



Scientific and Medical Considerations



GSSI Scientific Conference
May 17–20 Baveno, Italy

AGENDA

WEDNESDAY, MAY 17

18:00 – 21:30 Welcome reception - Group photo, cocktails, and buffet dinner

THURSDAY, MAY 18

07:15 – 08:00 Buffet breakfast

SESSION 1: THE PHYSIOLOGY OF SOCCER

08:00 – 08:30 Physiological requirements of the elite soccer player
Jens Bangsbo, DrSci - Denmark

08:30 – 09:15 Discussion

09:15 – 09:45 What contributes to the soccer skills of a top-class player?
What makes a Ronaldinho?
Turibio Leite de Barros Neto, PhD - Brazil

09:45 – 10:30 Discussion

10:30 – 11:00 Refreshment break

11:00 – 11:30 Physiological responses to training in youth soccer players
Sam Erith, MSc - UK

11:30 – 12:15 Discussion

12:15 – 12:45 Training capacity of adult female soccer players
Edward Coyle, PhD - USA

12:45 – 13:30 Discussion

13:30 Afternoon and evening at leisure

FRIDAY, MAY 19

07:15 – 08:00 Buffet breakfast

SESSION 2: OPTIMIZING NUTRITION FOR SOCCER

08:00 – 08:30 Challenges for optimizing nutrition of soccer players
Francis Holway, MSc - Argentina

08:30 – 09:15 Discussion

09:15 – 09:45 Maintaining water and salt balance in soccer players
Ron Maughan, PhD - UK

09:45 – 10:30 Discussion

10:30 – 11:00 Refreshment break

11:00 – 11:30 Benefits and challenges of carbohydrate feeding for soccer players
Clyde Williams, PhD - UK

11:30 – 12:15 Discussion

12:15 – 12:45 Nutrition strategies to counter physical stress in soccer players
Michael Gleeson, PhD - UK

12:45 – 13:30 Discussion

13:30 Afternoon and evening at leisure

SATURDAY, MAY 20

07:15 – 08:00 Buffet breakfast

SESSION 3: OPTIMIZING PERFORMANCE, HEALTH AND SAFETY

08:00 – 08:30 Protecting the performance of elite soccer players - the AC Milan experience
Jean Pierre Meersseman - AC Milan FC

08:30 – 9:15 Discussion

9:15 – 9:45 Considerations in protecting soccer performance: thermal, altitude, and travel-related stress
Thomas Reilly, DSc - UK

9:45 – 10:30 Discussion

10:30 – 11:00 Refreshment break

11:00 – 11:30 Reducing injury risk in soccer
Donald Kirkendall, PhD - USA

11:30 – 12:15 Discussion

12:15 – 18:00 Afternoon at leisure

19:00 – 22:00 Cocktails and conference dinner

SUNDAY, MAY 21

07:15 – 10:00 Breakfast at leisure; departures all day

09:00 – 16:00 Annual Board Meeting

19:00 – 22:00 Annual Board Dinner



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Jens Bangsbo, DrSci

Current Employment:

- Professor, Institute of Exercise and Sport Sciences, University of Copenhagen, Copenhagen, Denmark

Soccer (Football) Experience as a Player:

- Played in Danish national soccer teams both as youth and senior player
- Played about 400 matches in the top Danish league

Other Experience in Soccer:

- Consultant for the Danish National Football Team (1994-present)
- Adviser for the Juventus Football Club (1999-2001)
- Assistant coach for the Juventus Football Club (2001-2004)
- Assistant coach for the Danish National Football Team (2004)

Other Soccer-Related Activities:

- Member of the international steering group of football

Key Soccer-Related Publications:

