



## MAXIMIZING PERFORMANCE AND MINIMIZING INJURIES IN SOCCER

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### KEY POINTS

- Technical skills—dribbling, shooting, heading, and passing—are the most important attributes of successful soccer players, but high levels of speed, endurance, strength, power, and flexibility are also required.
- Although weight training and other types of conditioning activities are important primarily during the off-season, the qualities of a good soccer player are best developed in game-like situations with small groups of players.
- The most common injuries in soccer include leg contusions, ankle and knee injuries, strained leg muscles, and mild brain concussions, which are usually caused when two players collide while attempting to head the ball. The actual act of heading itself, when done correctly, is unlikely to cause any injury.
- Maintaining adequate carbohydrate reserves and avoiding dehydration are the most important nutritional challenges for soccer players, especially because play is continuous, limiting the possibilities for fueling and replenishing body fluids.
- Foods rich in carbohydrates, including sports drinks and other fluids that contain carbohydrate, are recommended for soccer players before, during, and after soccer games and as components of their regular training diets.

### INTRODUCTION

Soccer for youths and adults is becoming increasingly popular in the USA. According to the National Soccer Participation Survey of participation in 1996, there were more youths—13.4 million total—participating in organized league competition in soccer than in any other sport, and nearly 5 million American adults played soccer (Soccer Industry Council of America, 1997). For both organized and informal participation among youths aged 6-11, soccer was second only to basketball, and among those 12-17 years of age, soccer was third behind basketball and volleyball. Furthermore, the recent success of the U.S. Women's National Team in the World Cup captivated the country, and

many franchises in Major League Soccer seem to have established solid footholds in their communities. Still, many of us have little familiarity with the physical demands of soccer and the injuries that can plague soccer participants. We asked five experts to give us their opinions on these topics. Our panelists all have extensive experience as soccer players and/or as professionals who have worked with soccer teams. Jeff Lea has coached high-school soccer teams for 23 years and has achieved a remarkable record of 315-69-35. His teams have won five state championships, and one of his players, Kyle Martino, was the Gatorade High School Player of the Year in 1999. Michele Macedonio is a nationally prominent sports nutritionist who has consulted with both youth and professional soccer clubs. Hughie O'Malley began his career with U.S. Soccer as an assistant to the head athletic trainer with the 1994 U.S. National World Cup team. He currently administers the fitness development and sports medicine programs of 10 U.S. National Soccer Teams, ranging from Under-14 teams to the Senior National Teams. Delphis Richardson is a pediatrician and high-school team physician, and Yvonne Satterwhite is an orthopedic surgeon and college team physician; both have worked with soccer teams.

### 1. What player attributes are most important in soccer, and what approaches or techniques have you found most useful in improving some of these player attributes, especially in younger players?

**O'Malley:** For young players, the most important attributes are high levels of skill in passing, shooting, dribbling, and heading. The players must be able to execute these skills on a variety of field surfaces and when the ball is delivered either in the air or on the ground. Once these technical skills have been achieved, it is much easier for the player to develop the necessary decision-making ability, field positioning, speed, endurance, and psychological characteristics. It is important to first assess the ability levels of the players and then to challenge them at those levels, which will make the game more enjoyable.

Especially for players aged 6-13 years, it is advantageous to use any activities that emphasize touches on the ball, such as games matching two groups of four or eight players.

**Lea:** I agree that technical skills with the ball are the most important attributes for soccer players in all positions. Next, I think that speed—of running, skill execution, and thought—are critical. I coach high-school players, so most of our training involves performing skills already acquired at younger ages. What is important is to perform these skills under the pressure of adversaries. Defenders, midfielders, and attackers all need to perform in similar situations. Young players must develop their touch on the ball; this can be done individually or in pairs or groups. Juggling games, kicking the ball back and forth in a manner somewhat similar to tennis, and various trapping and passing drills with light and then progressively heavier pressure from opponents seem to be the most effective developers of individual ball skills. As suggested by Hughie O'Malley, we, too, train in small-sided game situations, first with the team possessing the ball having more players, then moving to equal-sided teams, and finally with the attacking team being under the pressure of playing with fewer players. We train for endurance through progressively longer sessions of high-pressure, small-sided games. Tactical understanding of the game can be best developed through the small-sided games mentioned above, particularly those in which the teams are of unequal numbers. The objectives of both defensive and offensive tactics are to quickly assess situations and to recognize a numerical advantage that your team can exploit or detect a disadvantage that must be corrected. Frequent exposure to such situations in training is the best way to develop the players' tactical knowledge.

