



FOODS & FLUIDS FOR **ENDURANCE SPORTS**

FUELING ATHLETIC PERFORMANCE

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Endurance athletes who are serious about their performance and are competing in events such as marathons, triathlons, cross-country skiing, cycling and swimming should focus on the foods and fluids they consume. Not only do the right fuels and fluids help the athlete to perform at their best on race day, they also can get the most out of their training for the big event.

Pre-Training or Race Foods & Fluids

Eating before an endurance event tops off the body's carbohydrate stores (called glycogen), especially if the training or race is in the morning.

The pre-event meal should be eaten 1-4 hours before exercise, contain 1-4 g/kg body weight of carbohydrate, and be low in protein, fiber, and fat to minimize the risk of gastrointestinal upset. The exact timing and amount of carbohydrate consumed during this time should meet the individual preferences of the athlete.² Additionally, it is recommended that athletes drink ~5-7 mL/kg body weight of fluids with sodium approximately 4 hours prior to a training session or race, and another 3-5 mL/kg body weight about 2 hours prior if the athlete does not urinate, or if the urine is dark in color.^{5,6}



Suggested Daily Macronutrient Intake (per kilogram body weight)

Macronutrient	Activity/Event	Intake (g/kg/day)
Carbohydrate ⁽²⁾	During Training (moderate to high intensity, 1-3 hours/day)	6-10 g/kg/day
	During Training (moderate to high intensity, >4-5 hours/day)	8-12 g/kg/day
	Preparation for events < 90 min	Same as needs during training (above values)
	Preparation for events > 90 min (carbohydrate loading)	10-12 g/kg for 36-48 h prior to event
Protein ⁽¹⁾		1.2 – 1.4 g/kg/day

Sample Pre-Training/Race Meals

(Examples for a 140 lb (64 kg) athlete)

Menu #1

(~4 h prior, target ~4g/kg, 256 g carbohydrate)

- Penne pasta (2 cups cooked) with 1 cup marinara sauce
- Medium piece French bread (~4 oz)
- 16 oz orange juice
- 1 cup vanilla fat free pudding (not sugar free!) with 1 cup sliced strawberries

Totals: 1286 calories, 256 g carbohydrate, 9 g fat, 31 g protein, 11 g fiber

Menu #2

(~3 h prior, target ~3g/kg, 192 g carbohydrate)

- Turkey sandwich
 - 3 oz Fat-free deli turkey
 - Mustard/low-fat mayo (use sparingly)
 - Plain bagel
- ~ 40 tiny twist pretzels
- 1 large apple
- 2 fig cookies
- 20 oz Gatorade Endurance Formula

Totals: 890 calories, 189 g carbohydrate, 5.5 g fat, 29 g protein, 9.5 g fiber

Menu #3

(~2 h prior, target 2g/kg, ~128 g carbohydrate)

- 1 Bakery-size bagel with 2 tsp low fat cream cheese
- 1 large banana
- 20 oz Gatorade Endurance Formula

Totals: 550 calories, 125 g carbohydrate, 3.5 g fat, 11 g protein, 5 g fiber

Ingesting carbohydrate within the hour prior to training or racing essentially begins to meet the athlete's during exercise fueling need,³ and may also help the athlete decrease feelings of hunger. The amount and form of carbohydrate, such as a beverage, chew or solid food, is the individual choice of the athlete.

Gatorade Prime: designed to provide carbohydrate energy shortly before exercise

	Serving Size	Carbohydrate	Sodium
Gatorade Endurance Carb Energy Drink	1 bottle (4 oz)	30 g	110 mg
Gatorade Endurance Carb Energy Chews	4 chews	31 g	105 mg

Pre-Training & Race Foods & Fluids

- Success in endurance events is related to adequate carbohydrate energy to fuel muscles
- The nutritional focus before training and racing for endurance athletes is to consume adequate carbohydrate and fluids. Minimize protein, fiber, and fat before training and racing.
- Athletes are individual and should use the recommendations to help them determine the right amount and time to eat carbohydrate prior to training and racing that works for them

DURING TRAINING AND RACING FOODS & FLUIDS

Dehydration

Dehydration of a 2% or more decrease in body weight (approximately a 3 lb loss in a 150 lb athlete) may negatively affect an athlete's performance, especially when exercising in hot and humid condition.⁶

Answering "yes" to any of these questions may indicate inadequate hydration:

- Am I thirsty?
- Is my urine a dark yellow color?
- Is my body weight noticeably lower than yesterday?

