5 Nutrient Timing and Training

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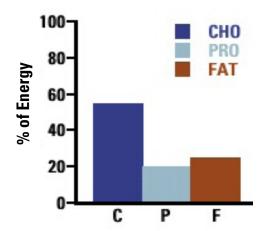
Recovery and Commercial-Off-The-Shelf
Products or COTS

Key Points

- The timing of nutrient delivery is critical to sustaining performance.
- The **Refueling Interval (RFI)** is the 45 minutes after finishing a workout.
- Eating during the RFI will accelerate recovery and restore energy for the next day's workout.
- A daily diet that is balanced and nutrient-dense will ensure better performance and optimal recovery.
- CHO foods and beverages that have a moderate to high glycemic index, such as sport drinks, raisins, honey, bananas or potatoes are ideal recovery foods.
- Adding protein to the recovery meal will help stimulate protein synthesis to assist in rebuilding muscle (anabolism).
- For exercise longer than 90 minutes, consume 50 grams of CHO and 12 grams of protein as food or drink immediately during the RFI and 50 grams of CHO every 2 hours for 6 hours.
- Adequate fluids must be ingested after a mission.
- Fluid replacement beverages should contain sodium and potassium.
- Sports bars, gels and drinks are lightweight, portable and easy to eat during military operations.

he goals of training are to promote changes in the body such that muscular strength, aerobic capacity, and endurance are optimized. Training goals cannot be achieved in the absence of appropriate nutritional strategies. Before and after training or missions, strategies to ensure adequate energy stores and rapid recovery for the next mission are critical. Well conceived meal and snack plans will enhance preparedness, boost morale, stimulate muscle protein synthesis, and help protect against training injuries. Nutrient timing combined with rest are essential. This chapter will provide information about nutritional strategies to optimize training in preparation for missions.







Warfighter Activity: Recall an operation that caused complete fatigue as a result of sustained effort for mission success.

Everyday Nutrition and the "ine" Diet

For performance and recovery to be optimal, the everyday diet of Warfighters must be as good as it possibly can be. Routine dietary habits must be considered to determine what should be done to ensure operational performance and overall good health. The usual CPF (CHO: Protein: Fat) pattern should approximate: CHO—55%; Protein—20%; and Fat—25%. This is not the usual Warfighter pattern.

Navy SEAL Mike Fullerton stated that all military members are on the so called "ine diet." "We all wake up at 0-dark thirty, grab a big gulp of java (caffeine), dip a pinch of Skoal (nicotine) and grab a few honey buns from the "gee-dunk" (vending machine)." This pattern of eating over many years comes back with revenge, and makes recovery from strenuous missions more and more difficult. The following other dietary practices are admitted by many Warfighters:

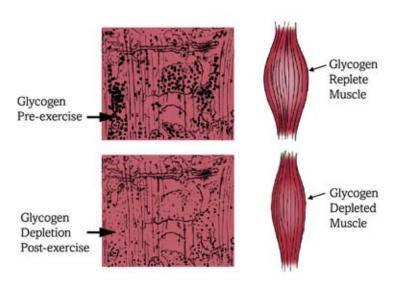
- · Consuming the majority of calories at the end of the day.
- Underestimating calories consumed and portions eaten.
- Planning meals poorly.
- · Eating too much fast food chow.
- Using multiple dietary supplements to enhance performance.
- Using caffeine and simple sugars to fill the void during the day.

The following operations require nutritional countermeasures to avoid complete exhaustion and muscular fatigue:

- Wearing boots and body armor and carrying heavy packs and ammunitions for over 60 minutes.
- Fast roping or dragging a wounded comrade to safety.
- Extended water operations.
- Altitude operations.
- Prolonged shivering in austere environments, such as operating in mountainous regions or diving in cold water.

Fatigue and Glycogen Depletion

Fatigue is a complex phenomenon caused by failure at multiple sites during exercise. The causes of fatigue can be central (mind/central nervous system or neuromuscular) and/or local (peripheral—muscle). One nutritional cause of fatigue is depletion of muscle glycogen. All strenuous exercise, be it endurance, resistance training or missions, will deplete glycogen. Muscle glycogen must be replenished through nutritional interventions to override fatigue and accelerate recovery.