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## 2. Other than playing the sport, what types of developmental and conditioning activities are most important for soccer players? Should these activities be emphasized during the competitive season or only during the off-season periods?

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**O'Malley:** Year-round weight training is important for injury prevention and power development. Supplementary endurance training is very important, but it must be started early in the preparatory period of training and should not be employed during the competitive season. Well-constructed on-the-field training can improve endurance sufficiently during the season. In general, high-volume, low-intensity training begins at the start of the training year; the volume is gradually reduced and the intensity increased as the season approaches. Flexibility training is a must and should be emphasized throughout the year to help minimize injuries. Supplementary agility training is of low priority because playing the game is an excellent way to develop this attribute.

**Lea:** During the season, we emphasize skill drills, but endurance is developed as players run with and without the ball. We spend little in-season time on sprints and shuttle runs; most of our training for endurance is done in game situations. Pushups, abdominal curls, and flexibility exercises also form an important part of our in-season conditioning. In the off-season, I recommend that my athletes participate in a regular supervised conditioning program that emphasizes weight training for strength, flexibility exercises, and cardiovascular endurance activities. During the season, the high-school players' time is so limited that our regular training sessions must do double duty to enhance both skill and conditioning.

**Richardson:** I recommend that young players use loads in weight training that they can lift correctly for 8-12 repetitions and then work up to at least 15 repetitions before adding weight. Although leg strength is most important in soccer, it is also critical to use upper-body exercises to help achieve better running balance, power, and form. To improve heading ability and to help minimize injuries, neck flexion and neck extension exercises, e.g., with weights attached to a head strap, should also be used to strengthen the neck and improve neck flexibility. Finally, single-leg squats and lunges are good exercises for strengthening the hip stabilizers.

**Satterwhite:** Although I recognize that school-age players have packed schedules, if possible, a strength and conditioning program should be adhered to year round. Hopping, jumping, and lateral movement, in addition to kicking and running, should be practiced regularly. Supervised speed training may aid the athlete who has difficulty achieving an explosive start when sprinting.

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## 3. What are the most common physical and psychological hazards of soccer competition? What steps can be taken to prevent or minimize these hazards?

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**Satterwhite:** The most common physical injuries are strains, sprains, and contusions affecting the legs, ankles, knees, and hips. Females are at a higher risk than males for tears of the anterior cruciate ligaments of the knees. Brain concussions are usually mild and may occur when a player's head is hit by a solidly-kicked soccer ball (up to 80 mph) from a close distance, when two players knock heads while both are attempting to head the ball, when a player dives for a ball and hits head-to-goalpost or head-to-ground, or when a player runs full speed into a goalpost or another player and is jolted suddenly. No long-term clinical studies have been performed using brain-imaging techniques to evaluate the incidence of brain injury after performing soccer headers. Intuitively, any player who complains of major headaches after heading the ball should be monitored carefully and advised to avoid heading while the symptoms persist. Athletes who note a short-lasting superficial stinging sensation after headers may benefit from a soccer headband and additional instruction in correct heading, but soccer headbands cannot prevent concussions. Overall, injury prevention revolves around sports mechanics, year-round conditioning, adequate nutrition and hydration, and appropriate rest.

**Lea and O'Malley:** In our experience, concussions are not caused when one player purposefully and correctly heads the ball. However, as Dr. Satterwhite suggests, players must be taught to correctly contact the ball with the forehead at the hairline. Stretching can help prevent muscle strains, and ankle supports may help prevent sprains. One of the best ways to help prevent injuries is to improve a player's physical condition. Overtraining and overtraining, often involving too much training and competition under extreme emotional pressure, can lead to psychological burnout. This can be prevented if coaches are sensitive to adverse changes in their players' moods, attitudes, and performances.

