GATORADE SPORTS SCIENCE INSTITUTE®

FOODS & FLUIDS FOR

EXPLOSIVE POWER SPORTS

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Explosive power sports require an all-out effort. Jumping, sprinting, throwing, track, cycling, wrestling, gymnastics, speed skating, canoeing, kayaking and sprint swimming are some events that require quick, explosive power and strength.

Power is defined as the rate of energy production, so a high power output requires a burst of energy over a short period of time. The longer an athlete competing in a power sport can sustain bursts of energy, the more successful they will be. Metabolically these athletes are completely dependent on their internally stored fuel sources, primarily the carbohydrate stored in the muscle (called glycogen). At high intensities of exercise, this stored carbohydrate is the fuel source for both anaerobic energy production (without oxygen) and aerobic energy production (with oxygen).[1] Since it is such a crucial fuel source, performance in high-intensity events of short duration has been shown to be compromised in athletes with low pre-exercise glycogen levels.[1]

Most explosive power sport athletes follow a periodized training schedule over the course of a year. As such, their nutrition goals should match the goals of their training period.[1] The focus of this summary is the nutritional recommendations for explosive power sport athletes during their competitive season. For a full review of recommendations during the various training periods, please see the paper by Stellingwerff et al.[1] on practices and games in the competitive season.

PRE-TRAINING & COMPETITION FOODS & FLUIDS

Eating carbohydrate before training or competition tops off the body's carbohydrate stores (glycogen). This habit is particularly important if the workout or competition is in the morning. Since stored carbohydrate is the primary fuel source for high-intensity muscle contraction, it is important for power sport athletes to start training sessions and competitions with enough carbohydrate stored in their body.

The pre-event meal should be eaten 1-4 hours prior, contain 1-4 g/kg 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.[1,2,3] Additionally, it is recommended that athletes drink ~5-7 mL/kg of fluids with sodium approximately 4 hours prior to training or competition and another 3-5 mL/kg about 2 hours prior if the urine is dark or not produced.[4,5] This practice will help an athlete to begin training sessions and competition in a hydrated state.

SUGGESTED DAILY MACRONUTIRENT INTAKE

(per kilogram of body weight)

Carbohydrate:[1,2,3] 3-6 or 5-8 g/kg/day

Amount dependent upon demands of the athlete's sport/activity.

Protein:[3] 1.2-2.0 g/kg/day

SAMPLE PRE-PRACTICE/GAME 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

Approximate 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 mayo sparingly)
  - Plain bagel
- ~40 tiny twist pretzels
- 1 large apple
- 2 fig cookies
- 20 oz Gatorade Thirst Quencher

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, 128 g carbohydrate)

- 1 bakery-size bagel with 2 tsp low-fat cream cheese
- 1 large banana
- 20 oz Gatorade Thirst Quencher

Approximate totals: 550 calories, 128 g carbohydrate, 3.5 g fat, 11 g protein, 5 g fiber

OPTIONS TO PROVIDE CARBOHYDRATE ENERGY SHORTLY BEFORE TRAINING AND COMPETITION

	Serving Size	Carbohydrate	Sodium
Gatorade Energy Chews	6 chews	21 g	70 mg
Gatorade Endurance Energy Gel	1 gel	20 g	90 mg
Banana	1 medium	27 g	1 mg

PRE-TRAINING OR COMPETITION KEY MESSAGES

- Success in power sports is partially determined by the athlete's ability to maintain high-intensity muscle contractions. The primary fuel source for this type of workout is the carbohydrate stored in the muscle (glycogen). Therefore, it is crucial that power sport athletes eat adequate carbohydrate before a training session or event to "top off" glycogen stores and support the metabolic demands of their sport.
- Since there is little or no opportunity to consume fluids during a competitive power sport event, athletes should begin their competitions in the hydrated state.

DURING-TRAINING & COMPETITION FOODS & FLUIDS

The actual competitions in power sport events are short duration and leave little opportunity or real need for fuel or fluid intake during the event. However, training sessions during the competitive season can be long and frequent, so athletes should be sure to consume fluid and carbohydrate during training. Additionally, during tournaments athletes should focus on hydration and energy intake during the breaks between individual competitions.

