

Nutrition and Soccer Performance

Dr. Don Kirkendall

You wouldn't put low octane gasoline in a race car, would you? Yet, even today, with all the research on nutrition and athletic performance, athletes still fail to realize the connection between the food they eat and their ability to compete in sports. The time for a reminder is now.

Proteins, fats and carbohydrates are the main components of your diet. Protein supplies amino acids for many processes in the body, but supplies little energy for exercise. Despite all the bad press, fat is a necessary ingredient. Fat insulates nerves, carries substances in the blood, packs organs and serves as a warehouse for energy, some of which is used to play soccer. Carbohydrate is the main source of energy in your diet. How much carbohydrate you eat will directly affect your ability to run and is the subject of this article.

Carbohydrate is found in many foods like vegetables, fruits, breads, grains, pasta, and dairy products. When eaten, carbohydrates are broken down into glucose and stored in your liver and muscles as a string of glucose molecules called glycogen. If your ability to run far and fast is related to how much gas you have in your tank (glycogen in your muscles), then the more you have stored, the farther and faster you can run. In addition, if you eat properly after heavy training, you can actually store more glycogen than if you ate improperly. So you could cover even more distance at a fast pace. Is fat used for energy in soccer? Yes, during low intensity work like walking and slow jogging. You won't run out of fat for fuel, but you can run out of glycogen. You need glycogen to go fast - remember, soccer is not played at a walk.

Do we know anything about muscle glycogen and soccer? Plenty.

1. Most soccer players make poor food choices (too much protein and fat) so they enter games with less than a full tank of gas (less muscle glycogen than most athletes should have).
2. Most the glycogen in the muscles is used in the first half of a game. By the end of the game, glycogen levels are almost zero. Your sprints get shorter and less frequent as the game goes on.
3. The more glycogen, the further and faster players run. A research study showed that players who ate lots of carbohydrate ran the most and only walked about 25% of the total distance. Players who ate a "normal" meal covered about 25% less distance and covered most of it at a walk. Can you guess who won this game?

Any suggestions for soccer players when choosing foods to eat?

- Choose foods with the highest carbohydrate and lowest fat count. Carbohydrates should make up 55-65% of the diet. Choose, for example, bagels over sliced bread, baked potato over French fries, a high carbohydrate cereal over a low carbohydrate cereal (read those labels!).
- A teenage or adult athlete should eat 450-600 grams of carbohydrate a day (spread it out over 24 hours-think you can eat that amount of spaghetti in one sitting? That's over 2 dry pounds of spaghetti!). Younger players would eat less because they are smaller. The rough formula is 7-10 grams/kg/day.
- If you make poor food choices and train regularly, you can't refill your glycogen levels before tomorrow's practice. Thus, glycogen levels stair-step down as the week goes on. It is important to eat plenty of carbohydrates during training, not just for matches.
- Your muscles are the most "thirsty" for glycogen right after exercise.

So try to eat a good supply of carbohydrates within the first 2 hours after play. Don't wait. Have carbohydrate rich foods available right after a game. This is especially important if you are playing in a tournament with many games in a short time. Give yourself every advantage and refuel for the next games. Choose fruit juices, carbohydrate replacement drinks, bagels and jam, fresh or dried fruit, uncooked "Chex Mix" types of finger food. If candy is acceptable to your parents, choose "clear" candy like "gummi" candy, jelly beans, etc. (chocolate-based candy has too much fat and calories). Stay away from the chips, burgers, fries, nachos, etc.; too much fat and not enough carbohydrates.

The smart athlete will try to give himself or herself every advantage to help their team to win. Knowing you are going into a game with a "full tank of gas" means you are ready for the highest demands of the game. Also, if you have eaten properly and are playing a team who played yesterday (who likely hasn't eaten properly), you know you are at an advantage and will be fresher in the second half.

Eating To Play

Notes adapted from Dr. Don Kirkendall's article

A letter was sent to the editors requesting information about eating around game times. With the new season nearly upon us, it is probably a good time to review some topics associated with nutrition and sports performance.

This has been one of the most intensely researched topics in the sports performance literature and there have been many advances from the "Saturday morning steaks" that dads might remember from their high school football days.

Research can be grouped into four categories regarding the timing of eating: training days prior to competition, day of competition, during competition and after competition. In brief, carbohydrates are the best choice so choose foods that give the most carbohydrate per serving.