Importance of Hydration

Endurance athletes spend several hours each day training - often twice a day - so paying attention to hydration is important. Athletes should be sure to drink enough fluid to prevent dehydration without over-drinking. Dehydration may strain the cardiovascular system and increase body temperature, which increases the risk of heat illness. However, endurance athletes who over-drink in relation to sweating could be at risk for a rare but very serious condition called hyponatremia (low blood sodium concentration).⁶ Consuming beverages with sodium during exercise may help maintain blood sodium levels.⁶

Hydrate the Right Way

To determine individual sweat rate, measure body weight before and after a training session, in the same environment as the race. And keep track of all the fluid consumed. A rough estimate of sweat rate can be obtained by using the following equation: $\text{Sweat Rate (L/h)} = (\text{weight loss} + \text{fluid intake (L)}) / \text{exercise time (hours)}$.

Sodium

Athletes sweat, and sweat contains sodium. Endurance athletes, especially when training or racing >2h or those who have high sweat losses, should replace both fluid and sodium during exercise.⁶ To estimate if an athlete is a "salty sweater," look for white residue on dark colored clothing after a training session.

Gatorade Endurance Formula contains 200 mg sodium per 8 oz serving. For athletes who need higher amounts of sodium or are prone to cramping, Gatorade Endurance Gatorlytes (one sachet) can provide an additional 780 mg sodium.

Tips for Hydration

- Know your sweat rate to customize a plan to meet your unique needs
- Practice your race strategy in training and make sure you can tolerate the fluids without problems
- Use sports drinks to provide fluid and electrolytes

Carbohydrate

Consuming carbohydrate during exercise provides fuel to both the muscle and nervous system.² For shorter durations, the presence of carbohydrate in the mouth is adequate as a mechanism to improve higher intensity performance.³ The longer the duration of exercise, the more important ingested carbohydrate becomes to help maintain higher intensity performance. For bouts lasting greater than 2.5 hours, athletes should consume blends of carbohydrates that take advantage of the multiple transport systems in the intestine. Specifically, the carbohydrate blend should consist of glucose and fructose. Glucose may come from sources such as maltodextrin.³

Recommended Carbohydrate Intake During Exercise³

Duration	Carbohydrate Amount	Notes
<30 minutes	None required	
30-75 minutes	Very small amounts	Mouthrinse appropriate
1-2.5 hours	30-60 g/h	Rapidly used sources such as sucrose, glucose, and maltodextrin
>2.5-3 hours	Up to 90 g/h	Use a blend of glucose & fructose

Sodium and Carbohydrate Content of Gatorade Perform Beverages and Chews

	Serving Size	Carbohydrate	Sodium
Gatorade Endurance Formula	8 oz	14 g	200 mg
Gatorade Thirst Quencher	8 oz	14 g	110 mg
Gatorade G2	8 oz	5 g	110 mg
Gatorade Endurance Carb Energy Chews	4 chews	31 g	105 mg

Examples of product combinations to achieve up to 30, 60, or 90 g/hour

Examples	Total Carbohydrate (g)
1 48-oz Gatorade G2	30
1 24-oz G2 + 2 Gatorade Endurance Carb Energy Chews	30-31
1 Gatorade Endurance Carb Energy Drink OR 1 sleeve Gatorade Endurance Carb Energy Chews	30-31
1 34-oz (1 L) G2 + 1 sleeve Gatorade Endurance Carb Energy Chews	52
1 34-oz (1 L) Gatorade Thirst Quencher OR 1 Gatorade Endurance Formula	60
1 20-oz Gatorade Thirst Quencher OR 1 Gatorade Endurance Formula + 1 Gatorade Endurance Carb Energy Drink	65
1 20-oz Gatorade Thirst Quencher OR 1 Gatorade Endurance Formula + 1 Gatorade Endurance Carb Energy Drink + 2 Gatorade Endurance Carb Energy Chews	80
1 34-oz (1 L) Gatorade Thirst Quencher OR 1 Gatorade Endurance Formula + 1 Gatorade Endurance Carb Energy Drink	90

*Gatorade Endurance Carb Energy Drink contains 30 g of carbohydrate; 4 Gatorade Endurance Carb Energy Chews contain 31 g carbohydrate

**These suggestions are to fulfill carbohydrate recommendations. Remember to supplement with water to also meet fluid needs

During-Training & Racing Foods & Fluids

- Athletes should determine their individual sweat rate and consume fluids with sodium to minimize body weight changes during training and racing
- Recommendations for carbohydrate intake during exercise are based on duration of exercise, not intensity
- Mix and match products to find the right combination of solids and fluids to meet both carbohydrate and fluid needs
- It is possible to train the gut! If athletes are currently consuming less than the recommendations, gradually increase intake to minimize gastrointestinal issues.

