blood plasma (Duvillard *et al.*, 2004). The remaining 40% comes from intracellular fluid. During physical training, these levels, individually or collectively, are affected and will diminish physical performance. This also may cause serious injury, medical emergency, and or death (Duvillard *et al.*, 2004). Loss in water is not only due to sweating, but also to breathing, urinating, and defecating. However, most water is lost in sweat. One of the ways to counter the negative affects of sweating is to consume sport drinks that are enriched with electrolytes.

Murray (1996) concludes that even low levels of dehydration can significantly impair cardiovascular and thermoregulatory response, which dampens physical performance. Murray evaluated a great deal of literature concerning sweat loss and fluid replacement and one thing was clear: the consumption of fluids in proportion to sweat

loss will dramatically improve exercise performance, even with exercises lasting only an hour. Sweat loss varies depending on the environment in which a person is physically working out. Even with a light workout in a cool, dry, environment, sweat loss can be 250 mL per hour, whereas in a warm, humid environment, sweat loss can rise to two liters per hour (Murray, 1996).

New guidelines have been established for fluid replacement during physical activities in light that the old guidelines for fluid replacement had nothing to do with the consumption of fluids in proportion to sweat loss. The American College of Sports Medicine published an article in 1996 "Exercise and Fluid Replacement," and the main point regarding fluid replacement during a cardiovascular workout was:

"...athletes should start drinking early and at regular intervals in an attempt to consume fluids at a rate sufficient to replace all the water lost through sweating (i.e., body weight loss), or consume the maximal amount that can be tolerated" (Murray, 1996).

Sometimes athletes are not able to consume fluids at regular intervals, like soccer players for instance. Their fluid needs are usually only met during half time, but it is still in their best interest to consume as much fluid as can comfortably be tolerated in an attempt to replace sweat loss. To reveal the benefits of hydration, Murray refers to an experiment done by Walsh *et al.* (1994). Walsh had subjects cycle up to a peak, which usually took 6-10 minutes to complete with no hydration. The subjects lasted a little over six minutes before becoming fatigued. When they remained hydrated by consuming fluid at regular intervals, they were able to cycle for nearly ten minutes before becoming fatigued (Murray, 1996). This experiment reveals

that there are advantages to the maintenance of physical performance by being properly hydrated.

The data that were collected in a study by Rehrer and Burke (1996) gave an idea of what sports or activities result in the most sweat loss. Data collection came in the form of weight of the participants, before and after physical exertion. Change in body weight determined the amount of fluid loss. Amount of fluid loss was expressed as kilograms per hour and, if time was not recorded, it was expressed as kilogram of body weight lost. What is also accounted for is the loss of weight due to respiration and substrate metabolism, but this should be minimal. With various sports, the majority of the data collected is composed of male participants. Females comprised only a small portion of the data collected. From the data, it is evident that sweat losses vary widely with different sports and physical activity. This is due to differences in intensity, environmental conditions, and the type of sport in general. What resulted in the most loss in sweat was running and basketball during a competition. From the data collected, cycling seems to produce similar sweat loss when compared to soccer and netball (netball is a game not familiar in the United States, but closely resembles basketball). It has also been noted that men sweat as much as women, given the same physical activity. Using the data collected, one could determine how much fluid should be consumed to provide proper hydration (Rehrer and Burke, 1996).

Sports drinks are designed to provide the body with lost electrolytes such as potassium and sodium. There are vast varieties of sports drinks available in today's market, but two of the major brands are Gatorade and PowerAde. The benefits of sports drinks are to restore the bodies of lost nutrients to maintain homeostasis, prevent injuries, and maintain physical performance

(Duvillard *et al.*, 2004). Sports drinks not only provide appropriate amounts of electrolytes, but also provide carbohydrates ( $\text{CH}_2\text{O}$ ) which are essential when working out for longer than an hour (Duvillard *et al.*, 2004). The advantages of consuming beverages with sodium chloride and carbohydrates are enhancing palatability, promoting fluid retention, and possibly preventing hyponatraemia. Hyponatraemia occurs when there is a lack of sodium in the blood caused by excessive sweating during prolonged physical exertion (Murray, 1996). Further consumption of water only dampens the sodium levels in the blood which affects nerve/muscle function, and also blood pressure. It is possible for an individual to die from water poisoning if the sodium levels remain dangerously low. However, it would take a vast amount of perspiration and consumption of water for this to occur (Murray, 1996).