It is important for players to plan day-long sports foods:

- Maintain proper pre-event carbohydrate and fluid intake. Adequate high carbohydrate pregame foods options are spaghetti, raisins, low fat granola or cran-raspberry juice.
- Eat high carbohydrate sports snacks in between games. Good foods to have on hand are bagels, bananas, juices, pretzels, yogurt, chocolate milk, and yogurt.
- Preselect an appropriate restaurant with good pre-game food choices when traveling to a tournament.
- Pack favorite sports foods to eat before, during, and between practice sessions and games. Good choices include sports drinks, oatmeal raisin cookies, trail mix, oranges, bagels or energy bars.

"The right sports diet can indeed enhance performance," Clark says. "Athletes and teams who are doing well despite poor food choices can do better when they pay attention to their diets."

Days Prior To Competition

This was the first real focus of study that led to the "glycogen loading" concept. Without going into a lot of scientific history, the typical routine now is to gradually reduce training volume and intensity while increasing the fraction of the total diet that is carbohydrates. This will help the muscles load up extra glycogen (the main fuel for muscles) for the game.

In soccer, this is not a common practice unfortunately. Most research shows that the muscle glycogen levels of (male) soccer players are no better than the spectators in the stands - not good.

Studies on soccer players have shown that those with the most pre-game muscle glycogen run the farthest at the fastest speeds during a game. As such, it is surprising to see that glycogen loading schemes have not been as universally adopted in soccer as they have in traditional endurance sports like running, cycling, cross-country skiing and triathlons.

Five to six grams of carbohydrate per kilogram of body weight over a 24 hours period is the typical suggestion so read those labels on food packaging. Remember, 1 pound of body weight/2.2 = kilograms of body weight.

Day of Competition

There is probably no more area full of misleading information than eating the day of competition - the proverbial pre-game meal. Most pre-game meals are eaten in the 3-4 hours prior to competition. But realize that the food eaten will have little to do with the energy expended in the game. That comes from what was eaten in the 2-3 days prior to the game.

Most players eat what they like so they won't still feel full come game time. Remember that the more calories (i.e. fat and protein) in a meal, the slower the food leaves the stomach. Carbohydrates are always the best choice and include fruits, cereals, juices, pancakes/waffles etc. over sausage, eggs, steak, or many choices on the breakfast menu at a fast food restaurant.

Food in general, and carbohydrates in particular, should be avoided in the last hour before play. Carbohydrates stimulate an insulin response which lowers blood sugar and also stimulates the production of serotonin, a chemical in the brain that reduces arousal (makes you listless and sleepy).

Both are obviously counterproductive to competition. If something must be eaten, choose low glycemic index foods as they cause less of an insulin response. (see table)

Immediately prior to competition (in the minutes before kickoff), carbohydrates can be taken in. The excitement of the game will counteract the insulin response and the fresh carbohydrates give the muscles an extra source of fuel. The type of carbohydrates is important. Foods should be of a moderate or high glycemic index.

Carbohydrate supplement drinks work great. "Clear" candies (jelly beans, "Gummy" candy, Skittles etc. you get the idea) are another choice.

Eating During Competition

During the game, carbohydrate supplement drinks given before the game and at halftime have been shown to increase running volume and intensity in the second half in soccer players. This is important to consider because goals become more frequent later in the game as players get tired.

If you have more energy than your opponents, you are more likely to have an advantage over the opposition and hopefully, score more goals later in the game. Ubiquitous orange slices at halftime are pretty low on the priority as a carbohydrate source.

Eating After the Game

The game uses muscle glycogen (carbohydrate) so it must be replaced. Research has shown that muscle is the most receptive for carbohydrate replacement in the first two hours after exhaustive exercise. Therefore, it is important to eat some moderate to high glycemic index foods in the first two hours after a game.

From the table below, you see there are quite a variety of options for food, most of which require a little planning and typically do not come in a bag or a tray from a fast food restaurant. Tournaments, with games at 12 noon and 4 pm, it is necessary to get some carbohydrates back into the muscles quickly.

Remember, fast foods are high in fat and protein and can remain in the stomach at the start of the next game (depending on when it was eaten and how much was eaten), and doesn't return much in the way of carbohydrates to the muscles, therefore should be avoided.

A nutritionist gave me a good suggestion: make up bags of Chex Mix with some pretzel sticks added (forget the oil and baking requirement) and let the players eat this after the game. Clear candy is also good as are raisins, cakes, pies, bagels. Ideally, eat 50-75 grams of carbohydrate every two hours until you reach the total based on your weight (5-6 grams/kg body weight).