POST-TRAINING AND RACING FOODS & FLUIDS

Restoring the carbohydrate used from the muscle and liver is a key focus of the post-exercise fueling needs of endurance athletes. When athletes have <8 hours between training sessions, 1.0-1.2 g/kg carbohydrate should be consumed every hour for 4 hours. When athletes have >8 hours between sessions, they should follow daily carbohydrate needs for an endurance athlete (6-10 g/kg/day) and choose carbohydrate-rich meals and snacks in a pattern that works for them.²

Consuming protein to start the recovery process as soon as possible after each training session helps to repair damaged muscle tissue as well as adapt to the demands of training. Athletes should choose a high quality, complete protein such as milk protein, whey, egg, or meat. However, while research has shown post-exercise protein to be important to stimulate synthesis of new proteins following aerobic exercise, the effective amount has only been confirmed following resistance exercise. Based on that information, endurance athletes should aim to consume about 20 g of protein shortly after training sessions.⁴

Following exercise athletes should drink 16-24 oz per pound of body weight lost of fluid with sodium.^{1,6}



Recovery Food and Fluid Examples:

		Calories	Carbohydrate (g)	Fiber (g)	Protein (g)	Fat (g)	Sodium (mg)
Option 1	Gatorade Recover Protein Shake	270	45	1	20	1.5	320
Option 2	Gatorade Recover Whey Protein Bar	340-370	42-43	1-2	20	9-12	160-210
Option 3	Fruit & Yogurt Smoothie <i>(5oz non-fat greek yogurt, 1 cup skim milk, 3/4 cup frozen mixed berries)</i>	293	51	7	24	0	445
Option 4	Egg Sandwich <i>(plain bagel, 1 egg, 1 slice 2% swiss cheese)</i>	380	49	4	22	12	625

Post-Training & Racing Foods & Fluids

- Restore carbohydrate after training sessions and racing to replace used glycogen (carbohydrate stored in the muscle and liver) and to store more glycogen as an adaptation to training
- Athletes should consume ~20 g of high quality protein as soon as possible following training or racing to help repair muscle tissue
- Rehydrate with 16-24 oz of fluid with sodium for every pound of body weight lost during exercise



AN EXAMPLE: PUTTING THE SCIENCE-BASED RECOMMENDATIONS INTO PRACTICE

Athlete Profile

Name: Katie

Age: 30

Weight: 128 lbs (58 kg)

Type of athlete: Competitive Female Marathon Runner

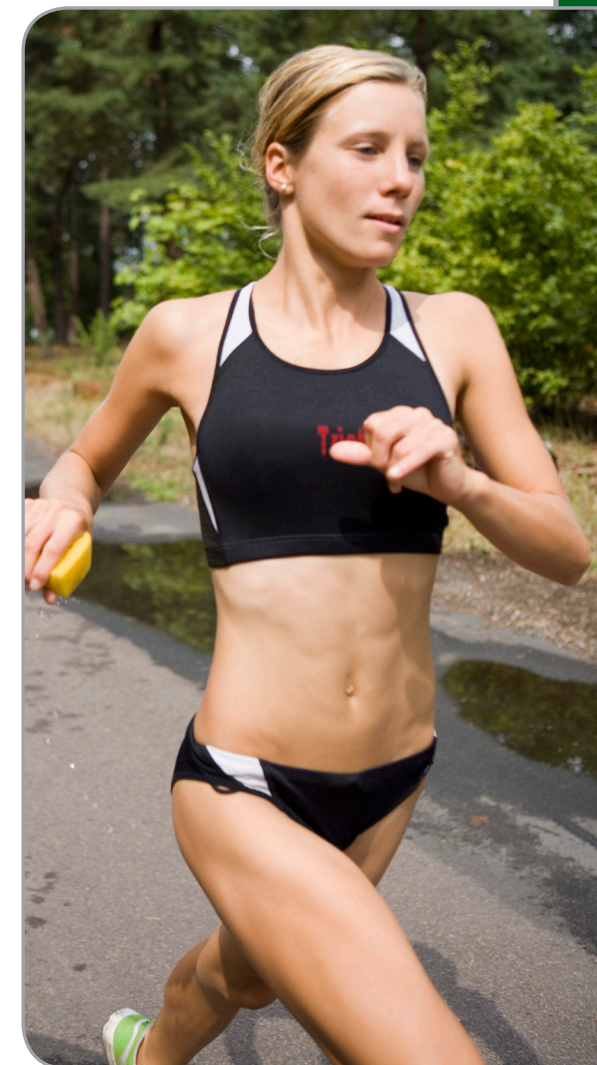
Goal: To PR at the Boston Marathon, goal time 3:15