DEHYDRATION

Dehydration of a 2% or more decrease in body weight during a training session (approximately a 3 lb loss in a 150 lb athlete) may negatively affect an athlete's performance,[3,4] especially if exercising in hot and humid conditions such as a gym or weight room without air conditioning.

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

- Am I thirsty?
- Is my urine a dark yellow color (like apple juice)?
- Is my body weight noticeably lower than yesterday?

IMPORTANCE OF HYDRATION

Power sport athletes may spend several hours each day training, so paying attention to hydration is important. 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.

HYDRATE THE RIGHT WAY

To determine your individual sweat rate, measure your body weight before and after a training session, and keep track of all the fluid you consumed. A rough estimate of your sweat rate can be obtained by using the following equation: sweat rate (L/h) = (weight loss + fluid intake (L))/ exercise time (hours).

SODIUM

Athletes sweat and sweat contains sodium. Consuming fluid with sodium, such as in a sports drink, is important because sodium helps maintain the physiological desire to drink and helps retain the fluid consumed.[6] To determine if you are a "salty sweater," wear dark-colored clothing and look for white residue after your training session. Sweat that stings your eyes may be another sign that you're a "salty sweater."

TIPS FOR HYDRATION

- Know your sweat rate to customize a plan to meet your unique needs.
- Be sure to focus on hydration in training sessions and during tournaments; begin competitive events in the hydrated state.
- Monitor your urine color; it should be a light yellow color (like lemonade) to indicate adequate hydration.
- Use sports drinks to provide fluid and electrolytes for hydration and carbohydrate for energy.

CARBOHYDRATE

Consuming carbohydrate during exercise provides fuel to the muscle, brain and nervous system.[7] Adequate carbohydrate intake during longer training sessions and between competitions in a tournament may be especially important for power athletes in highly technical sports to improve neuromuscular performance.[1] Rinsing of the mouth with carbohydrate may achieve this benefit; however, to date, this benefit has only been studied in longer bouts of exercise.[1,3] When training for longer than 60 minutes, the recommended amount of carbohydrate is 30-60 g/h.[7] The form (solid, semisolid or liquid) should be determined by the preferences of the individual athlete. [8]

SODIUM AND CARBOHYDRATE CONTENT OF GATORADE BEVERAGES

	Carbohydrate (g/12 oz)	Sodium (mg/12 oz)
Gatorade Thirst Quencher	21	160
G2	8	160
Gatorade Endurance Formula	22	310
G Zero	0	160
Gatorlytes powder*	0	780 (mg/ packet)
Gatorlyte RTD	8	300

** Gatorlytes are not a beverage. They are a packet of electrolytes to be added to a 20 oz bottle of Gatorade Thirst Quencher.*

EXAMPLES OF STRATEGIES TO MEET THE 30-60 G/H CARBOHYDRATE RECOMMENDATION

- 16 oz Gatorade Thirst Quencher = 28 g carbohydrate
- 32 oz Gatorade Thirst Quencher = 56 g carbohydrate
- 32 oz Gatorade G2 plus Gatorade 6 Gatorade Prime Energy Chews = 45 g carbohydrate

DURING-PRACTICE OR GAME KEY MESSAGES

- There is little opportunity or need to consume fluids or fuel during a single, short-duration competitive event.
- Long and frequent training sessions are common for power sport athletes. During these sessions, it is important to consume carbohydrate for fuel and maintain hydration.
- During tournaments, power sport athletes should focus on maintaining hydration and consuming carbohydrate during the breaks between events.