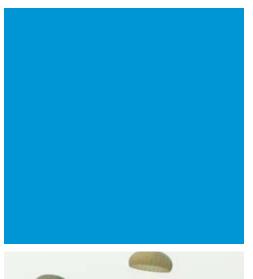
It takes at least 24 hours to replenish muscle glycogen stores following exhaustive exercise or operations.

Glycogen repletion occurs when enough CHO is provided. If diet is neglected over time, "staleness" can become a problem.

"Staleness" and Overtraining

The terms "staleness and "overtraining" are consistently noted for competitive athletes and may apply to Warfighters as well. Staleness and/or overtraining are believed to result from too little recovery time in combination with too much training. Other factors or non-training stressors can also contribute to staleness. A multitude of symptoms are associated with overtraining, including:

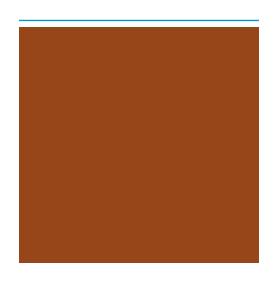
- Unexplained, persistently poor performance.
- · Moodiness, general fatigue, depression, and irritability.
- Painful muscles.
- · Elevated morning resting pulse.
- Insomnia.
- · Weight loss.
- · Overuse injuries.
- Increased susceptibility to upper respiratory infections and gut problems.







CHO intake over 24 hours will typically not exceed 650 grams.



Too rigorous a training program can impair immune function.

How staleness or overtraining is expressed depends upon the physical and physiological makeup of the warrior, type of training regimens, dietary practices, sleep patterns, and various other factors. No single test can identify overtraining, but a number of key markers that change over time have been proposed. Possible markers include stress hormones, immune markers, indicators of muscle damage, compromised muscle glycogen reserves, and decrements in aerobic and anaerobic capacity. Drs. Jack Raglin and William Morgan from Indiana University developed a scale to identify endurance athletes who exhibit signs of distress resulting from intensive training. Called the Training Distress Scale, it consists of ten items that are individually scored and then used to create a total score. If an individual's total score is high over several consecutive days, a couple of days of rest are critical to preserve future performance.

Click here to complete the Training Distress Scale.

The Remedy

- Make sure that training is accompanied by periods of rest.
- Ingest a meal providing 1.5 gram of CHO per pound of body weight approximately 4 hours prior to exercise.
- Ingest 0.4 grams of a low GI CHO drink or solid food per pound of body weight 1 hour before exercise/operations.
- Consume an easily digested, high-CHO drink or food that provides approximately 50 grams of CHO and 12 grams of protein within 45 minutes after exercise.
- Consume 0.5 grams of CHO per pound of body weight every 30 minutes until 4 hours after exercise.
- Consume a high CHO drink or solid food providing at least 250 kcal (60 grams) of CHO with each meal.
- Be certain your body weight is stable during all phases of training by matching energy intake to energy requirements.

Example: CHO in grams for a 155 lb warrior: Before Exercise:

233 g (155 x 1.5) of CHO 4 hrs before 62 g (155 x 0.4) of a low GI CHO up to 1 hr before

Immediately After Exercise:

50 g of CHO and 12 grams of protein 1-4 hours after exercise 78 g (155 x 0.5) of CHO every 30 minutes until 4 hrs

Click here to calculate CHO intake before and after exercise.

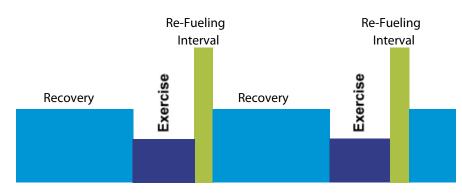
Nutrient Timing

The timing of "when" nutrients are consumed may be as important as "what" nutrients are consumed.

The timing of nutrients should be viewed as three very distinct phases:

- · Recovery or maintenance.
- Exercise when energy stores are being depleted.
- The RFI, or critical period after exercise.

