Cliff Scherb
GSSI Laboratory Report

RESULTS – June 8-9, 2006

Purpose: Assess electrolyte and fluid balance during a 56 mile cycle and 13 mile run event in the heat. We learned:

- You are a average to high sweater (1.5 L/h) at the tested intensity in the heat.
- You are a average salty sweater (1.7 g/h), and did a fairly good job replacing your losses.
- With average sodium and sweat losses, dehydration can be prevented with a simple fluid replacement strategy. In this half-Ironman simulation test, you were less than 1% dehydrated.

	Bike	Run	Total
Sweat Loss	4.0 L	1.9 L	5.9 L
Sweat Rate	1.56 L/h	1.36 L/h	1.46 L/h
Sodium Loss	4.9 g	2.3 g	7.2 g
Fluid Balance	- 0.69%	- 0.8%	- 1.4%

A Comment About Hydration:

Failing to replace sweat losses results in a decrease in circulating blood volume. This means the heart must work harder to pump blood to the skin (to cool the body), and to the muscle (to deliver oxygen and nutrients). Consequently, the body will lose some of its cooling capabilities, and the muscles will have to rely more heavily on glycogen (carbohydrate) stores because of the decreased availability of oxygen and nutrients.

Drinking enough to match sweat losses requires practice. The stomach must be trained to accept fluid in the same way the heart, lungs, and muscles are trained. Maintaining hydration will allow the body to train harder and race faster!

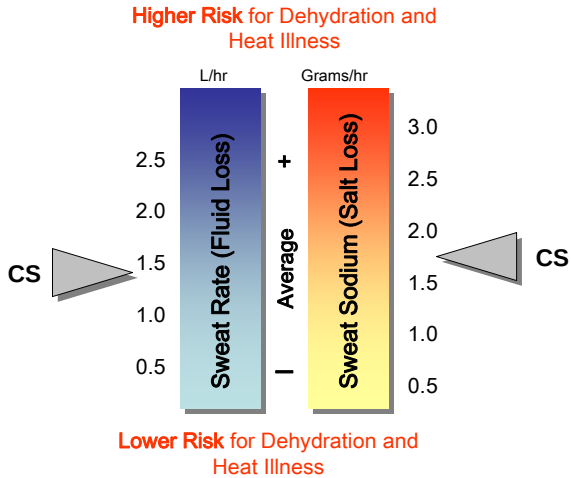


Figure 1. Athletes that have arrows on the upper portion end of the bar graphs (shown above) are encouraged to develop a drinking and salty-diet strategy to minimize the potential for dehydration and heat-related problems.

For Further Information, Contact:

GSSI Physiology, 617 West Main Street, Barrington, IL 60010 • 847-304-2406 • Fax 847-304-2239

Detailed Laboratory Report

OVERVIEW

We conducted a test of sweat rate, sweat electrolytes, and fluid loss during a simulated half-Ironman (bike and run segments) race in the heat.

Test: Bike (56 miles), Treadmill (10.7 miles), continuous w/ short breaks for procedural logistics
Intensity: Self-Determined: **Bike:** Avg 170 bpm (21.4 mph)
Treadmill: Avg 166 bpm (7.7 mph)
Conditions: **Air Temp:** 85°F **Humidity:** 50%

INITIAL HYDRATION ASSESSMENT

Using a pre-test urine sample, we determined that you were very well hydrated prior to testing at GSSI. Remember, in the absence of a formal test on a urine sample, pale urine is a good indicator of adequate hydration. Continue to keep up the good work maintaining adequate hydration.
(Your USG = 1.007). Dehydrated (>1.020)

FLUID INTAKE

Total fluid consumed was 4.1 liters (70 % of total sweat loss). On the bike and treadmill, the fluid you consumed was Gatorade Endurance Formula (GEF) and water. You consumed about 65% more water than GEF. The total fluid volumes are as follows:
Bike: 3.23 L (109.25 oz)
Treadmill: .86 L (29.1 oz)

SWEAT RATE

We determined your overall sweat rate at 1.46 L/hr (~50 oz/hr). You lost a total of ~5.87 liters of sweat. More specifically, we estimated your sweat rate on the bike and run to be fairly consistent as follows:
Bike: 1.56 L/hr
Run: 1.36 L/hr

FLUID BALANCE

Replacing 70% of sweat lost, you finished exercise almost 2% dehydrated. During this test you did a decent job of maintaining fluid balance. Under similar conditions you should stick to a drinking strategy of consuming about 600-700 mL (20-24 oz) every 30 minutes on the bike or run. The goal is to maintain your body weight during training and competition.