Is there a correlation between sweat loss and the consumption of a sports drink, like Gatorade? If an individual is participating in a strenuous physical activity and is perspiring, he or she is losing water and electrolytes essential to maintaining physical performance. To counter this loss, consumption of sports drinks enriched with carbohydrates, electrolytes and water, should replace that which is lost. Therefore, physical performance should be relatively normal. So if you are able to get more performance out of a sports drink, you should sweat more compared to consuming plain water, which doesn't provide any electrolytes. This means you can keep activity high, working and exerting yourself without being as fatigued with the consumption of plain water. I tested whether consumption of sports drinks yielded more sweat loss when compared to the consumption of plain water during physical activities. I hypothesize that given a high cardiovascular activity, Gatorade

should yield more sweat loss, due to the replenishment of electrolytes essential to the maintenance of physical performance. My reasoning for choosing Gatorade instead of some other sports drink is because Gatorade is the popular beverage consumed by athletes. If you were to watch a basketball game or football, etc. you would notice that Gatorade seems to be everywhere in the sports arena.

## Methods

### Measurements

For the weight measurement, I used an electronic scale at the Tae Kwon Do school. I have personally weighed myself before a workout and after one hour of physical activity I noticed a reduction in weight. The scale read measurements in pounds (lbs) and in 0.5 lb increments. Thus, the data collected was expressed in pounds per hour of exercise. Since sweat is primarily water, one pound of water will equate to one pound lost of sweat. It should also be mentioned that weight loss is not only due to sweat loss, but also to respiration and substrate metabolism (Rehrer and Burke, 1996). Before the one hour workout, participants were required to drink twenty fluid ounces of the given beverage and then weighed. This is done so that their original weight would include the weight gain of the given beverage.

### Sports Drink Selection

I chose Gatorade for my sports drink, because it is enriched with electrolytes. Gatorade is primarily water, but also contains a 6% carbohydrate solution (or 14 grams per 8 ounces) (Gatorade.com, 1998). I obtained six flats of Gatorade at Costco so as to have a sufficient amount for my participants. For the last two weeks of my experiment, participants hydrated with

twenty ounces of Gatorade during the workout session.

### **Hydration**

My participants underwent a one hour of high cardiovascular activity for the first two weeks, hydrating with water. For the remaining two weeks, participants went through the same workout routine, except they consumed Gatorade instead of water for their hydrating needs. Participants were advised to consume a full bottle (twenty fluid ounces) before the start of the one hour workout.

### **Subjects**

All of my participants had been participating in Tae Kwon Do for at least one year or longer and attend class 3-5 days a week, so they are athletic. I have a total of 14 participants ranging from the age of 15 to mid 40's. The majority of my participants were adults. I originally planned to conduct a four week study; however some of my participants were unable to attend certain days, so I conducted an extra week to make up. My objective was to get twenty days of data with each participant; ten days on water and ten days on Gatorade.

### **Room Temperature**

Sweat loss is influenced by the climate temperature, so it is very important to maintain roughly constant temperatures. Cool dry environments yield less sweat loss compared to warm, humid climates (Murray, 1996). I discussed this with my Tae Kwan Do instructor and he agreed to set the thermostat to 70-72 degrees Fahrenheit. This will be very difficult to control, because everyone is exerting a vast amount of heat as they perspire, so there should be a correlation of more sweat loss with the rise in temperature.