During exercise the environment is "catabolic" so that energy can be delivered to the working muscles. Insulin, an important hormone for promoting muscle protein synthesis, is not released during exercise because it is not needed. After exercise the environments must become "anabolic," so the process of recovery and building up what was lost begins: insulin



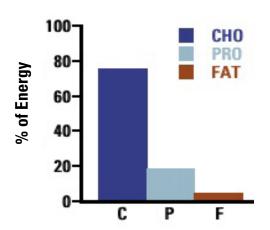
Phases of Timing Nutrient Intake

Table 5–1. CHO Content (grams) of Various Foods and Beverages

Low-fat milk, 1 cup	12
Bread, 1 slice	13
Oatmeal cookie, 1	15
Pound cake, 1 slice	15
Apple, 1	19
Blueberries, 1 cup	20
Wheaties, 1 cup	25
Blueberry muffin, 1	25
Pear, 1	25
Baked potato, 1	25
Bean & meat burrito, 1	33
Banana, 1	35
Sweet corn, 1 cup	40
Macaroni, 1 cup	40
Rice, 1 cup	40
Cinnamon bagel, 4"	50
Bagged pretzels, 10	50
Pancakes & syrup, 2	90
Seedless raisins, 1 cup	130



Nutritional intervention within 45 minutes after exercise is the most critical time, or "RFI," for recovery.



release must be stimulated. Ingestion of CHO stimulates "insulin." Thus, immediately after exercise, when glycogen stores and muscle protein synthesis are low, is the critical time to provide what the body or muscle needs: CHO with a small amount of protein.

Running on an empty tank for too long after strenuous operations or PT will be detrimental to performance and duties the next day. To avoid performance decrements, or fatigue, a CPF of 80%/20%/0%, or as little fat as possible, is recommended. This means a small meal of CHO (50–60 grams) and protein (12–15 grams), taken as food or fluid within 45 minutes after completing exercise, will help begin repletion of muscle glycogen stores and synthesis of muscle protein. This RFI will set the stage for both recovery, repair, and muscular growth.

RFI: Consume 50 g of CHO and 12 g of protein within 45 minutes after training.

More protein may compromise recovery and muscle protein synthesis.

Glycemic Index:

Describes how a particular food raises blood glucose levels.

** List of Glycemic Index Classification.

Table 5–2. Possible RFI Foods				
Food and/or Beverage Product(s)	CHO (g)	Protein (g)		
Peanut butter, 2 Tbsp, and jelly, 2 tsp, on wheat bread, 2 slices	43	14		
Wendy's Mandarin Chicken Salad and Cran-apple juice, 8 oz	88	27		
Hard-boiled egg, 1, and bagel	56	12		
Hand-Tossed Style Chicken Supreme Pizza (Pizza Hut), 1 slice, and juice, 8 oz	57	13		
McDonald English Muffins with Jam, 2	36	5		
Subway Oatmeal Raisin Cookie and 6" Deli Turkey Breast Sub	76	21		
Subway Breakfast Western Egg with Cheese on Deli Roll with orange juice, 4 oz	43	0		
Taco Bell Bean Burrito, 1	54	13		

Table 5–2. Possible RFI Foods				
Food and/or Beverage Product(s)	CHO (g)	Protein (g)		
Low-fat yogurt with fruit, 8 oz	47	11		
Soldier Fuel Bar, 1, or other high CHO Sports Bar	40	10		
String cheese, 2, and apple or pear, 1 large	23	14		
Cereal with low-fat milk, 1 cup	53	13		
Arby's Jamocha Shake, regular size	81	11		

Good food choices should be made throughout the recovery/maintenance phase when muscle growth and tissue repair are needed.

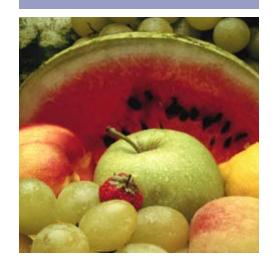
After the first 45 minutes, nutrient intake will depend on the duration, intensity, and type of activity. Low intensity exercise of short duration will require regular meals at regular intervals, whereas high intensity exercise of both short and long duration will require regular snacks of carbohydrate and protein, with some fat. Obviously, the longer the duration of the activity, the greater the energy drain, thus a greater need for refueling the tank.

A recovery meal to ensure nutrients, fluids, and calories are replenished immediately after PT during the RFI and over the course of the day is important. Examples of nutrient-dense recovery foods include the following:

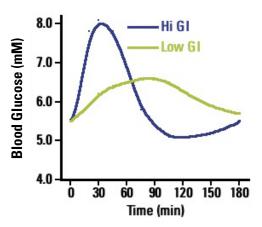
- Sports bar, 1, with 50 g CHO and 12 g protein.
- 100% fruit juice, 8 oz.
- Low-fat yogurt, 8 oz.
- Whole grain bagel, 1.
- · Honey, 1 oz.
- · Cottage cheese, 4 oz.
- · Tuna fish, 3 oz.
- Tomato or V8 juice, 8 oz.
- Whole fruit, 1 piece.
- Homemade trail mix, 6 oz.