- Bangsbo J. (1994). The physiology of soccer with special reference to intense intermittent exercise. *Acta Physiol. Scand.* 151:Suppl. 619.
- Bangsbo J. (1994). Fitness training in football a scientific approach. HO Storm: Bagsværd, Denmark, pp. 1-325.
- Krstrup, P., M. Mohr, H. Ellingsgaard, and J. Bangsbo. (2005). Physical demands during an elite female soccer game: importance of training status. *Med. Sci. Sports Exerc.* 37:1242-1248.
- Mohr M., P. Krstrup and J. Bangsbo (2003). Match performance of high standard soccer players with special reference to development of fatigue. *J. Sports Sci.* 21:519-528.
- Mohr M., P. Krstrup, L. Nybo-Nielsen, J.J. Nielsen, and J. Bangsbo (2003). Muscle temperature and sprint performance during soccer matches – beneficial effect of re-warm-up at half time. *Scand. J. Med. Sport Sci.*,14:156-162.

PHYSIOLOGICAL REQUIREMENTS OF THE ELITE SOCCER PLAYER

KEY SCIENTIFIC POINTS

- The ability to repeatedly perform high-intensity exercise is essential for a top-class soccer player.
- Fatigue occurs temporarily during and at the end of a game. With aerobic and anaerobic training, the degree of fatigue can be reduced.
- There are large individual differences in physical performance during a game depending on, among other things, the players' physical capacities and tactical roles. The training should be specific to the activities during the game.
- At the start of the second half, reduced performance is related to lowered muscle temperature, so the players should prepare physically for the second half.
- There is a significant utilization of muscle glycogen during a soccer game, and top-class players have high energy utilization during a week, with significant individual differences. The players should consume a high-carbohydrate diet.

RECOMMENDATIONS FOR COACHES

- Coaches should carry out sessions with repeated sprints 2-3 times a week during the last 4-5 weeks of the pre-season preparation period and during the season.
- Aerobic high-intensity training should be carried out frequently (2-3 times a week) after the first week of the preparation period and during the season.
- At a top-level, speed-endurance training should be performed once or twice a week during the last 4 weeks of the preparation period.
- Examples of appropriate drills for soccer players can be found in the following publication and web-site:
 - Bangsbo, J. (2006). "Aerobic and Anaerobic Training in Soccer - With Special Emphasis on Training of Youth Players" In: *Fitness Training in Soccer I*. HO+Storm: Bagsvaerd, Denmark, pp. 1-231.
 - www.soccerfitness.com
- Fitness training in soccer should be prescribed individually. The prescription should be based on the player's tactical role on the team (based on analysis) and the player's physiological capacities. *An example of a drill in which the players are training in relation to position on the team is provided in the "Aerobic and Anaerobic Training in Soccer" reference cited above.*
- While performing aerobic and anaerobic training in soccer, the player should be dribbling, passing, and receiving the ball.
- The players should perform aerobic moderate-intensity exercises in the last 6-7 minutes of the half-time. For example, the players are divided into groups of 3-4 players, and they are passing the ball and then changing positions.
- Players should consume 8-10 grams of carbohydrate per kilogram of body mass on a daily basis.



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Turibio Leite de Barros Neto, PhD

Current Employment:

- Assistant Professor, Department of Physiology, São Paulo Federal University São Paulo, Brazil
- Director, CEMAFE (Medicine & Sports Center), São Paulo Federal University São Paulo, Brazil
- Exercise Physiologist, São Paulo Soccer Team, São Paulo, Brazil

Experience in Soccer:

- 20 years, exercise physiologist of São Paulo professional Soccer Team, São Paulo, Brazil [9 times São Paulo State Champion; 2 times Brazilian Champion; 3 times South American Champion; 3 times World Team Champion]
- 1 year, exercise physiologist for Brazilian National Soccer Team, Brazil

Other Soccer-Related Activities:

- Co-author, FIFA Consensus Statement on Nutrition in Soccer (Zurich, 2005)
- Speaker, FIFA Science of Soccer Meeting (Los Angeles, 1998)
- Speaker, NCAA Annual Meeting (Nashville, 1996)