But don't get the idea that all the carbohydrate can be replenished in a couple of hours. Under the best of conditions, it can take 20 hours to fully replenish muscle glycogen from muscles that have been completely depleted.

Eating for sports performance requires a bit of planning and clock watching, but can lead to improvements in performance. When done properly, the players will notice they have more energy late in games as well as when they have multiple games with minimal recovery between games.

For more information, try:

<http://www.olympic-usa.org/inside/> - USOC website for nutrition information including some sample menus.

<http://www.mendosa.com/gi.htm> - a complete discussion of the glycemic index.

<http://www.mendosa.com/gilists.htm> - for a long list of foods with their glycemic index. These last two sites are written for diabetics, but contain much useful information.

High Glycemic Foods

Syrups (e.g. maple, corn, cane); Honey; Bagel, white bread, jams, jellies; Potato; Most cereals; Raisins, banana, watermelon, pineapple; Carrots, cooked; White rice; Maltodextrin; Jelly beans, Skittles, pretzels, most candy bars

Moderate Glycemic Foods

Whole grain bread; Spaghetti; Corn; Oatmeal; Oranges, grapes

Low Glycemic Foods

Yogurt; Peanuts; Beans, peas; Apple, peach, pear; Milk and milk products.

SOCCER SNACK FOODS

- Apples
- Bananas
- Dried Banana Chips
- Apricots
- Raisins
- Fig Newton's
- Graham Crackers
- Bagels

- English Muffins
- Blueberry Muffins
- Oatmeal-raisin cookies
- Granola bars
- Hard Pretzels
- Bread Sticks
- Popcorn
- Cold Cereal
- Corn Flakes
- Juice in a box
- Raw Vegetables
- Fruit snack
- Fruit Sauce

Foods that are high in carbohydrates:

FRUITS:

- Apples
- Bananas
- Peaches
- Apricots
- Raisins
- Oranges
- Grapefruit
- Kiwi
- Pineapple
- Plums
- Dates

BREADS/CEREALS

- Bagels
- English Muffins
- Granola Bars
- Rice
- Blueberry Muffins
- Toast
- French toast
- Dry Cereal
- Pancakes
- Waffles
- Oatmeal
- Pasta

VEGETABLES

- Corn
- Broccoli
- Potatoes
- Carrots
- Peas
- Beans
- Cabbage
- Yams
- Cauliflower
- Turnips
- Green Peppers

DAIRY FOODS

- Milk
- Yogurt

Glycemic Index Table

Cereals		Snacks		Pasta		Beans	
All Bran	51	chocolate bar	49	cheese tortellini	50	baked	44
Bran Buds + psyll	45	corn chips	72	fettuccini	32	black beans, boiled	30
Bran Flakes	74	Croissant	67	linguini	50	butter, boiled	33
Cheerios	74	Doughnut	76	macaroni	46	cannellini beans	31
Corn Chex	83	graham crackers	74	spagh, 5 min boiled	33	garbanzo, boiled	34
Cornflakes	83	jelly beans	80	spagh, 15 min boiled	44	kidney, boiled	29
Cream of Wheat	66	Life Savers	70	spagh, prot enrich	28	kidney, canned	52
Frosted Flakes	55	oatmeal cookie	57	vermicelli	35	lentils, green, brown	30
Grapenuts	67	pizza, cheese & tom	60	Soups/Vegetables		lima, boiled	32
Life	66	Pizza Hut, supreme	33	beets, canned	64	navy beans	38
muesli, natural	54	popcorn, light micro	55	black bean soup	64	pinto, boiled	39
Nutri-grain	66	potato chips	56	carrots, fresh, boil	49	red lentils, boiled	27
oatmeal, old fach	48	pound cake	54	corn, sweet	56	soy, boiled	16
Puffed Wheat	67	Power bars	58	green pea, soup	66	Breads	
Raisin Bran	73	Pretzels	83	green pea, frozen	47	bagel, plain	72
Rice Chex	89	saltine crackers	74	lima beans, frozen	32	baguette, French	95
Shredded Wheat	67	shortbread cookies	64	parsnips	97	croissant	67
Special K	54	Snickers bar	41	peas, fresh, boil	48	dark rye	76
Total	76	strawberry jam	51	split pea soup w/ham	66	hamburger bun	61
Fruit		vanilla wafers	77	tomato soup	38	muffins	
apple	38	Wheat Thins	67	Drinks		apple, cin	44
apricots	57	Crackers		apple juice	40	blueberry	59
banana	56	Graham	74	colas	65	oat & raisin	54
cantaloupe	65	rice cakes	80	Gatorade	78	pita	57
cherries	22	Rye	68	grapefruit juice	48	pizza, cheese	60