Click for nutrient content of recovery foods and a trail mix recipe.

These Recovery Meals ensure that nutrient-dense foods, to include carbohydrate-rich, high quality protein, and healthy fats are eaten by Warfighters at the right time. Commercial Off the Shelf (COTS) products are being used in some military commands currently to help provide carbohydrate-rich foods such as sports drinks, bars, and gels during training so



- Click here for more information on electrolyte balance.
- Click here for more information on potassium.





they can train and deploy with the same products. These nutrition initiatives have allowed Warfighters to access nutritionally desirable foods within their commands immediately after PT and in operational settings. Most importantly, COTS are considered "comfort foods" because they are familiar and previously used during phases of training.

All Carbohydrates are NOT Created Equally

Not all CHO foods are equally effective in restoring blood glucose. Certain foods raise blood glucose concentrations and promote glycogen synthesis better than others. The term Glycemic Index is used to describe (and rank) how high a particular food will raise blood glucose; foods with a high glycemic index (GI) are the most effective for restoring glycogen. As shown in the graph, a high GI food produces a "spike" in blood glucose, whereas a low GI food takes a longer time to peak. Immediately after a mission, foods and beverages that have a moderate to high GI should be consumed. During recovery and maintenance, foods with a low GI are preferred.

Click here for a list of foods according to their GI.

Click here for more information on the Glycemic Index.

Rehydration

Fluid requirements can vary from 2–16 liters/day depending on:

- · Workload.
- · Level of heat stress.
- Sweat rates.

Sweat loss varies depending on age, training, and acclimation status, exercise intensity and duration, air temperature, humidity, wind velocity, cloud cover, clothing, and individual sweat rates.

The adequate fluid intake for men between 19–50 years of age is 13 cups/day. On average, 20–25% of the fluid comes from food and 75–80% from beverages. Plain water, coffee, tea, soups, fruits, and vegetables also provide fluids and support hydration. A small amount of caffeine in tea or coffee (< 200 mg) should not negatively affect hydration status, but if more caffeine is taken in, fluid balance may be negatively affected.

Click for the caffeine content of various products.

For each liter of sweat lost, a loss between 115–690 mg of sodium is possible in a well-conditioned warrior. If unaccustomed to working in the heat, heavy sweaters can lose as much as 2,500–5,000 mg of sodium per liter of sweat! To individualize fluid and electrolyte recommendations:

 Record weight before and after exercise to determine how much fluid should be replaced. • Consume 2.5–3 cups of fluid for every pound lost.

Typically, voluntary consumption of fluids will restore only part of the fluid lost. Whenever possible, weigh yourself before and after a training so you can quantify your fluid loss. Your sweat rate during a mission will differ based on the environmental conditions, and this could intensify weight loss. To determine how much fluid you may lose during a strenuous mission in 64°F versus 82°F or 18°C versus 28°C, click here.

Over a period of several hours, you should ingest more water and sodium than initially lost. The total replacement volume should be between 125% and 150% of the decrease in body mass. So, if you lost 4 pounds, you would want to take in 5–6 "pounds," or 10–12 cups of water. The fluid **must** be taken in over a period of time rather than at one time. Ingesting 8–16 ounces every 20–30 minutes will allow for water absorption and minimizes water lost by urination. Do not drink more than 48 oz or 1.5 L per hour.

Fluid replacement beverages used during exercise are also appropriate for rehydration. Rehydration beverages containing a higher percentage of CHO than used during exercise are suitable, but it is better to obtain CHO from real foods. Oral Rehydration Solutions (ORS) available through the military medical supply channels can be used, but they are often higher in sodium and lower in CHO than desired.

Rehydration in the Field

A drink that will rapidly promote rehydration, is almost palatable, and contains an acceptable amount of electrolytes (although barely enough potassium) can be made in the field. The fluid is prepared by mixing ½ strength of a fluid replacement beverage (Gatorade, Powerade, Gookinade or the like) with ¼ strength of a standard ORS. However, this drink will **not** restore glycogen because it is too low in CHO.

