GATORADE SPORTS SCIENCE INSTITUTE®

FOODS & FLUIDS FOR ENDURANCE SPORTS







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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-PRACTICE OR GAME FOODS & FLUIDS

Eating before an endurance event helps top 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 be determined by the individual preferences of the athlete.[1] 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.[2,3]

Daily carbohydrate and protein needs are shown in the table below. Both depend on the intensity of the training period. Information on newer research related to the periodization of carbohydrate during training can be found in SSE #134, Manipulating Carbohydrate Availability to Promote Training Adaptations by Dr. John Hawley at GSSIweb.org.

SUGGESTED DAILY MACRONUTRIENT INTAKE (PER KILOGRAM BODY WEIGHT)

Macronutrient	Recommendation	Intake Amount
Carbohydrate[1,4]	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[4]		1.2-2.0 g/kg/day

SAMPLE PRE-TRAINING/RACE MEALS

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

Menu #1

(~4 hours prior, target ~4 g/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: 1,286 calories, 256 g carbohydrate, 9 g fat, 31 g protein, 11 g fiber

Menu #2

(~3 hours prior, target ~3 g/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 hours prior, target ~2 g/kg, 228 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 needs,[5] 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.

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-PRACTICE OR GAME FOODS & FLUIDS

DEHYDRATION

Dehydration of a 2% or more decrease in body weight (approximately a ~2.8 lb loss in a 140 lb athlete) may negatively affect an athlete's performance, especially when exercising in hot and humid conditions.[3,4]

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).[3] Consuming beverages with sodium during exercise may help maintain blood sodium levels.[3]

HYDRATE THE RIGHT WAY

At lower levels of dehydration, drinking when thirsty may be an appropriate approach for some athletes. However, thirst is affected by many factors that are not dependent on dehydration. Also, at the time an athlete is thirsty, they might

not have access to fluids. Developing a hydration plan allows the athlete to practice their strategy to help ensure they remain hydrated while focused on the competition.

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: Sweat Rate (L/h) = (weight loss (lbs) + fluid intake (L))/ exercise time (hours). Reference Sweat Calculator Worksheet on Page 10.

SODIUM

Athletes sweat, and that 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.[3] To estimate if an athlete is a "salty sweater," look for white residue on dark-colored clothing after a training session. The Gatorade Gx sweat patch is a commercially available, scientifically validated, single-use patch that can be used to determine sweat rate and sweat sodium losses.[5] Gatorade Endurance Formula contains 310 mg sodium per 12 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 muscles and nervous system.[1] For shorter durations, the presence of carbohydrate in the mouth is adequate as a mechanism to improve higher-intensity performance.[2] The longer the duration of exercise, the more important ingested carbohydrate becomes to help maintain higher-intensity performance.[7] For bouts lasting greater than 2.5 hours, athletes should consume a blend of carbohydrates that take advantage of the multiple transport systems in the intestine. Specifically, the carbohydrate blend should consist of a 2:1 ratio of glucose to fructose.[4,8] Glucose may come from sources such as maltodextrin.[9]

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 AND 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 of an endurance athlete (6-10 g/kg/day) and choose carbohydrate-rich meals and snacks in a pattern that works for them.[1,4]

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. Additionally, if inadequate carbohydrate is consumed, protein can help accelerate glycogen repletion.[4] 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 or 0.25-0.30 g/kg, of protein shortly after training sessions.[4,10] Research is emerging on the use of plant-based proteins for recovery and muscle gain. Athletes consuming plant-based proteins should ensure they are eating a variety of foods in order to meet their essential amino acid needs to support recovery and training adaptations.[11]

Following exercise, athletes should drink 20-24 oz per pound of body weight lost of fluid with sodium.[3,4]

RECOMMENDED CARBOHYDRATE INTAKE DURING ENDURANCE EXERCISE[4]

Duration	Carbohydrate Amount	Notes
< 30 minutes	None required	N/A
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

CARBOHYDRATE AND SODIUM CONTENT OF GATORADE PRODUCTS

Product	Carbohydrate (g/12 fl oz)	Sodium (mg/12 fl oz)
Gatorade Thirst Quencher	22	160
Gatorade Lower Sugar	5	160
Gatorade Endurance Formula	21	310
Gatorade Zero	<1	160
Gatorade Endurance Gatorlytes*	0	780**
Gatorlyte	9	300