SWEAT SODIUM

You have average (normal) sodium content in your sweat.
Sodium: 1213 mg/L **Rate of Sodium Loss:** 1.77 g/hr **Average Reference:** 460-1840 mg/L

SODIUM BALANCE

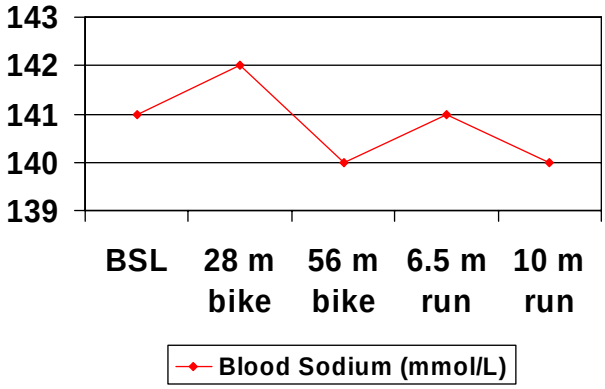
Sodium Intake: 3,756 mg **Sodium Loss:** 7380 mg (based on volume of sweat and urine lost)
Sodium Deficit:: -3,624 mg **Sodium replaced:** 51% (via supplements and fluids)

RUNNING ECONOMY (RE)

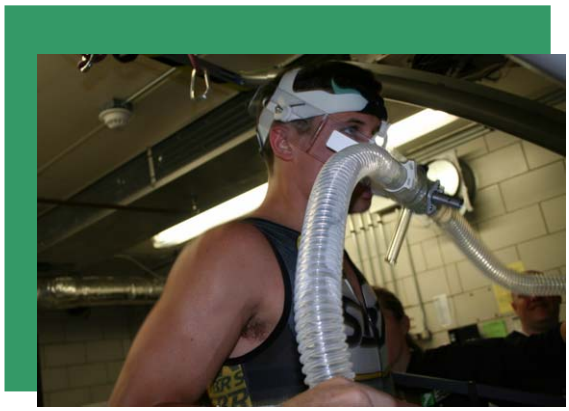
Your running economy did not change much throughout the testing period. Your oxygen consumption ranged from 3.4 L/min to 3.7 L/min. The smaller number on your first RE test (3.4 L/min) indicates that you were slightly more economical (i.e. used less oxygen to run at 9 mph) than you were at the final RE test at the end of the half-Ironman sweat test. Please refer to the graph on the following page.

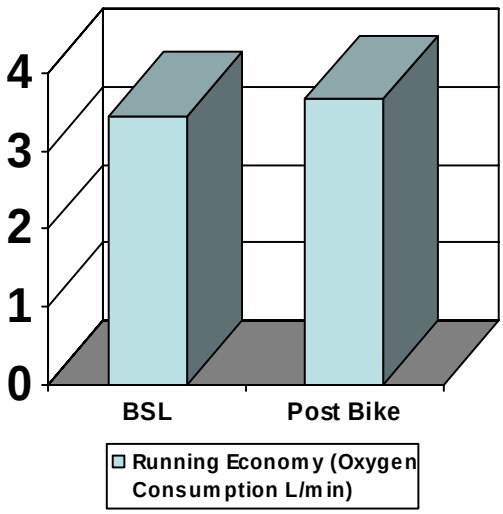
BODY COMPOSITION

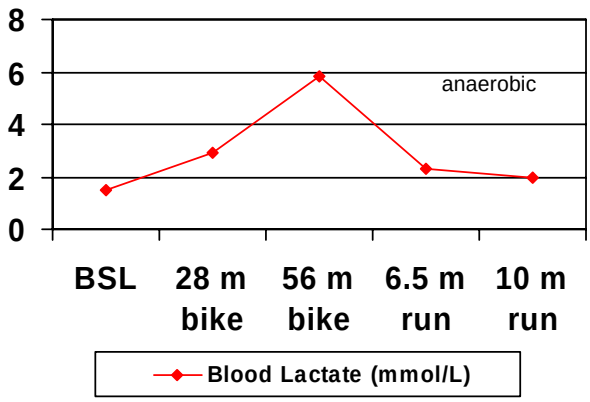
Your body composition was determined by the Bod Pod Body Composition Tracking System. You fell into the category of Lean (9-12% body fat for men), a range that is generally excellent for health and longevity.
Body Mass: 73.792 kg **Body Fat %:** 10.5%



Blood sodium response stayed within normal range.

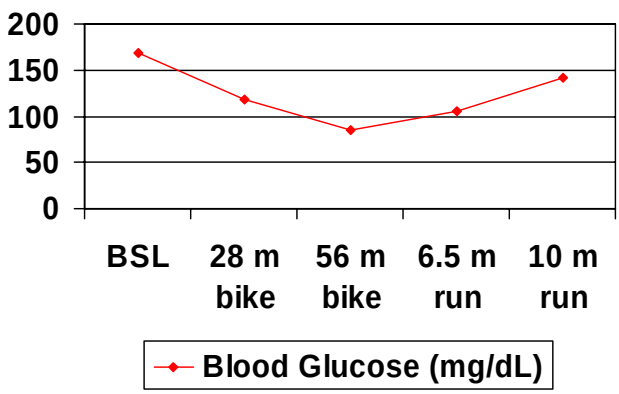






Blood lactate is normal.

Running economy was reduced as you fatigued, which is not unexpected.



Fueling Strategy

A Little Physiology Background…
Your body has three needs during exercise: Fluid, fuel, and electrolytes.