### **Experimental Conduct**

Throughout the five week trial, I personally met with each participant to do the following: Meet with participants after they undergo a one hour, high cardiovascular activity. Before they begin the activity, they consumed twenty ounces of the given beverage, removed their clothing and weighed themselves three times to obtain an accurate measurement using a digital scale. The only specific reason for weighing three times was to make sure that the readings were consistent. If you were to step onto the scale and were fidgety, this could yield an inaccurate reading. Participants were in the bathroom alone, and reported their weight to me. Since it is on a voluntary basis, my participants had no reason to lie about their weight. The participants then participated in a one hour cardiovascular activity hydrating with water for one week, and Gatorade for the remaining week trial. After the one hour session was complete, they again removed their clothes and weighed themselves three times. However, they were also notified to remove any residue sweat that may still be on their body, especially in their hair, since hair tends to hold in liquid. I then recorded their weight and compared it to the first recording in order to calculate how much fluid was lost (Rehrer and Burke, 1996). Participants were also instructed not to urinate within the hour session or results would have been affected. So they were informed to handle their personal needs before they were weighed given the hour session. A majority of the one hour activity consisted of a high cardiovascular workout which deals with an extensive amount of kicking and punching for thirty-five minutes. During an average class: the first ten minutes were dedicated to a light warm up consisting of jogging and active stretching. The remaining fifteen minutes of class was a cool down period, which involved light kicking and punching (or forms, which is a

fixed pattern of movements to show technique and form). The workout routine changed with only slight variations on a day to day basis.

**Data Analysis**

I compared how much sweat was lost with the consumption of Gatorade versus water with each participant. To accomplish this, I used Minitab 14 (Minitab Inc, 2005). I compiled individual results of all fourteen participants to see which individuals showed a variance between the two beverages. To do this I use a one way, unstacked ANOVA test. I then compared all participants' sweat loss with water versus Gatorade to see which, as a whole, exhibited more sweat loss. To do this, I conducted a Paired T-Test (Minitab Inc, 2005).

**Results**

Sweat loss was recorded for a two week period during a 1 hour Tae Kwon Do class.

During this period, participants hydrated with 20 ounces of water for one week (5 day period) and 20 ounces of Gatorade for the remaining week. Subjects were instructed to consume the entire twenty ounces before the start of the workout session. Sweat loss was recorded in 0.5 lb increments (scale only read in 0.5 lb increments).

A majority of participants experienced significantly more sweat loss with the consumption of Gatorade ( $t = 4.77$ ;  $d.f. = 69$ ;  $P = 0.0005$ ). Basically, on average, participants yielded 1.7 lbs of sweat with Gatorade hydration, whereas water hydration only yielded 1.2 lbs of sweat (Figure 1).

The data presented in Figure 2 represent individual results of all 14 participants. Out of all 14 participants, 11 showed greater sweat loss with the consumption of Gatorade.

Only subjects 3, 4 and 7 (Figure 3) showed the opposite results, with greater sweat loss while drinking water.

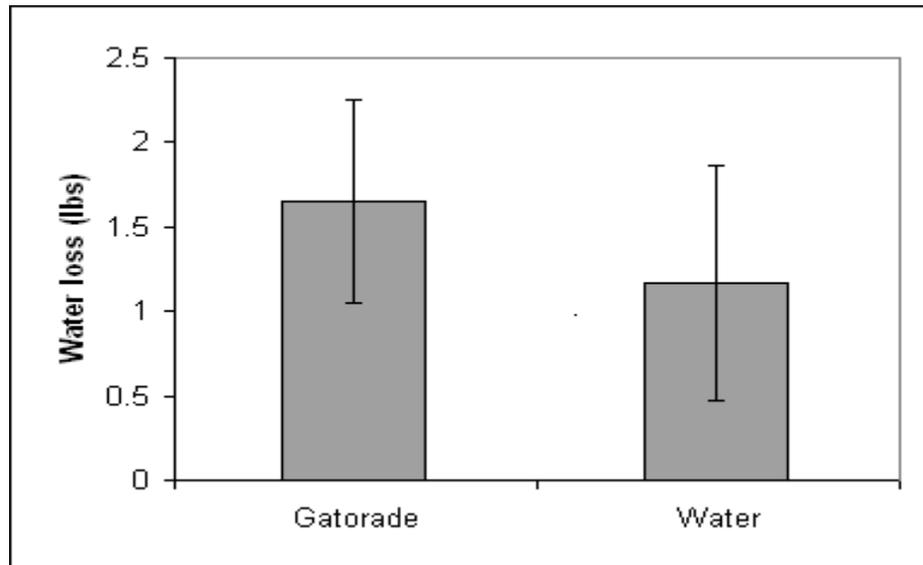


Figure 1. Mean sweat loss compiled from the two week study. Each bar represents 14 participants on the given beverage for a single week. Error bars represent one standard deviation about the mean.