POST-TRAINING & COMPETITION FOODS & FLUIDS

Restoring the carbohydrate used from the muscle during training is a key focus of the post-exercise fueling needs of power sport athletes, since muscle glycogen is their primary fuel source.[1] Therefore, power sport athletes should consume 1.2-1.5 g of carbohydrate per kilogram of body weight as soon as possible following exercise to replenish glycogen stores.[1]

More research is needed on the recovery protein needs of power sport athletes. Current recommendations are to consume about 20 g or ~0.25-0.3 g of protein per kilogram of body weight to start the recovery process as soon as possible after each training session and competition (21 g for a 70 kg [154 lb] athlete).[3,9] Athletes should choose a high-quality, complete protein such as milk protein, whey, egg or meat.[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 of fluid with sodium per pound of body weight lost to replace the amounts lost during training and competition.[5]

RECOVERY FOOD OPTIONS

	Calories	Carbohydrate (g)	Fiber (g)	Protein (g)	Fat (g)	Sodium (mg)
Option 1 **Gatorade Protein Recovery Shake** Water (amount based on body weight changes)	270	45	1	20	1.5	320
Option 2 **Gatorade Recover Whey Protein Bar** Water (amount based on body weight changes)	340-370	42-43	1-2	20	9-12	160-210
Option 3 **Beef jerky (2 oz) & 10 saltine crackers** Water (amount based on body weight changes)	360	28	1	21	14	1,490
Option 4 **Muscle Milk 100% Whey protein mixed with water plus a banana**	235	30	3	25	2	160
Option 5 **Evolve plant-based protein powder mixed with water**	160	21	10	20	2.5	380

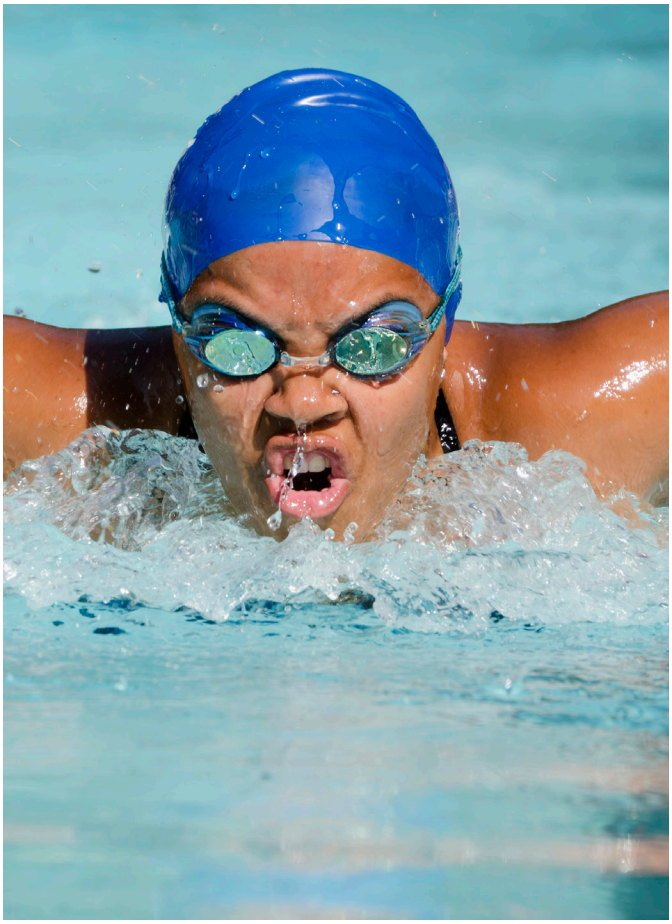
ADAPTED FROM STELLINGWERFF ET AL.[1]
TABLE II: RECOMMENDATIONS FOR RECOVERY NUTRITION ACROSS DIFFERENT TRAINING AND COMPETITION SITUATIONS FOR POWER ATHLETES

	Long aerobic/ endurance training	Intense short duration or prolonged resistance circuit training	Technical drills/ short duration resistance training	Situations of short recovery (<4 hours)
Exercise Characteristics	Prolonged aerobic exercise (>1 hour) of easier intensity	High-intensity training of shorter durations (~20-40 min)	Low volume of explosive movements	Multiple races or training sessions on the same day
Training Objective	Enhance oxidative enzymes, fat metabolism and endurance	Enhance glycolytic enzymes, buffering capacity, lactate tolerance and muscular power	Sub-maximal and maximal muscular strength, technique and economy development	N/A - specific to the training and racing demands
Specific Recovery Needs	CHO intake of primary importance for glycogen resynthesis Protein needed for muscle recovery and remodeling	Carbohydrate intake of primary importance for glycogen resynthesis Protein needed for muscle recovery and remodeling	Lower carbohydrate intake needs (some glycogen resynthesis needed) Protein needed for muscle recovery and remodeling	CHO intake of primary importance for glycogen resynthesis Focus on foods that are GI tolerable for subsequent exercise (minimal FAT and PRO intakes)
Macronutrient Recommendations *(within ~2 h)*	CHO: ~1.2-1.5 g/kg PRO: ~0.3 g/kg FAT: ~0.2-0.3 g/kg	CHO: ~1.2-1.5 g/kg PRO: ~0.3 g/kg FAT: Minimal requirements	CHO: ~0.5-1.0 g/kg PRO: ~0.3 g/kg FAT: Minimal requirements	CHO: ~1.2-1.5 g/kg PRO: Minimal requirements FAT: Minimal requirements