dates	103	Soda	72	orange juice	46	pumpernickel	49
grapefruit	25	Wheat Thins	67	pineapple juice	46	sourdough	54
grapes	46	Cereal Grains		Milk Products		rye	64
kiwi	52	Barley	25	chocolate milk	35	white	70
mango	55	basmati white rice	58	custard	43	wheat	68
orange	43	Bulgar	48	ice cream, van	60	Root Crops	
papaya	58	Couscous	65	ice milk, van	50	French fries	75
peach	42	Cornmeal	68	skim milk	32	pot, new, boiled	59
pear	58	Millet	71	soy milk	31	pot, red, baked	93
pineapple	66	Sugars		tofu frozen dessert	115	pot, sweet	52
plums	39	Fructose	22	whole milk	30	pot, white, boiled	63
prunes	15	Honey	62	yogurt, fruit	36	pot, white, mash	70
raisins	64	Maltose	105	yogurt, plain	14	yam	54
watermelon	72	table sugar	64				

Fluids

These days, drinking fluids during exercise is considered normal behavior.

The importance of drinking water was first documented during the construction of the Hoover Dam near Las Vegas in the mid-1930's. Unfortunately, the athletic community didn't catch on until the middle 1960's. In the late 60's and early 70's, the opinion of many began to shift and drinking water during exercise started to become commonplace. Nowadays, withholding water might even be considered negligent.

- We begin to sweat within the first seconds of exercise, but we don't perceive it on our skin because the sweat evaporates so fast. Once our body temperature rises, sweat production exceeds evaporation and that is when we start to notice it on our skin. Evaporation of the sweat is the actual loss of heat. The lower the humidity, the faster the evaporation. There are even modern fabrics that help in the evaporation process.
- Sweat is mostly water. The amount of salt in sweat is small, so our most important task is to replace water. (were you aware that the first sports drink, Gookin-Aid, was simply the salt and water composition of the sweat of a runner named Matt Gookin?)
- We don't begin to get thirsty until about 1% of our body weight is lost. However, our thirst mechanism is not very good. We get thirsty after we've started to become dehydrated. When we start drinking, we satisfy our thirst before we have replaced the lost fluid. If we lose 3 pounds of weight by sweating (that is 3 pints of water-remember that relationship: 1 pint of water = 1 pound of body weight), we don't drink back those 3 pints of lost water. We typically stop drinking well before full replacement of water.
- It is best to drink some fluids 15-20 minutes prior to exercise. Two to three good size mouthfuls of fluid is about right.
- Drink 2-3 mouthfuls every 15-20 minutes during exercise (performance drops off with dehydration not too mention that the real risk of heat illness accompanies dehydration)
- Drinking during exercise helps keep performance up and the body temperature from getting too high. Place water bottles around the field, in the goals, and make it easily accessible on the bench so players can freely drink during the game. Use the normal stoppages in play to replenish your fluids-remember, a 90-minute game only has around 60 minutes of play, even less on hotter days so there are plenty of opportunities to drink.
- Water or a commercial drink? Actually, the salt in the commercial drinks helps get the water absorbed a little faster. Taste also has a lot to do with it. The better the taste (water is a bit bland) the more consumed. Carbonated sodas are never a good choice -- not before, during or after a game. The carbonation fills you up too fast and you drink less.

- It takes a while to replenish your fluid levels. Do not force fluids in a short period of time. Research shows that it can take up to 6 hours to get back to a normal water balance.
- To get back into water balance after exercise, drink 1.5 times your weight loss. Therefore, if you lose 4 lbs. of weight in a game (4 pints of water) - you should drink 6 pints of fluids in the hours after the game.
- Remember to drink 8 glasses of water (or 2 of those 32 oz water bottles many players have) every day. The suggestions mentioned are in addition to the normal 8 glasses per day.

Heat illness is a very dangerous condition, but it is an entirely preventable problem. Drink before, during and after each exercise session. Weigh yourself at the same time each day. Unless you are trying to lose weight, your weight should be stable. If it's not, you may be becoming progressively dehydrated.