**Richardson:** I agree with the above comments. I, too, am doubtful that heading the ball, if done correctly, causes brain injury. Although strength and flexibility exercises for the neck are important, I think that heading technique and proficiency are probably the most crucial factors in minimizing injuries to the head and neck.

**Lea:** My goaltenders have suffered sprained or fractured fingers, which are also common in basketball and volleyball. Proper catching techniques must be taught to prevent these injuries, and proper training on techniques of diving and jumping helps prevent some of the leg and head injuries resulting from the goaltenders' contact with the ground.

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#### 4. Research has shown that replacing fluid is important to health and performance in sports such as soccer. What are the particular challenges inherent in soccer when it comes to proper replacement of fluids?

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**Richardson:** Because soccer involves continuous play, it is very difficult to provide fluids optimally during the match. I believe that mandating scheduled breaks for fluid and energy replenishment would be a positive rules change to minimize heat illness and maximize performance for soccer players.

**Macedonio:** To facilitate adequate intake of fluid for soccer players, I recommend that fluid replacement beverages be available prior to, during, and immediately after matches. To minimize the risk of heat injury, soccer players should try to drink cool fluids every 15-20 minutes during a match. Unfortunately, most of the time stoppages of play are too infrequent to make this possible. In high heat and humidity, players, especially children, should be given more frequent fluid breaks and should be shaded from direct sun as much as possible. Currently, it is up to the discretion of the referee to call for additional fluid breaks in hot, humid weather. To provide an added measure of protection, particularly for young players, it would be prudent to specify within the official rules of soccer specific conditions under which more frequent fluid breaks should occur. If a health professional is not assigned to cover all games, coaches should be trained to recognize the early signs of heat illness and should be prepared to take appropriate measures in the case of overheating. Since most outdoor soccer fields offer little shade for players, teams should be encouraged to include a portable tent as a standard piece of team equipment. Simple preventive measures should be outlined for coaches and recommended as a matter of routine.

Impaired performance, especially during the second half of a soccer match, is primarily related to fatigue, which in turn is associated with dehydration. Sweat loss equivalent to as little as 1% of body weight—0.7 L (less than 1 qt) in a 70 kg (154 lb) player—can lead to impaired performance. Sweat losses during a soccer match can be as great as 3 qt or more when temperature and/or humidity are especially high. Given both the physical and mental demands of soccer, it is clearly in the best interest of the player to minimize fluid losses. Players should be instructed to drink before coming to the field. A good routine to establish is to interrupt warm-up 15 minutes before the match for a brief game-plan huddle during which players are instructed to drink. It is important to individually encourage frequent drinking and to hand players drinks at each stoppage of play. Although difficult to achieve, players should try to drink enough to match their usual fluid losses that occur during competition. To gauge how much fluid is generally lost in a game, players need to weigh themselves immediately before and after training or competition and then replace the lost fluid during and immediately after the game. When soccer is played in hot or humid climates, fluids should be kept cool in either individual thermal bottles or in a large cooler. If players prefer to bring individual squeeze bottles, the containers should be stored in a cooler with ice so the fluid remains cool. Athletes are likely to drink more if beverages are cool, flavored, and contain sodium.

**Satterwhite:** Since 30% of total goals are typically scored in the last 15 minutes of a game, fluids, carbohydrates, and electrolytes are imperative to sustain the high performance levels required until the end of the game. Coaches, nutritionists, and athletic trainers must take the lead in emphasizing the need to ingest fluids and fuels before, during, and after a match.

**Lea and O'Malley:** In general, soccer players are good about hydrating before games, but during a game it is difficult for the player to adequately replace fluids. We concur that this problem can be alleviated somewhat by placing individual bottles of sports drinks around the field and in the goals so the players can drink during any stoppages of play. Of course, it is also important to insist that players drink plenty of fluids during the half-time intermission.