Fluid:
Your body fuels the muscle by delivering oxygen and nutrients in the blood. Likewise, blood flow to the skin cools the body. As you sweat, fluid is lost and the blood volume shrinks. This causes the heart to work harder to do the same amount of work. You may notice that your heart rate increases over time even though your pace may have slowed. This is called cardiac drift and is largely due to dehydration. As dehydration continues, fatigue sets in due to high core body temperature (reduced cooling) and lack of oxygen and nutrients delivered to the muscle.

Fuel:
The second need your body has during exercise is for fuel. Carbohydrate is the muscle's preferred fuel during moderate/high intensity exercise. The body stores enough in the liver and muscle in the form of glycogen to fuel 90-100 minutes of high-intensity exercise. Carbohydrate must be consumed during endurance events in order to maintain exercise intensity. "Bonking" or "hitting the wall" are terms used when sufficient carbohydrate has not been taken in and the stores in the body have been used up. Your body's fat stores are also used during exercise by way of intramuscular triglycerides as well as from your adipose tissue. Protein is used to a very small extent. Protein and fat taken in *during* exercise are not efficient fuels and largely contribute to gastrointestinal (GI) distress.

Before the body can use the carbohydrate being taken in, however, it must go through a couple of steps. First it must empty from the stomach. Gastric emptying is dependent upon the volume in the stomach (high volume = faster emptying) and the energy content of the fluid/food (high calories = slower emptying). For example, water contains no calories so it empties quickly. Soda and juice contain a lot of calories so they empty relatively slowly. Gatorade is formulated so that it delivers the maximum number of calories while emptying at the same rate as water (6% carbohydrate). Gels and bars are concentrated forms of carbohydrate which will significantly slow gastric emptying unless eaten judiciously and consumed with water to decrease the caloric density.

Secondly, the carbohydrate must be absorbed in the small intestine. Again, absorption is dependent up the energy load (more calories = slower absorption) but also on the type of carbohydrate. Multiple carbohydrates (sucrose, fructose, glucose, etc) activate several transporters in the small intestine resulting in a large amount of carbohydrate being absorbed. Products that contain just one type of sugar (glucose or fructose) easily saturate the transporters slowing absorption. Gatorade is absorbed at the same rate as water and contains multiple sugars (sucrose, glucose, and fructose).

Finally, taking both of these steps into consideration, the body can only empty, absorb, and oxidize between 60-100 grams of carbohydrate per hour. Taking in any more than this is not only unnecessary but may result in cramping, bloating, and nausea. ***Matching your body's energy expenditure is NOT the goal during exercise. Taking in enough to keep the muscles fueled IS the goal.***

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FUELING STRATEGY continued

Electrolytes:
Sodium is the primary cation (positively charged mineral) lost in sweat. As such, the more sweat an athlete is losing either because of a long exercise session, a high sweat rate, or both, the more important it is to replace it. Sodium in a sports drink serves two functions. First, it stimulates the thirst mechanism so more fluid will be taken in. When blood sodium concentration increases which is what happens during dehydration, the brain recognizes that the body needs fluid (thirst). Water and other low-sodium beverages dilute the blood sodium quickly and turn off the thirst mechanism so the athlete is no longer thirsty but is also not properly hydrated. Sodium keeps the thirst mechanism stimulated so that more fluid is consumed. Secondly, sodium allows the body to hold on to the fluid that is taken in instead of being excreted by the kidneys. Low-sodium beverages are not retained well by the body.

Test Results:

Fluid Needs: Sweat Rate= 1.46 Liters/hour (avg of bike and run) or 10-12 oz every 15 minutes

Carbohydrate: g consumed on the Bike ~ 150 g on the Run ~ 110
Total g consumed: 260 g over 4 hours

You have a moderately high sweat rate so drinking enough to match your sweat losses is doable at least on the bike. As stated above, the upper limit to what the body can absorb and oxidize is about 1.7 grams per minute or 100 grams per hour under the BEST of circumstances. It is advisable to keep your carbohydrate intake closer to 1 gram of carbohydrate/kg body weight or 70-80 grams of carbohydrate per hour. Taking more than that will only serve to draw fluids into your stomach, impeding hydration and causing GI distress. Keep in mind that dehydration will also slow down gastric emptying so if you're not keeping up with your fluid needs, it becomes more important to slow down on your carbohydrate intake. *If* you choose to meet all of your fluid replacement needs with Gatorade, you would be taking in 91 grams of carbohydrate per hour. This is more than enough carbohydrate. If you choose to meet you carbohydrate needs another way, plan ahead to make sure you are not taking in more than the recommended amount per hour.

Just a word about carbohydrate supplementation during the race: As mentioned above, your body can only absorb and oxidize between 60- 100 grams of ingested carbohydrate per hour. If you're keeping up with your sweat losses and drinking 48-52 oz of Gatorade per hour, you will be getting 84 - 91 g of carbohydrate per hour. This is plenty of carbohydrate and the upper limit of what your body will be able to utilize. **If you would like to get carbohydrate in another form, remember the following:**

Make sure that you have water on board if you would like to eat gels or bars. Don't take them with Gatorade because this will slow down the rate at which they empty from the stomach.

Do NOT put any additional carbohydrate into Gatorade or mix Gatorade into a more concentrated solution. You will only be increasing the likelihood of GI problems.