Sodium/Electrolyte Replacement

Sodium and potassium losses in the sweat can be quite high during prolonged physical activity, especially in warm weather. Replacing these elements is an important part of the recovery process. Most commercially available fluid replacement beverages contain electrolytes. Roughly, 1–2 grams of sodium/L of fluid (0.25 teaspoon/quart) will effectively replace the sodium lost during exercise or a mission. Also, sodium is widely present in a variety of foods and fluids, such as bagels, pretzels, tomato juice, sport drinks, and pizza.

A bit of salt will speed up rehydration more effectively than plain water. Typical commercial fluid replacement beverages contain both sodium and potassium, but recovery foods should also include foods rich in potassium. Some excellent food sources of potassium are listed to the left. You will

After a training session or mission, fluid ingestion is essential.

Drink at least two 8 oz cups of fluid every 20-30 minutes for two and a half hours after exercise.



Each one quart of fluid should contain about one quarter teaspoon of salt.

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Table 5-3	(innd	Potassium	Sources

Foods	Beverages
Banana	Orange juice
Apricots, dried	Tomato juice
Orange	Pineapple juice
Baked potato	Grapefruit juice
Melons	Skim milk
Yogurt	Sports drink

Note: 1 cup of orange juice or tomato juice will replace the potassium, calcium and magnesium lost in 3 quarts of sweat.

Drinking sports drinks as recreational fluids only adds calories, and artificial coloring and flavors to the diet. notice that these foods are also good sources of CHO and most have a moderate to high GI.

Sports Drinks

Fluids providing CHO and the electrolytes, sodium and potassium, have been shown to sustain athletic performance. The genesis of sports nutrition came about when beverages were created so that CHO, electrolytes, and fluids could be consumed without having to mix, assemble or combine ingredients. The purposes of sports drinks are to:

- · Maintain hydration during exercise.
- Ensure rehydration after exercise.
- Replace electrolytes lost during sweating.
- Supplement CHO stores and provide fuel for the working muscles during exercise.
- Minimize muscle from strenuous workouts.
- Protect the immune system.

Although sports drinks containing electrolytes will enhance endurance performance, many people use these drinks as a recreational fluid. This only adds calories, artificial coloring and flavors to their dietary intake. Sports drinks are recommended when exercise is longer than 60 minutes and then, only 8 oz should be ingested every 15 minutes. For activities less than one hour, water is the best choice for hydration needs. Minimal sodium and potassium are lost through sweat and glycogen stores will not be depleted during short, low intensity workouts.

General rules for fluid replacement:

- If you are sweating profusely, try to consume fluids at the rate lost (not to exceed 1.5 L/hour) or as much as tolerated if sweat rate is exceeding the rate of stomach emptying.
- Develop a plan for fluid consumption and practice it during training and operations.
- Sip frequently rather than gulp on occasion; drinking small amounts of fluids at a time are more effective than large amounts only occasionally.
- · Start drinking before thirst kicks in.

The ideal CHO/electrolyte drink:

- · Is not carbonated.
- Empties rapidly from the digestive tract.
- · Tastes good.
- Provides energy for exercise > 1 hr.
- Delivers 9-19 grams of CHO per 8 oz.
- · Contains sodium and potassium.
- · Does not cause digestion problems.
- Is cool (10 to 15°C).

Sports drinks should be used during and after long bouts of exercise in hot and humid conditions. However, if real food and 100% fruit juices are available after exercise, these high CHO foods are the best electrolyte choices. Sodium is still important to take after exercise as it helps increase the desire to drink fluids and improves fluid retention.

Recovery and Commercial-Off-The-Shelf-Products (COTS)

Many Commercial-Off-The-Shelf (COTS) products are used for recovery. In addition, sport drinks, sports bars, gels, and other similar products are used. Some have many nutrients added, which are usually not needed or are provided in excessive amounts. The Nutrition Committee and the Dietary Supplement Committee within the Department of Defense developed criteria for various COTS categories. The criteria were prepared as guidelines on what products are safe and useful, according to scientific data, because such products are important when real food is not available. The criteria for sports bars and gels are provided below.

Sports Bars

Sports bars originated in the early 1980s when it was shown that ultramarathoners and other endurance athletes did better when provided concentrated sources of easily absorbable CHO during long training runs. Sports bars, in contrast to sport drinks, are solid, so the user must drink water to enhance digestion and absorption.

Table 5–5. Criteria for COTS Recovery Sports Bars

CHO: ≥ 53% of Energy.

CHO/PRO: ≥ 4:1.

Fiber: ≥ 1 grams.