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#### 5. What foods and fluids should soccer players eat before a match, at half-time, and after a match? What is the best way to ensure that players follow this advice, especially when they must often eat in restaurants while traveling?

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**Macedonio:** It is essential that athletes' muscle glycogen stores be at maximum levels before a match begins. It is also sensible for players to consume carbohydrate in a sports drink during the match to help maintain blood sugar and delay the depletion of glycogen in the liver and muscles. Still, despite efforts to conserve glycogen, the intensity and duration of soccer greatly reduces muscle glycogen stores. Brief educational sessions that display food for athletes and their partners or parents tend to be most effective and serve as an illustration of foods to select that are high in carbohydrate. Distributing high-carbohydrate snack foods and drinks after a game is a good way to introduce appropriate foods and beverages to young players. Providing handout material with food suggestions and recipes is generally well received by soccer parents.

**Macedonio and Satterwhite:** Players need to replace and even "superload" their glycogen stores by eating carbohydrate-rich foods within the first few hours after a game. Rehydration and electrolyte replenishment must also be accomplished prior to the next match. Players should consume high-carbohydrate beverages and solid carbohydrate foods, including bagels, breads, rice, pastas, bananas, grapes, and snacks such as pretzels, raisins, or a ready-to-eat cereal mixed with dried fruits.

**O'Malley:** Usually a national-level team eats a meal high in carbohydrate and low in fat and protein 3-4 hours before a game; this helps reduce hunger during the game. Some players consume carbohydrate replacement drinks or carbohydrate gel supplements just before the match begins and at half time. After the game, it is essential for the players to ingest extra fluids and carbohydrates (e.g., sports drinks, fruit, candy, cereals, pasta, potatoes, and other easily-digested vegetables). A good way to promote appropriate food intake on the road is to have the team eat at a buffet-style restaurant so the team nutritionist or other knowledgeable professional can monitor each player's food choices.

**Lea:** I recommend a meal rich in carbohydrates before the game and a post-game meal emphasizing carbohydrates and proteins. My players particularly like bagels, fruits such as apples and bananas, and pasta. I recommend sandwiches made with whole-grain breads, lean turkey, tuna, or chicken, as well as high-carbohydrate energy bars such as granola bars or fig bars.

We recommend the consumption of sports drinks and the avoidance of carbonated beverages and those containing caffeine because of their diuretic effects.

**Macedonio:** Suggestions for selecting food while traveling need to be realistic and simple. Most menus have several standard food items that fit nicely into an athlete's diet with a few modifications. Familiar high-carbohydrate breakfast foods that are available anytime in some restaurants are hot and cold cereals, bagels, toast, English muffins, pancakes with syrup, and fruit. Some versatile menu items that can be added to a lunch or dinner to pump up carbohydrates include baked potatoes topped with vegetables or a small amount of vegetarian chili or salsa, pasta with meatless tomato sauce, steamed rice, steamed vegetables, humus and pita bread, vegetarian baked beans, garden burgers, fruit salad, tortillas, bread sticks, rolls with honey or jam, sherbet, sorbet, or fruit smoothies. Fast-food restaurants pose a greater challenge because of their limited selection, but a savvy athlete can order items that will support a training regimen. For instance, if a player chooses two small hamburgers versus one double cheeseburger, fat is lowered, and carbohydrate intake is raised. Simply by ordering selections without sauces, adding fresh vegetables and salads, and choosing low-fat or fat-free beverages, the athlete can reduce the contribution of fat and increase the carbohydrate level. Many fast-food restaurants serve low-fat shakes that supply a fair amount of carbohydrate. As a precautionary measure when appropriate foods are not available, I suggested that players have one or two cans of a liquid meal and several bottles of sports drinks on hand.