Purpose of Consultation: Katie is beginning her training for the Boston marathon, and would like to develop a fueling plan specifically for before, during, and after her 20+ mile training runs, which will mimic her race day plan.

Before Exercise

Katie plans her training runs on Sunday mornings, and is willing to wake up two hours prior to eat breakfast. We first suggested 2.5 g carbohydrate/kg body weight, but she felt too full, so we backed down to 2 g/kg and that amount worked well for her stomach. As a result, the carbohydrate goal for her pre-run meal is 116 g (464 calories). Katie does not like to cook in the morning, and also wants to train with a meal she can travel with and eat before the race. Incorporating Katie's favorite foods, and aiming for a meal low in fiber, protein, and fat, her pre-run meal is: plain bagel with 1 tablespoon strawberry jelly, one small box raisins (~1/4 cup), 12 oz Gatorade Endurance Formula, water as needed (~480 calories, 111 g carbohydrate, 2 g fiber, 9 g protein, and 1 g fat).

Katie doesn't like to have too much in her stomach right before the race, but does feel the need for some energy, so we suggest one bottle of Gatorade Endurance Carb Energy Drink to give her a small amount of carbohydrate. During training she will experiment with taking it 5, 10, and 15 minutes before her run to determine what timing works best for her.



During Exercise

In training for marathons in the past, Katie would carry 2 gels with her on long training runs and find water fountains along the way. Since her training runs will take ~2.5 hours, two gels (~60 g total carbohydrate) doesn't come close to meeting the recommendation of up to 90 g per hour. We don't want her to immediately start consuming 90 g/hour and upset her stomach, so we will gradually increase and train her stomach to be ready for that amount on her long training runs.

In terms of fluid, Katie has never figured out her sweat rate. Luckily Katie lives in Chicago, so her training climate will be similar to Boston. On a 10 mile run, we had her weigh herself immediately before in minimal clothing, and again immediately after in the same clothing, wiping off excess sweat. We also had her carry fluid with her on the run and measure how much she drank. Katie lost 1.5 lbs and drank 20 oz of fluid during a 75 minute run. Therefore, her sweat rate is 0.7 L/h, or 24 oz/hour. Also during this run, we had Katie wear dark colored clothing. There was minimal evidence of salt on her clothes, and she doesn't report a history of cramping, so higher sodium levels are likely not needed.

For her 20 mile training runs and the race, to meet her fluid and carbohydrate energy needs we recommend 24 oz of Gatorade Endurance Formula and nine Gatorade Endurance Carb Energy Chews per hour (90 g carbohydrate, 24 oz fluid, 758 mg sodium per hour).

After Exercise

During training for past marathons, Katie often didn't feel great in her next training sessions after a long run, and she never paid very much attention to what she ate after a run. We helped her understand that recovery nutrition is important so she can stay strong throughout her training and get the most out of every run, as well as maximize training adaptations, such as the ability to store more carbohydrate as muscle glycogen. Katie is hungry after her long training runs, but doesn't feel like her stomach can easily accept food. Gatorade Recover Post-Game Recovery Beverage will be available at the finish line, so we recommend she use that product in her training (after hard or long workouts) as well to get carbohydrate, protein, fluid and electrolytes shortly after she finishes to start the recovery process. Then, after she showers, rests and feels like she can eat solid food again, she can have a meal. Since she always takes a day off after the long training runs, the timing of the meal is not crucial, but should be high in carbohydrate, moderate in protein, and low in fiber and fat, helping to meet the daily recommendation of 6-10 g/kg/day (for Katie, 348-580 g, or 1392-2320 calories from carbohydrate per day). Katie's favorite meal after a long run is a burrito, so we helped her craft an appropriate "recovery burrito" with rice, black beans, chicken, lettuce, tomato and a small amount of cheese.