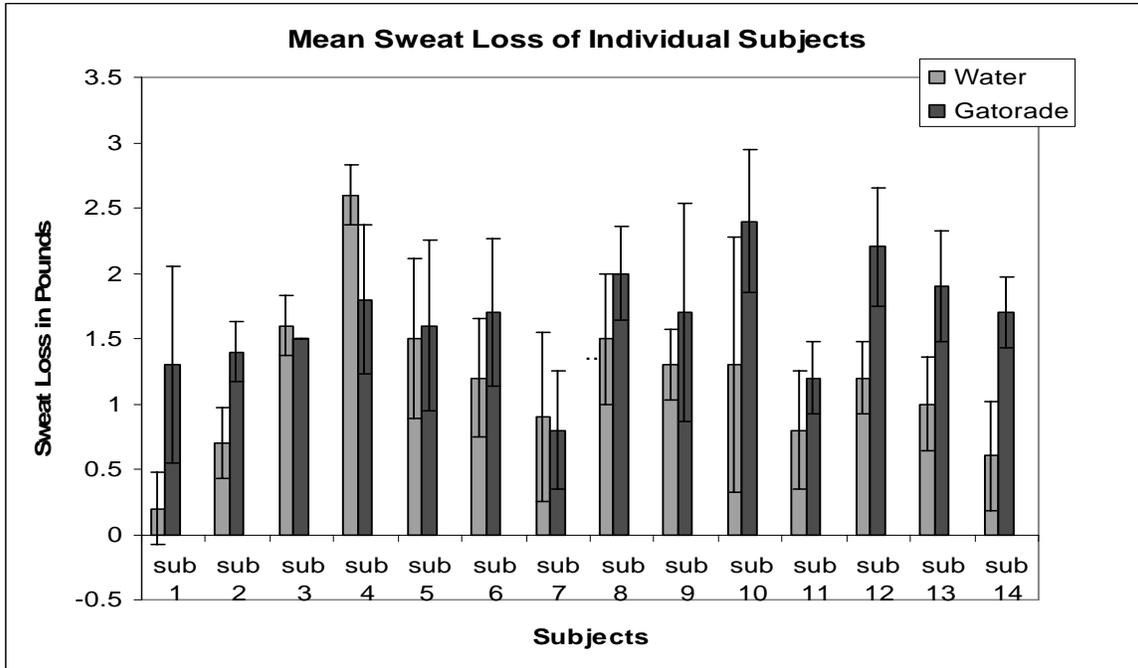


Figure 2. Individual results of all 14 participants revealing their averages for the two week study. The 2 week study consisted of the consumption of Gatorade for a week and water for the remaining week. Each test week consisted of a 5 day period. Each error bar represents one standard deviation about the mean. Subject 3 had no change in standard deviation during the week of Gatorade consumption, so there is no error bar for that subject.