## SUMMARY

Excellent playing skills are the most important attributes of successful soccer players at all levels, but soccer skills must be coupled with superior speed, agility, endurance, power, aggressiveness, and strategic decision-making ability if a player is to reach the highest levels. Although standard fitness training can be useful to develop many of these characteristics, actual playing of the game, especially with small numbers of players per team, is the best way to develop soccer players. Injuries in soccer, particularly in youngsters, are typically minor, consisting of bruises, cuts, and scrapes, but brain concussions can occur, often when two players collide while attempting to head the ball. Excellent physical conditioning and correct development of soccer skills are the best ways to minimize injuries. The two greatest nutritional challenges in soccer are providing adequate fluids and carbohydrates during the continuous play of a match. These challenges can be addressed partially by having individual bottles of sports drinks available on the sidelines and encouraging players to drink whenever possible during any stoppages in play.

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## FUEL AND FLUIDS FOR SOCCER

Successful soccer players must have great skill, endurance, power, speed, agility, flexibility, and mental alertness. Nutrition is a key factor both in providing energy for soccer, thus optimizing performance, and in minimizing injuries caused by fatigue. The heightened energy demands of the sport can drain you of fuel and fluid, thus compromising your physical and mental performance and putting you at risk of heat illness. A good nutritional plan provides sufficient fluid and energy (mostly as carbohydrate) to power you throughout the match and to minimize dehydration.

### TOTAL ENERGY INTAKE

- Consume 45-60 kcal per kg body weight per day (20-27 kcal/lb). A player who weighs 70 kg (154 lb) should consume approximately 3100-4200 kcal/day.

### CARBOHYDRATE AND FLUID INTAKE DURING ROUTINE DAILY TRAINING

- Consume 8-10 g of carbohydrate per kg body weight per day (3.5-4.5 g/lb) or roughly 60%-70% of total calories. An athlete who weighs 70 kg (154 lb) should eat about 560-700 g of carbohydrate every day.
- Drink enough fluids every day so that your body weight remains constant at the start of each training session. If your urine color is not clear, it is likely that you are becoming dehydrated.

### THE PRE-GAME MEAL

- Eat 3-4 hours before the match begins; 60%-70% of meal calories should be from carbohydrates; foods should be customary and easy to digest.
- Avoid high-fat and fried foods, which are not easily digested and may cause gastrointestinal discomfort.
- Avoid high-fiber foods because they may cause abdominal cramping and gas.
- Avoid solid foods immediately before or during the game; they are digested too slowly during exercise.
- If you are extremely nervous before a game or recovering from an illness, consider liquid meals.

- Consider liquid meals when travel time to a game is short.
- Drink 16-32 oz of a fluid-replacement sports drink 2 hours before the game plus another 8-16 oz 15-20 minutes before the event to top off the fluid reservoirs.
- Avoid the dehydrating effects of caffeine or alcohol for 72 hours before a game

### NUTRITION DURING THE GAME

- Consume a fluid-replacement sports drink that contains carbohydrates and electrolytes at every stoppage in play. Plain water provides necessary fluid, but it reduces overall fluid intake and does not supply needed carbohydrates.
- Remind your teammates to drink whenever possible during the game, even though they may not be thirsty. Place your individual bottles containing a cold sports drink at the sidelines so it will be more convenient to drink during stoppages of play.
- At half-time, try to drink enough fluids to replenish all of the body weight you have lost during the first period of play. Fluids exit the stomach much faster than do solids, so sports drinks are preferable to solid foods during the half-time break.

### AFTER THE GAME

- During recovery from strenuous soccer play, you should strive to replace your body's reserves of carbohydrate (glycogen), water and electrolytes, especially sodium.
- For the first 2-3 hours after the game, drink at least 24 oz of fluid for every pound of weight lost. Sodium chloride (table salt) in a sports drink or in regular foods is needed to minimize urine production, enhance fluid intake, and ensure rapid replacement of body fluids.
- Immediately after the game, consume 1 g of carbohydrate (preferably consisting of sugars or other rapidly digested carbohydrates) per lb of body weight.
- Over the following 24 hours, resume your training diet, consuming 8-10 g of carbohydrate per kg of body weight with 10-12 cups of fluid.

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