Key Soccer-Related Publications:

- Barros, T.L., and I. Guerra (2004) A Ciência do Futebol. São Paulo:Editora Manole.
- Guerra, I., R. Chaves, T. Barros, and J. Tirapegui (2004). The influence of fluid ingestion on performance of soccer players during a match. *J. Sports Sci. Med.* 3:198-202.
- Monteiro, CR., I. Guerra and TL.Barros (2003). Hydration in soccer: a review. *Rev Bras Med Esporte* 9(4):243-246.
- Oliveira, M.C., J.D..Assumpção, and T.L. Barros (1999). Influencia del ritmo en la agilidad en la practica delfútbol. *Rev. Cs. Activ. Física* 7(13):7-20.
- Silva, NP., DT. Kirkendall, and TL. Barros Neto (2005). Movement patterns in the elite brazilian youth soccer players. *J. Sports Med. Phys. Fit.* (In press.)

WHAT CONTRIBUTES TO THE SOCCER SKILLS OF A TOP CLASS PLAYER? WHAT MAKES A RONALDINHO?

KEY SCIENTIFIC POINTS

- Although methods are imperfect, talented young soccer players can be identified and developed.
- Elite players are naturally endowed with appropriate physiological capacities and the ability to acquire complex neuromotor skills.
- Exceptional physiological characteristics by themselves are of no predictive value in identifying soccer talent.
- The enhancement of physiological capacities and the development of sport-specific skills of young soccer players are accelerated by involvement in normal physical activities, by well-coached soccer play and training, and by good nutrition.
- The development of physical fitness is critical to the development of motor skills required in soccer.
- Soccer experience, stage of maturity, and natural talent are all important to the development of soccer-specific skills.
- The beginning of the skill learning process is critically important.
- Step-by-step teaching schemes and appropriate testing protocols are important in development of high-level soccer players.
- South Americans (Brazilians) and Europeans have somewhat different methods of teaching and learning soccer skills.
- Soccer skills can break down under pressure, both mental and physical.
- Development of the elite player can be hindered by serious and/or frequent injuries. Prevention of soccer injuries is crucial.

RECOMMENDATIONS FOR COACHES

- Certain physiological characteristics that are crucial to the development of elite players, e.g., agility, aerobic and anaerobic endurance, movement speed and acceleration, gross motor skills, and muscular strength should be evaluated in young players. But do not over estimate the importance of these assessments as predictors of success.
- Other important characteristics, e.g., motivation to succeed, willingness to be a team player, ability to learn soccer-specific skills, temperament, aggressiveness, and pain tolerance are more difficult to assess.
- Emphasize development of physical fitness in both young and adult players because improved fitness will contribute to the development of soccer-specific skills.
- Consider modifications of training plans to address individual differences among young players in body size and maturation. Do not expect smaller and/or less mature players to perform as well or to develop at the same rate as larger, more mature players.
- Pay special attention to the earliest stages of teaching soccer skills. High-quality early teaching and learning are crucial to the optimal development of young players.
- Adhere to step-by-step teaching plans in developing training programs.
- Use appropriate physiological tests and soccer-skill evaluations at regular intervals to assess the effectiveness of training programs.
- Use both verbal information and visual cues to increase skill acquisition by improving task reproduction capabilities.
- Become informed on both European and South American methods for developing soccer players and consider using the best of both approaches.
- Avoid scheduling training sessions and matches too frequently or for too long a duration because this may cause mental or physical deterioration, especially in young players.
- The incidence of soccer injuries can be reduced by preventive interventions, mainly in young players. Coaches and players must include such strategies as part of their regular training.