Hopefully with our fluid intake plan during exercise, Katie will lose minimal weight during her run. However, we encouraged Katie to always weigh herself before and after long runs, and to drink ~16-24 oz of fluid with sodium (or drink water with sodium-containing food) for every pound she lost. The amount of weight she loses each time will depend on a number of factors, so tracking weight changes is the best habit she can adopt to make sure she is getting what she needs.



References:

- (1) American College of Sports Medicine, American Dietetic Association, Dietitians of Canada. (2009). Nutrition and athletic performance. *Medicine and Science in Sports and Exercise*, 41, 709-731.
- (2) Burke L., Hawley J., Wong S., & Jeukendrup A. (2011). Carbohydrates for training and competition. *Journal of Sports Sciences*, 29 Suppl 1, S17-27.
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- (4) Phillips, S. & Van Loon, L. (2011). Dietary protein for athletes: from requirements to optimum adaptation. *Journal of Sports Sciences*, 29 Suppl 1, S29-38.
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- (6) Shirreffs, S. & Sawka M. (2011). Fluid and electrolyte needs for training, competition, and recovery. *Journal of Sports Sciences*, 29 Suppl 1, S39-46.

CALCULATIONS/YOUR WORKSHEET

1. BODY WEIGHT

For many calculations, you need to know your body weight in kilograms:

Body weight in pounds _____ / 2.2 = kg

2. DAILY MACRONUTRIENT NEEDS

Carbohydrate (choose based on your daily duration):

A. **During Training** (moderate to high intensity, 1-3 hours/day)

_____ body weight (kg) * 6 g/kg = grams per day

_____ body weight (kg) * 10 g/kg = grams per day

B. **During Training** (moderate to high intensity, > 4-5 hours/day)

_____ body weight (kg) * 8 g/kg = grams per day

_____ body weight (kg) * 12 g/kg = grams per day

C. **Preparation for Events** > 90 minutes duration

_____ body weight (kg) * 10 g/kg = grams per day

_____ body weight (kg) * 12 g/kg = grams per day

*for 36-48 hours prior to event

Protein:

_____ body weight (kg) * 1.2 g/kg = grams per day

_____ body weight (kg) * 1.4 g/kg = grams per day

3. BEFORE EXERCISE CARBOHYDRATE NEEDS

A. Enter the time before exercise you like to eat (1-4 hours): _____ (h)

B. Enter your desired amount of carbohydrate (1-4 g/kg body weight): _____ (g)

C. _____ body weight (kg) * _____ carbohydrate amount from line 2 (g/kg) = g carbohydrate

4. BEFORE EXERCISE FLUID NEEDS

A. **4 hours** prior to exercise:

_____ body weight (kg) * 5 mL/kg = mL

_____ body weight (kg) * 7 mL/kg = mL

B. **2 hours** prior to exercise (if needed):

_____ body weight (kg) * 3 mL/kg = mL

_____ body weight (kg) * 5 mL/kg = mL

*To convert mL to ounces: _____ mL * 0.03 = _____ fluid oz

5) DURING EXERCISE CARBOHYDRATE NEEDS

Use the "Recommended Carbohydrate Intake During Exercise" table, based on your intended duration

A. Duration of Exercise _____ h

B. Recommended carbohydrate intake: _____ g/h

*Remember you should train your gut to accept the right amount of carbohydrate, so start lower and build to this value if needed

6. DURING EXERCISE FLUID NEEDS

A. Pre-Exercise Weight = _____ lbs

B. Fluid consumed during exercise = _____ L

*(_____ fluid ounces / 33.8 = _____ L)

C. Post-Exercise Weight = _____ lbs

D. **Weight Change** = Pre-Exercise Weight _____ lbs - Post-Exercise Weight _____ lbs =

E. Exercise time = _____ hours

F. **Sweat Rate** = (Weight Change _____ + Fluid Intake _____ L) / _____ hours = L/h

7. POST-EXERCISE CARBOHYDRATE NEEDS (WHEN <8 HOURS RECOVERY)

_____ body weight (kg) * 1 g/kg = g Carbohydrate

_____ body weight (kg) * 1.2 g/kg = g Carbohydrate

8. POST EXERCISE FLUID NEEDS

Weight Change = Pre-Exercise Weight _____ lbs - Post-Exercise Weight _____ lbs =

Fluid Needs:

_____ body weight lost * 16 oz = oz

_____ body weight lost * 24 oz = oz

9. POST EXERCISE PROTEIN NEEDS

No calculations aren't needed, ~20 g is appropriate for everybody