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 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: Melissa

Age: 19

Weight: 135 lbs (61.4 kg)

Type of athlete: Swimmer

Goal: To combat fatigue in her two-hour training and competition

Melissa is a collegiate swimmer and competes in sprint events. During her sophomore season, she has been having trouble feeling energized throughout an entire training session or during her races. By the end, she is always dragging, even though she gets plenty of sleep. She has also seen a doctor, and she does not have any indication of iron-deficiency anemia. Her coach has asked her to consult with the team's sports dietitian for advice.

After completing a three-day food record for the sports dietitian, it was pretty apparent what could be causing Melissa's lack of energy. Over the summer, she was on a program to gain lean mass and lose body fat and had adapted a higher protein, lower carbohydrate diet. However, Melissa never altered her diet as she entered pre-season training, and as a result, during the season her diet is still higher in protein than desired for a power sport athlete. Stored carbohydrate is the primary fuel source for Melissa's muscles to contract while swimming, so as a result of her diet it is likely she has fairly low stores of muscle glycogen, which may be causing her fatigue toward the end of training or competitions. Based on the guidelines, Melissa should be eating ~368-737 g of carbohydrate per day. For a female, the sports dietitian recommended she be on the lower end of this range, around 450-500 g/day. Right now, Melissa is only eating about 200-250 g/day! So, the first step is to alter her habitual diet and introduce more carbohydrate, cutting back on the high levels of protein.

Although she didn't eat much carbohydrate throughout the day, Melissa did do a good job eating a high-carbohydrate meal before training or competition. However, she never thought about fueling or hydration during her workouts or competitions. To provide energy and hydration, another suggestion from the sports dietitian was to make sure Melissa had a sports drink on the side of the pool during practices and to drink a sports drink during her breaks in a meet. Swimmers do sweat in a pool, so the dietitian weighed Melissa before and after a practice and measured any fluid intake, calculating her sweat rate to be about 0.5 L/hour, which is pretty typical for a swimmer. Keeping a 20 oz bottle of Gatorade Thirst Quencher on the side of the pool to drink every hour will meet Melissa's hydration needs and provide 35 g of carbohydrate, which falls into the 30-60 g/hour recommended range. The dietitian will monitor her

progress and reports of fatigue. If she still needs more energy, during breaks she can also eat the Gatorade Energy Chews for an additional 21 g of carbohydrate to get her to the upper end of the suggested range. Melissa should follow the same plan she uses at practice during breaks at a meet.

Lastly, Melissa never paid attention to recovery nutrition, just eating when she felt hungry and got a chance to find food. Because glycogen is such an important fuel source for a swimmer, it is important that she replenishes those muscle carbohydrate stores shortly after training or competition. Since Melissa needs to get about 74-92 g of carbohydrate for recovery based on her body weight, the sports dietitian recommended a bottle of Gatorade Recovery Shake along with a bagel for ~50 g of extra carbohydrate to meet the goals (which Melissa doesn't mind since she's always starving when she's finished swimming!).

These suggestions are pretty big changes to Melissa's overall diet as well as sport nutrition plan. In order to avoid any stomach upset and turn her away from wanting to make these changes, the dietitian put together a plan to slowly introduce the carbohydrates. Over the course of a month, Melissa gradually increased her carbohydrate intake during the day, during training or competition and for recovery. Melissa has reported that the extreme fatigue she was feeling is very much improved.

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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