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Sam Erith, MSc

Current Employment:

- Sports Scientist, Tottenham Hotspur Football Club, England, UK
- P/T Ph.D Student, Loughborough University, England, UK

Soccer (Football) Experience as a Player:

- 4 years Captain of Loughborough University 1st Team
- 2 years semi-professional standard
- Regional representation as schoolboy

Other Experience in Soccer:

- 4 years as sports scientist for England Youth International Teams (U16s – U21s)
- 4 years as coach educator for the English Football Association
- 3 years as a consultant to several professional English soccer clubs at both senior and youth levels
- 3 years as a youth soccer coach for Derby County Soccer Club

Other Soccer-Related Activities:

- Course tutor on the UEFA Pro Licence Award for managers and coaches
- Presenter at several FA conferences
- Presenter at Asian Football Confederation Medical and Science Conference
- Examiner and Lecturer on the FA Fitness Trainers Postgraduate Diploma

Key Soccer-Related Publications:

- Bailey, D., S. Erith et al. (2004). Influence of cryotherapy on indices of muscle damage following prolonged intermittent shuttle-running exercise. *J. Physiol.* 560P, S106.
- Erith, S. (2005): Are your players drinking enough? *Insight*, The FA Coaches Association Journal, Spring/Summer.
- Erith, S., D. Bailey et al. (2005). The effect of cold water immersion on indices of muscle damage following prolonged intermittent shuttle-running exercise. *J. Sport Sci.* 23 (11-12): 1149.
- Erith, S., and C. Williams (2005). Fitness testing within English professional soccer and training induced changes in elite female soccer players. *Med. Sci. Sports Exerc.* 37(5): S78.
- Erith, S., C. Williams et al. (2004). The effect of high carbohydrate meals with different glycaemic indices on 22-h recovery from prolonged intermittent shuttle running. *Conference Proceedings: 9th Annual Congress. European College of Sport Science.*

PHYSIOLOGICAL RESPONSES TO TRAINING IN YOUTH SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- Inter-individual variation in growth and maturation is considerable during childhood—and especially adolescence.
- Due to the physical demands of soccer, the early maturing youth players are likely to have an advantage over late maturers in the same chronological age group.
- The physical needs and capabilities of youth soccer players change as they progress through childhood and adolescence.
- There is some evidence to suggest that at different stages of a youth player's development certain physical training regimes are more appropriate than others.
- The greatest changes in the physical and physiological characteristics of young players are likely to occur during the years of 14-16.
- When using appropriate scaling, the averages for VO_2 max, strength, and anaerobic capacity of youth soccer players are lower than those for their adult counterparts.
- It appears that substantial improvements can be made in the aerobic capabilities of elite youth soccer players following high-intensity interval training.
- Improvements in strength, speed and power are largely caused by growth and development, although age-appropriate training can lead to improvements in each of these variables.
- Youth soccer players are likely to have a lower tolerance to heat while exercising than do adults.
- The dietary requirements for youth players are not fully understood, but the key guidelines are similar to those for adult players (relative to body mass).
- Some elite youth players apparently do not support their training with the most appropriate nutritional strategies.

RECOMMENDATIONS FOR COACHES

- Before working with a group of players it is important for the coach to have a good understanding of each individual's stage of development and maturation. This can be achieved by subjective observations or, better still, by keeping a record of simple measurements, including height, body mass, and muscle girths of the lower and upper limbs.
- Training practices must attempt to accommodate these differences in physical capacities among youth players. Some suggestions to achieve this goal include:
 - Match players of similar size against each other in opposed practices.
 - Use appropriately sized training areas and playing fields. (Areas that are too large will favor the early maturing, more powerful, young players.)
 - Consider dividing the groups up according to players' stage of development rather than actual age.
- Devise training goals according to the individual needs of the group rather than attempt to make 'one size fit all'. For example, smaller players may need more rest during demanding practices compared to larger, more powerful players in the same age group.
- Establish the following age dependent training priorities;
 - 6 – 11 years: Focus on agility, coordination, body awareness and balance. Any strength work should be based on technique and endurance and can be developed from small games.
 - 11 – 14 years: Group players according to development stage. It may be possible to structure a small amount of endurance training and short-duration anaerobic activities. Physical training could still be incorporated within soccer training.
 - 14 – 20 years: This is a period when physical training may be done in isolation, and greater emphasis can be placed on structured development of strength, power and endurance.