To avoid gastrointestinal distress when fluid losses are high (> 4L), beverages should be diluted with water to half of their original strength.

Table 5–4. Suggestions for Selecting Sports Bars

Bars should **not** provide more than 100% of the DRI for vitamins and minerals.

Bars should be used with water, not sports drinks, to prevent overloading on CHO.

Bars should be high in CHO, and low in fat and protein.

Protein should not exceed 1 gram to every 4 grams of CHO.

Fat take longer to digest than CHO, so sport bars high in fat should be avoided during exercise.

High protein bars (40-30-30) should only be consumed when real food sources of protein are limited.



Total Fat: \leq 30% of Energy.

Saturated Fat: ≤ 20% of Energy.

No trans fats.

Sodium: 50-240 mg.

No substances other than vitamins, minerals, protein and fat.

Table 5–6. COTS Recovery Sports Bars Meeting Criteria				
PRODUCTS	kcal	CHO (g)	Protein (g)	Fat (% of kcal)
Bear Valley Pemmican Mealbar	420	62	16	25
Gatorade Bar	260	46	8	17.0
Soldier Fuel (Formerly Hooah)	270	40	10	26.0
Odwalla Bars (not Super Protein)	240	40	6	20.8
PeakBars	244	57	4	<10
Smart Fuel MPN Oatmeal WARPBar	180	31	8	16.7
PowerBar Performance	230	45	10	10



The Hooah Bar, now known as "Soldier Fuel," is an excellent recovery bar available throughout the military. It must not be mistaken for the old Hooah bar. In 2004 the manufacturer worked closely with Natick Soldier Center researchers to refine, reformulate, and improve the original bar for the military and commercial marketplace. The new bar has been rated highly by all who have tasted it. The Washington Post rated the bar above all other sports bars. The reformulated bar contains no trans fats and provides the requisite amount of CHO and protein for recovery.

Sport Gels

Sport gels were developed in the 1990s in response to complaints by endurance athletes that sports bars were difficult to digest and absorb when used during exercise. Gels have become increasingly popular for long workouts as they help maintain blood glucose and fuel the tank. However, drinking fluids is essential when using gels. Gels are popular with Warfighters because they are:

- · An absorbable form of CHO, which makes eating on the go easy.
- Lightweight (1 oz) and easy to pack for many long and enduring operations lasting more than 90 minutes.

Gels may be useful after exercise for glycogen repletion when real foods are not available, but are unnecessary for short workouts, regardless of intensity.

Potential Problems with Gels

Gels are virtually 100% CHO, so it is easy to take in too much, which will lead to GI issues, such as diarrhea. Gels should be tested before combat situations to see which one works best. After over an hour of exercise, 1–2 packets are recommended, but they should be used with water, rather than sports drinks to prevent CHO overload. Listed below are the criteria for gels and various products that meet the criteria.

Table 5–7. Criteria for Commercial Off-The-Shelf Sport Gels

CHO to Protein Ratio: \geq 4:1 ratio if any protein.

Sodium: \leq 3 mg/g weight.

Energy: $\leq 3 \text{ kcal/g weight.}$

No substances other than CHO, electrolytes, protein, and caffeine.

Table 5–8. COTS Sport Gels Meeting Criteria				
Products	kcal/100g	CHOg/100g	CHO:Pro	Sodium
			≥ 4	mg/g
Carb-BOOM!	268	66	-	1.2
Pro-Boom	170	30	-	2
Hammer Gel	253	64	-	0.6
Lava Gel	294	74	-	0.7
Clif Shot Gel	300	71	-	1.2

It is both healthier and cheaper to use real foods.

These CHO-rich supplements are used more often than needed because they are convenient, easy to use, and provide readily absorbable energy. Many athletes habitually eat sports foods instead of wholesome meals, even though sports products cost more than other foods. Sports drinks cost more than water, sports bars cost more than Fig Newtons, and sports gels cost more than honey.

The right combination of fluids, carbohydrates, proteins and fats in a timely manner will provide the nutritional optimization required for strenuous activities and high impact missions. The body is the vehicle that allows Warfighters to do what they have been trained to do, and it must be fed the same way as any vehicle requiring high-octane fuel. The strategies in this chapter will, in the long run, greatly benefit the mission and the Warfighter.

"Who would have thought just eating breakfast would make the difference."

Sean Morrison, SO1, USN