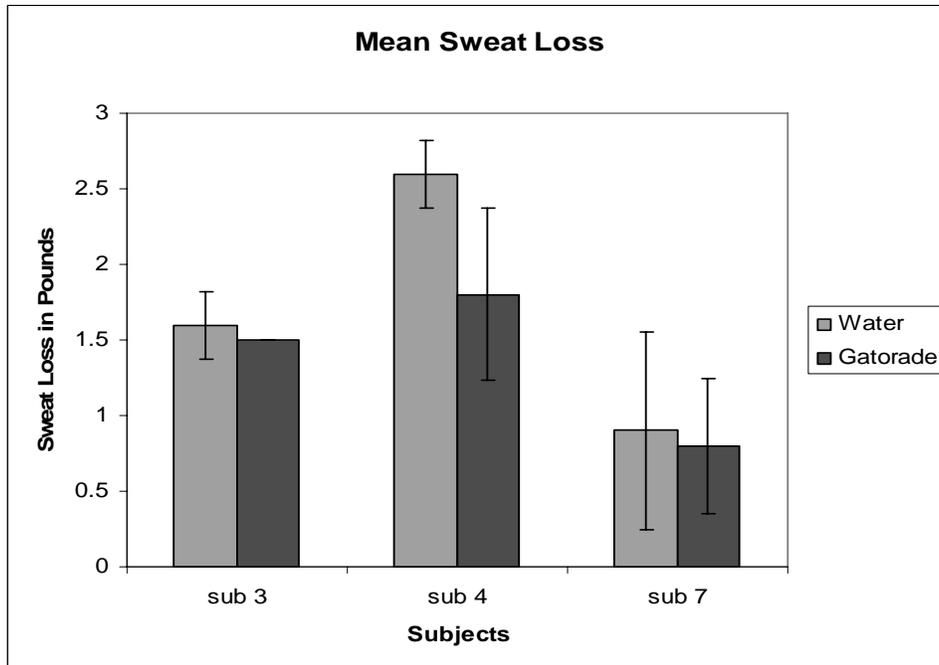


Figure 3. Individual results (Subjects 3, 4, and 7) revealing averages for the two week study. The 2 week study consisted of the consumption of Gatorade for a week and water for the remaining week. Each test week consisted of a 5 day period. Error bars represent one standard deviation about the mean. Subject 3 had no change in standard deviation during the week of Gatorade consumption, so there is no error bar for that subject.

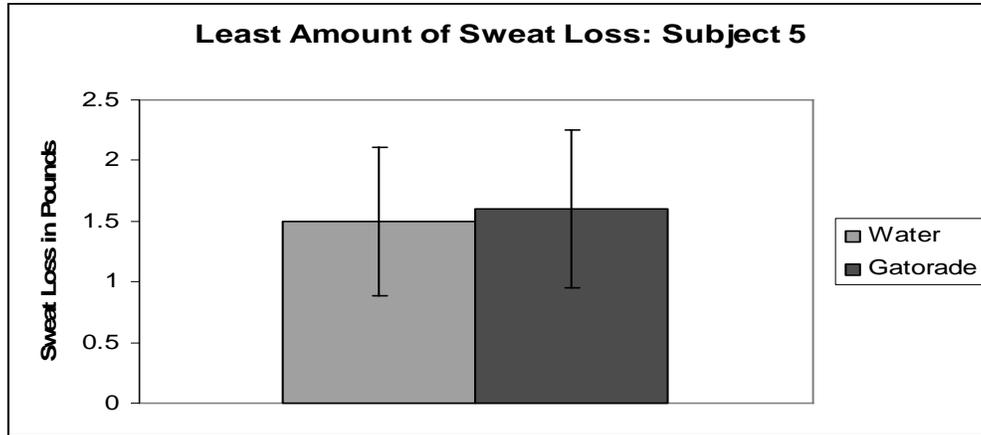


Figure 4. Individual results (subject 5) revealing averages for the two week study. The 2 week study consisted of the consumption of Gatorade for a week and water for the remaining week. Each test week consisted of a 5 day period. Each error bar represents one standard deviation about the mean.