Sam Erith, MSc (cont'd)

PHYSIOLOGICAL RESPONSES TO TRAINING IN YOUTH SOCCER PLAYERS

RECOMMENDATIONS FOR COACHES (cont'd)

- The coach must be aware that during rapid phases of growth a player's performance may temporarily decline. Regular monitoring of the height and weight of each player will alert the coach to these phases.
- It is both unreasonable and counterproductive to expect youth players to cope with the same training sessions that adult players undertake. The coach must set realistic training goals and be able to accommodate a larger variation in physical capacities within a group.
- Although it is possible to improve a youth player's speed, strength and power with the appropriate training, this should not be a priority during their younger years.
- To improve the endurance capabilities of older youth soccer players, the coach should employ high-intensity interval training twice a week for a 6-10 week period. The intensity of each bout should be high (90-95% of maximum heart rate) and sustained for 3-4 minutes, repeated four times. The rest periods should be active and last 2-3 min.
- When coaching youth soccer players in hot conditions, it is sensible to break from training every 15-20 min and ensure that players have access to drinks and to some shade from direct sunlight.
- It is important that players eat a balanced diet high in carbohydrates. Furthermore, young players need to eat sufficient carbohydrates and proteins to meet the energy demands of everyday living, growth and training.
- Do not assume that youth players are aware of the most appropriate nutritional strategies to adopt. It is highly likely that players will need appropriate nutrition education.



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Edward F. Coyle, PhD

Current Employment:

- Professor and Director of The Human Performance Laboratory, Department of Kinesiology and Health Education, The University of Texas at Austin

Experience in Soccer:

- Training advisor to the women's collegiate team at The University of Texas at Austin

Other Soccer-Related Activities:

- Attended FIFA Consensus Conference on Nutrition for Football, Zurich, 2005
- Speaker and author, FIFA Consensus Conference on Nutrition for Football, Rome, 1990

Key Soccer-Related Publications:

- Coyle, E.F. (2004). Carbohydrate ingestion prior to and during intense exercise. *Proceedings of National Academies: Food and Nutrition Board (August)*. National Academy Press: Washington, D.C.

TRAINING CAPACITY OF ADULT FEMALE SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- Female collegiate soccer players in the USA often lose maximal leg power during the course of the fall season (September to November).
- The fall season is characterized by two or three games per week. This high frequency of competition requires that training stress be carefully monitored and moderated to avoid over-training.
- The first-year players are most susceptible to over-training.
- Examples of successful and unsuccessful training programs aimed at peaking maximal power for conference and national tournaments in late October and November will be discussed.
- Training for maximal aerobic power and endurance must be developed carefully so as not to impair maximal power and precipitate over-reaching or over-training.

RECOMMENDATIONS FOR COACHES

- Monitor players' sleep duration and level of leg fatigue. Too little sleep and too much fatigue are often predictive of over-training.
- Ensure optimal nutrition—with special emphasis on adequate carbohydrate—before and after matches played on Friday nights to minimize residual fatigue during subsequent games on Sunday afternoons.
- If players exhibit reductions of in-season physical performance ability, do not attempt to remedy the problem by reintroducing strenuous endurance running programs. More training is often counter-productive.
- Peak power can be maintained for several weeks when programs are well designed.