** Gatorade Endurance Gatorlytes to be added to 20 oz Gatorade Thirst Quencher RTD.*

*** Per Gatorade Endurance Gatorlytes packet.*

EXAMPLES OF GATORADE PRODUCT COMBINATIONS TO ACHIEVE UP TO 30, 60, OR 90 G/HOUR

Product	Total Carbohydrate (g)
20 fl oz Gatorade Thirst Quencher	36
12 fl oz Gatorade Endurance Formula + 1 pouch Gatorade Energy Chews	42
28 fl oz Gatorade Thirst Quencher	51
20 fl oz Gatorade Thirst Quencher + 1 pouch Gatorade Energy Chews	61
24 fl oz Gatorade Endurance Formula + 1 pouch Gatorade Energy Chews	67
2 × 20 fl oz Gatorade Thirst Quencher	72
28 fl oz Gatorade Thirst Quencher + 1 pouch Gatorade Energy Chews	76
20 fl oz Gatorade Thirst Quencher + 2 pouches Gatorade Energy Chews	86

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

RECOVERY OPTIONS

Product	Calories	Carbohydrate (g)	Fiber (g)	Protein (g)	Fat (g)	Sodium (mg)
Muscle Milk Pro Protein Shake 14 fluid ounces	240-250	14-15	<1-2	42	2-2.5	310-350
Muscle Milk Pro Protein Shake 11 fluid ounces	190-200	11-12	<1-2	33	1.5-2	250-280
Muscle Milk Protein Shake 14 fluid ounces	170	13	1-2	26	1-1.5	290-330
Muscle Milk Protein Shake 11 fluid ounces	160	10-11	<1-2	26	1-1.5	240-270
Gatorade Recover Protein Bar	330-360	39-43	0-2	20	10-13	160-310

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.
- Endurance athletes should consume ~20-25 g, or 0.25-0.3 g/kg of high-quality protein as soon as possible following training or racing to help repair muscle tissue.
- Rehydrate with 20-24 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 6 oz Gatorade Endurance Formula plus one sleeve of Gatorade Energy Chews 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 13-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 on the run and measure how much she drank. Katie lost 1.5 lbs and drank 20 oz of fluid during a 100-minute run. Therefore, her sweat rate is 0.8 L/h or 26 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 2 Gatorade Endurance Energy Gels per hour (84 g carbohydrate, 24 oz fluid, 820 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 Protein Bar 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 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 ~20-24 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.

Any opinions or scientific interpretations expressed in this document are those of the author and do not necessarily reflect the position or policy of PepsiCo, Inc.

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CALCULATIONS/YOUR WORKSHEET

1. BODY WEIGHT

For many calculations, you need to know your body weight in kilograms. To do this calculation:

Body weight in pounds _____ / 2.2 = [ ] kg

2. DAILY MACRONUTRIENT NEEDS

Carbohydrate:

_____ body weight (kg) * 5 g/kg = [ ] grams per day

TO

_____ body weight (kg) * 7 g/kg = [ ] grams per day

Protein:

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

TO

_____ body weight (kg) * 2.0 g/kg = [ ] grams per day

Amounts within these ranges should be determined based on the requirements of the individual sport and athlete.

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. Pre-exercise carbohydrate intake = _____ 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

TO

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

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

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

TO

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

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

5. DURING-EXERCISE CARBOHYDRATE NEEDS

The recommendation is 30-60 g/hour, no calculation needed. Amount should be determined based on the requirements of the individual sport and athlete.

6. DURING-EXERCISE FLUID NEEDS

A. Pre-exercise weight = _____ lbs

B. Fluid consumed during exercise = _____ L

(_____ fluid oz / 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

TO

Body weight _____ (kg) * 1.2 g/kg = [ ] g carbohydrate

8. POST-EXERCISE FLUID NEEDS

Weight lost = Pre-exercise weight _____ lbs - Post-exercise weight _____ lbs = [ ]

Fluid needs:

_____ body weight lost * 20 oz = [ ] oz

TO

_____ body weight lost * 24 oz = [ ] oz

9. POST-EXERCISE PROTEIN NEEDS

About 20 g is appropriate for most athletes; however, to calculate your individual needs use this equation:

Body weight _____ (kg) * 0.25 g = [ ] g protein

TO

Body weight _____ (kg) * 0.3 g = [ ] g protein


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