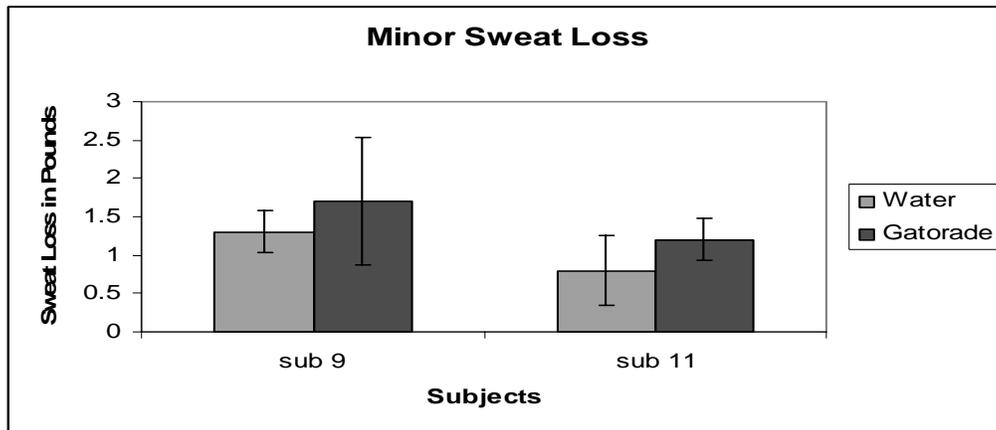


Figure 5. Individual results (9 and 11) revealing averages for the two week study. The 2 week study consisted of the consumption of Gatorade for a week and water for the remaining week. Each test week consisted of a 5 day period. Each error bar represents one standard deviation about the mean.

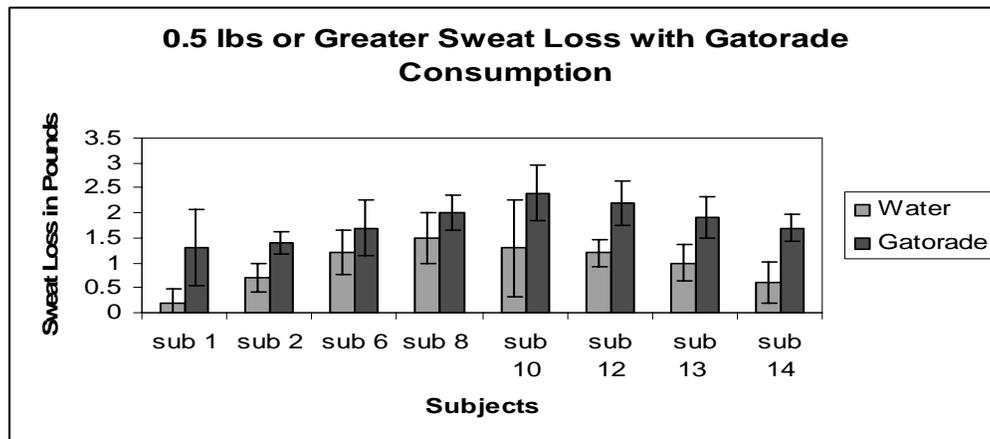


Figure 6. Individual results revealing averages for the two week study. The 2 week study consisted of the consumption of Gatorade for a week and water for the remaining week. Each test week consisted of a 5 day period. Each error bar represents one standard deviation about the mean.

Subject 3 was the only participant to have a steady loss of 1.5 lbs of sweat during the test during the Gatorade test week. So for the week of Gatorade consumption, subject 3 is the only one who ended up with no standard deviation. As for the rest of the subjects, their data reveal that Gatorade had a greater influence on sweat loss compared to water hydration.

Most subjects noticed a considerable difference in sweat loss when hydrating with Gatorade based on their individual weight losses, whereas others, subjects 5 and 9, only experienced minor changes in sweat loss. During the two week trial, subject 5 (Figure 4) revealed the least amount of sweat loss with an average of 1.5 lbs with water hydration compared to 1.6 lbs with Gatorade hydration, revealing only a 0.1 lb gain in sweat loss with Gatorade hydration.

Subject 9, while not as extreme as subject 5, had similar results. Subject 9 yielded on average 1.3 lbs sweat with water hydration and 1.7 lbs of sweat with Gatorade hydration. This shows a 0.4 lb increase in sweat loss. Subject 11 yielded identical results with only a 0.4 lb increase (Figure 5).

Other than what was mentioned earlier, other subjects experienced an average 0.5 lbs or greater sweat loss, hydrating with Gatorade before each session. Subjects who experienced an average of 1 lb or more in sweat loss are subjects 1, 10, 12, 14. Highest average sweat loss was 1.1 lbs with subjects 1 and 14 (Figure 6).