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Francis Holway, MSc

Current Employment:

- Director of Nutrition Department, Club Atlético River Plate, Buenos Aires, Argentina

Soccer (Football) Experience as a Player:

- School teams, Buenos Aires, Argentina (I was a lousy player)

Other Experience in Soccer:

- Team nutritionist:
 - 1 year, Ferro Carril Oeste (Professional team), Buenos Aires, Argentina
 - 1 year, Boca Juniors (Youth divisions), Buenos Aires, Argentina
 - 4 years, River Plate (Professional team), Buenos Aires, Argentina

CHALLENGES FOR OPTIMIZING NUTRITION OF SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- Nutritional recommendations for football (soccer) players are controversial.
- Compared to recommended amounts, players typically consume too little carbohydrate and fluids and too much fat and protein.
- Common barriers to the implementation of nutritional guidelines:
 - Lack of nutrition knowledge among players, coaches, and support staff.
 - Nutritional myths, fears and superstition that affect feeding habits.
 - Tournament logistics and travel schedules reduce nutritional options.
 - Players accept dietary advice from non-nutritionally-trained personnel.
 - Players' limited food preferences.
- Common myths among Argentine players (outcomes from focus group sessions):
 - Bread is fattening, crackers are not.
 - Water is better than sports beverages because it quenches thirst better.
 - Sports beverages can be fattening.
 - Nutrition is "not important" (older generation of coaches and trainers).
 - Vitamins are useful in restoring energy.
 - Protein and carbohydrate foods should not be mixed.
 - Robust, muscular, or stocky players are always fat.
- Common adverse cultural habits among Argentine players:
 - Sleeping late instead of eating breakfast on game day.
 - Minimizing carbohydrate foods when attempting to lose weight.
 - Eating a "good luck" barbeque the day before a game.
 - Eating half the energy requirements on game day.
 - Substituting junk food for food with high nutritional value.
- Supplement use among Argentine players:
 - Creatine, amino acids, multi-vitamin minerals, energy drinks, magnesium, fat burners, weight gain powders and protein powders are common.
 - Most notice no positive effect and have ceased to use supplements.
 - Several players experienced GI-distress or unwanted weight gain, and a few blamed muscle tightness or injuries on creatine.
- Hydration habits among Argentine players:
 - Many players do not know how much weight they lose during play.
 - Many players complain of GI-distress from drinking sports beverages during game situations.
- Travel situations (most international travel requires more than 6 h):
 - North-South travel involves major differences in weather and environments, as opposed to East-West travel.
 - Airport delays and airline-worker strikes are common.
 - Marked regional differences exist in foods.
 - Food-borne illness sometimes occur, especially with ice for beverages.
- Tournament logistics and frequent matches can compromise nutrition.



Francis Holway, MSc (cont'd)

CHALLENGES FOR OPTIMIZING NUTRITION OF SOCCER PLAYERS

RECOMMENDATIONS FOR COACHES

- Employ a sports dietitian/nutritionist whenever possible to:
 - Design menus and plan meals for regular competition and training.
 - Anticipate special situations such as travel and pre-season training.
 - Monitor food hygiene.
 - Develop and supervise implementation of hydration strategies.
 - Educate athletes about supplement use.
 - Advise athletes on appropriate body composition modifications.
 - Educate players and family members about food preparation.
- Use objective measurements as much as possible to aid in decision-making:
 - Biochemical analysis of blood and muscle enzymes and metabolites, such as CPK, LDH, BUN, lactate, and/or glucose.
 - Anthropometric measurements.
 - Records of changes in body weight and of fluid intake during activity.
 - Weighted food records.
- Ensure that players eat the two most important meals—before and after training or match play—under supervision.
- On game day it is usually better to eat breakfast—thereby increasing carbohydrate stores—than to sleep late.
- Use nutritional screening to identify potential problem individuals—“heavy sweaters,” those with low iron status, low-muscle mass and/or high fat mass, and those who chronically eat insufficient carbohydrate.
- Educate players about the facts that most nutritional supplements and so-called ergogenic aids have little or no scientific support for use in soccer and that players rarely notice any positive effect of these products.
- Gastrointestinal distress and increased body weight may occur in some individuals taking supplements, particularly creatine.
- Plan for modifications in body composition and body size while the soccer player is playing in the younger divisions because there rarely is time to do so while under a heavy competition schedule in the professional leagues.
- Expect travel and airport delays. Plan for them by having an extra allotment of carbohydrate-rich snacks and/or sandwiches, as well as fluids.
- Use standardized buffet-style eating when overseas or in unfamiliar locations; if a food item turns out to be wearisome, replacement items can be included. Also make sure to avoid ice and have beverages refrigerated beforehand. Above all, ask the nutritionist to arrange all matters related to diet and nutrition before traveling begins.
- Nutrition and hydration strategies cannot ensure optimal recovery from two-a-week games, so rotation of players, when possible, is recommended.
- Examine your own nutritional beliefs and knowledge, and be open and flexible enough to accept changes.
- Nutritional education works. Implement short, didactic lessons by the team nutritionist, targeting players and their immediate family members and staff members involved in players' food preparation.