Fluids -- Drink Types

At a recent data collection session with Carolina United Soccer Club, we had the pleasure of chatting with a favorite political force of President Clinton: the soccer mom. There seemed to be some confusion about the different kinds of sports drinks on the market and what drink should be used and when should it be used. There are basically two types of commercial sports drinks: an electrolyte replacement drink and a carbohydrate replacement drink. Each has their own unique properties that can benefit the soccer players. However, these drinks are not interchangeable. Electrolyte replacement drinks: These drinks are designed to replace the fluids (water) and electrolytes (sodium, potassium, chloride, etc) that are lost when exercising. Water is important because all our bodily processes depend on water. When we lose as little as 1-2% of our body weight as water, our ability to run distances and perform high power output activities gets worse. Water loss also impairs our ability to regulate our body temperature. The electrolytes in the drinks replace the salt lost through sweating. The salt in the drinks also helps the body retain the water ingested and makes it a little easier for the intestines to absorb the ingested fluids. There is a little sugar in the drinks to make them more palatable. Too much sugar (too many sugar molecules per unit of water - this will come up again) and the amount of water emptied from the stomach slows down ? not good.

There are "prescriptions" for fluid intake before, during and after exercise that attempt to maintain water balance. Before exercise (the half-hour prior), one should weigh themselves, then drink up to 10-12 oz of fluids. Once exercise has started, about 6 oz should be ingested every 15-20 minutes. After exercise, weigh again and determine the amount of fluids lost (remember: 1 pound of weight lost = 1 pint of water lost) and drink back 1.5 times that amount. For example, lose four pounds (four pints of water), drink back six pints over the next six or so hours.

Carbohydrate replacement drinks: For high intensity exercise, muscles prefer to use muscle glycogen, the storage form of glucose. The purpose of these drinks is to supply a lot of carbohydrate in liquid form. The carbohydrate is a glucose polymer; a string of glucose molecules (the ingredient label should say malto-dextrin or maybe high fructose corn syrup). Above, it was mentioned that too much sugar impairs emptying of the stomach. The important factor is the number of molecules, not the size of the molecule, so these drinks contain a lot of larger molecules. Once emptied by the stomach, the glucose gets into the blood fast, within five minutes in many cases. This elevates the blood sugar pool of energy and gives muscles another source of carbohydrate for exercise.

These drinks are typically used in two settings. First, to give a source of energy during exercise. Some teams drink this (6-12 oz depending on the size of the players) immediately prior to playing a game, then at halftime (not as a substitute for water or an electrolyte replacement drink). This helps delay fatigue seen in the 2nd half (players run farther at high speeds in the second half). Second, players will ingest these drinks right after a game (another 6-12 oz) to get a start on refilling their muscles with glucose (glycogen) for the next game. These drinks, which have a higher caloric content than electrolyte replacement drinks, are not meant to be fluid replacement drinks.

Many teams will have water as well as both types of drinks; water or electrolyte replacement drink before, during and after the game and the carbohydrate drink right before kick-off, at half-time and right after the game.

This sports science article comes from the Sports Medicine Section at the Duke University Medical Center and UNC Hospitals. The authors are members of the US Soccer Sports Medicine Committee including from UNC Dr. William E. Garrett, Jr (US National Teams Physician and Committee Chairman), and John Lohnes. From Duke are Dr. Don Kirkendall (exercise physiologist) and Patty Marchak (athletic trainer for 1996 US Women's Olympic Team).

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- One week before competition DOUBLE your intake of fluids
- 4 quarts per day 1 week before competition
- Gatorade not just water
- Carbohydrate means sugar
- Carbohydrates 50-60% of total daily
- Glycogen = Muscle fuel
- Glycemic Index = How long does it take for food to break down into the blood stream
- Sleep Greater tissue growth during sleep
- Calories into athletes after performance, cookies etc, as long as they are eating correctly and regularly. You have a 2 hour window after exercise
- Glycogen only from carbs, 24 hours for glycogen to be restored
- 4 hours metabolic rate – gone in 4 hours
- When glycogen is low, performance is compromised
- Half Time – fiber free

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candy like "gummi" candy, jelly beans, etc. (chocolate-based candy has too much fat and calories). Stay away from the chips, burgers, fries, nachos, etc.; too much fat and not enough carbohydrates.

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Moderate Glycemic Foods

Whole grain bread; Spaghetti; Corn; Oatmeal; Oranges, grapes.

Low Glycemic Foods

Yogurt; Peanuts; Beans, peas; Apple, peach, pear; Milk and milk products.