## Discussion

During my two week study, the main goal was to see whether Gatorade had a greater influence on sweat loss compared to water during a one hour, high cardiovascular activity. Murray's study (1996) suggested that athletes should consume maximum amount of fluid that can be comfortably tolerated. Taking this into consideration, I

had my participants consume twenty ounces of fluid before the start of the one hour session. The first week of testing, I had 14 participants consume 20 ounces of plain water and then weighed them before and after the session. I then calculated how much weight was lost due to sweat loss. Based on my statistical analysis, participants lost an average of 1.2 lbs of sweat, with the consumption of water. The second week of testing involved the same routine, except participants consumed 20 ounces of Gatorade before the start of a given session. Results of this trial revealed that on average, participants underwent a 1.7 lbs sweat loss.

According to my analysis, it would seem my data support with my hypothesis: given a one hour session of high cardiovascular activity, Gatorade should yield more sweat loss, due to the replenishment of electrolytes essential to the maintenance of physical performance. According to Maughan and Shirreffs, (2004) cardiovascular performance is seriously affected through the loss of electrolytes (through sweat loss), which helps to control fluid levels in the body. This helps maintain ideal pH levels that ensure correct electric potential between nerve cells which enable nerve transmission. With the consumption of Gatorade, fluid is placed back into the body as well as essential electrolytes to maintain optimal performance. Therefore, with the consumption of electrolyte enriched fluids, performance is not as dampened, one is able to workout for longer periods of time, meaning more sweat is ultimately expelled through a more consistent workout pace and without being as fatigued. With the consumption of plain water, no electrolytes are replaced back into the body; therefore, the body will not function as well, making it more fatigued and prone to injury (cramps and such). However, according to Murray (1996), one of the other advantages of

consuming electrolyte enriched beverages is possible fluid retention.

Most of the participants experienced more sweat loss with the consumption of Gatorade compared to plain water. However, I would have to agree with Murray (1996), that it also has some fluid retention capabilities. Out of 14 participants, 3 of them experienced more sweat loss with water consumption, whereas Gatorade yielded less sweat loss. I would like to explore this trend if I was able to have more participants and more time to test this occurrence. More specifically, if I had about 20 participants and at least two weeks of data with both water and Gatorade I would be able to fully explore test this occurrence.

My results could have been affected by external variables, like workout routine. Due to the setup of class, repeatable routine was hard to maintain. If I were to repeat this experiment, I would have a set routine that is easy to repeat on a day by day basis, like bicycling, for example. I could have many participants ride stationary bicycles at a certain speed for a fixed time, and this would be easy to repeat. The problem with the Tae Kwon Do training is that it would vary, day after day, with different intensities. Temperature was another issue that could have affected results. Classroom temperature varied on a day by day basis, due to prior classes before the given session. There were two classes that took place before the start of the class where I conducted my experiment. Hence, the room temperature was elevated, due to the body heat by the previous class. Some sessions were warmer than others, and with the rise in temperature, gave rise to more sweat loss in my measured subjects. Given this, temperature never deviated to any extremes, where I would have to exclude any data.

My study had to be cut short two weeks due to injury, making participants

unable to workout at normal capacity. Over half of my participants were injured during the spring break week, in preparation for a local tournament, 5 of them were injured before the tournament, and 3 others were injured because of the tournament. My original plan was to have two weeks of both Gatorade and water with one week to make up any absentees. Luckily, I started my experiment with one week of water consumption and the following week with Gatorade consumption before the start of the break. This experiment reveals that not only does Gatorade provide optimal cardiovascular performance, but also has some fluid retention capabilities and participants are able to lose water weight without as much harm done to the body (such as dangerous levels of dehydration or hyponatraemia).

Gatorade or any other electrolyte enriched drink, not only benefits athletes, but also anyone who deals with physical exertion, such as construction workers. This occupation demands a lot of physical work, meaning sweat loss is inevitable, making the job more grueling. Therefore, with the consumption of these fluids, working ability will be more efficient, due to the replenishment of electrolytes.

### **Acknowledgments**

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