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Ron Maughan, PhD

Current Employment:

- Professor, School of Sport and Exercise Sciences, Loughborough University Loughborough, UK

Soccer (Football) Experience as a Player:

- Almost scored a goal for Dept of Surgery team in intramural soccer match, 1982

Other Experience in Soccer:

- Occasional adviser to various football clubs

Other Soccer-Related Activities:

- Organizer, FIFA Consensus Conference on Nutrition for Football, Zurich, 2005
- Author of the Football Association Dietary Supplements Program, 1997
- Speaker and author, FIFA Consensus Conference on Nutrition for Football, Zurich, 1993
- Contributor to various FIFA and FA sports medicine programs

Key Soccer-Related Publications:

- Leiper, JB, AS Prentice, C Wrightson, and RJ Maughan (2001). Gastric emptying of a carbohydrate-electrolyte drink during a soccer match. *Med Sci Sports Exerc* 33:1932-1938.
- Maughan, RJ (2006). *Nutrition for Football*. Routledge: Oxford.
- Maughan RJ. (1997). Energy and macronutrient intakes of professional football (soccer) players. *Br J Sports Med* 31:45-47.
- Maughan, RJ, and LM Burke (1999). L'alimentation du footballeur au cours de l'entraînement et de la compétition. *Science et Sport* 14:227-232.
- Maughan, RJ, SJ Merson, NP Broad, and SM Shirreffs (2004). Fluid and electrolyte intake and loss in elite soccer players during training. *Int J Sport Nutr Exerc Metab* 14:327-340.
- Maughan, RJ, SM Shirreffs, SJ Merson, and CA Horswill (2005). Fluid and electrolyte balance in elite male football (soccer) players training in a cool environment. *J Sports Sci* 23:73-79.
- Shirreffs, SM, LF Aragon-Vargas, M Chamorro, RJ Maughan, L Serratos, and JJ Zachwieja (2005) The sweating response of elite professional soccer players to training in the heat. *Int J Sports Med* 26:90-95.

MAINTAINING WATER AND SALT BALANCE IN SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- Sweat loss is essential in football training and competition to maintain body temperature. Water and electrolytes – especially sodium – are lost in sweat.
- Water and salt needs vary greatly among individuals. Water losses may vary from less than 1 l to more than 3 l in a typical 90-minute training session.
- Salt (sodium chloride) losses in training and match play may vary from less than 1 gram to more than 10 grams.
- Sweat rate and sweat composition are influenced by work rate, fitness levels, state of heat acclimation, environmental conditions and clothing worn.
- Even when known factors are accounted for, sweat rate is highly variable among individuals.
- Sweat losses may be high even in cold weather conditions.
- Failure to maintain salt and water balance within certain limits will lead to impaired performance and, in susceptible individuals, to muscle cramps.
- Some players drink too much, but most are in net negative fluid balance at the end of training and match play.
- Some players may already be dehydrated at the start of training and match play.

RECOMMENDATIONS FOR COACHES

- A personalized hydration plan should be developed for each player, rather than using a single plan for all players.
- Planning should begin with an assessment of the needs for water and salt for each player and the player's current practices for replacing water and salt losses.
- Individual fluid needs can be assessed by recording body weight before and after training or competition. A loss of 1 kg of body mass indicates a net fluid deficit of approximately 1 L. (Similarly, a loss of 1 lb of body mass indicates a net fluid deficit of approximately 16 ounces.)
- Plans should be based on individual need and should be practiced and refined in training.
- Use of a urine color chart may help identify players who are dehydrated before training or match play begins. Players who consistently arrive in a dehydrated state should be encouraged to drink more fluids throughout the day, especially in the hours before training or match play.
- It is not necessary to replace all sweat losses during training or match play, but coaches should try to ensure that each player loses not more than about 2% of body mass during practice or match play, perhaps even less in hot weather.
- Recording body weight before and after training sessions and match play is key to identifying individual needs and developing personal hydration plans.
- Salty sweaters may be more prone to muscle cramps and may benefit from taking extra salt in drinks. A salty sweater can be identified by salt crusts on the player's clothing.
- Plans for maintaining optimal water and salt balance in each player must be adaptable to take account of changing circumstances, including changes in the environment, intensity and duration of play, and dietary habits of each player.
- It may be necessary to have different drinks available to meet the needs, as well as the taste preferences, of individual players.



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Clyde Williams, PhD

Current Employment:

- Professor, School of Sport and Exercise Sciences, Loughborough University, Loughborough, UK

Experience in Soccer:

- Sports Science Advisor to England Team Managers preparing for the 1986, 1990, and 1994 World Cup Tournaments

Other Soccer-Related Activities:

- Member, England Football Association Medical Committee, 1990-1994
- Co-Chair, 'Nutrition in Soccer' FIFA International Consensus Conference, 1994
- Co-Author, FIFA International Consensus Conference, 2005

Key Soccer-Related Publications:

- Foskett A., K. Tsintzas, C. Williams, and L. Boobis (2004). The effects of carbohydrate ingestion on muscle glycogen utilisation during exhaustive high-intensity intermittent running. *J. Physiol.* 555P:C63.
- McGregor S., C. Nicholas, H. Lakomy, and C. Williams (1999). The influence of intermittent high intensity shuttle running and fluid ingestion and fluid ingestion on the performance of a soccer skill. *J Sports Sci.* 17:895-903.
- Nicholas C., P. Green, R. Hawkins, and C. Williams (1997). Carbohydrate intake and recovery of intermittent running capacity. *Int. J. Sport Nutr.* 7:251-260.
- Nicholas C., F. Nuttall, and C. Williams (2000). The Loughborough Intermittent Shuttle Test: A field test that simulates the activity pattern of soccer. *J. Sports Sci.* 18:97-104.
- Nicholas C., C. Williams, H. Lakomy, G. Phillips, and A. Nowitz (1995). Influence of ingesting a carbohydrate-electrolyte solution on endurance capacity during intermittent, high intensity shuttle running. *J Sports Sci.* 13:283-290.

BENEFITS AND CHALLENGES OF CARBOHYDRATE FEEDING FOR SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- The major fuels for sprints in soccer are muscle glycogen, phosphocreatine, and ATP. Muscle glycogen is especially important as the training session or match play progresses.
- During repeated brief maximum sprinting with only 30 s or less between each sprint, failure to maintain sprint speed is largely due to an inadequate recovery of phosphocreatine stores.
- During prolonged repeated brief periods of high-intensity exercise, muscle glycogen concentrations are gradually reduced. Consuming a high-carbohydrate diet in the days before exercise increases glycogen stores and extends exercise time to fatigue.
- Drinking a well-formulated carbohydrate beverage before and throughout prolonged exercise reduces glucose output from the liver and spares liver glycogen.
- Drinking a well-formulated carbohydrate beverage contributes to carbohydrate metabolism during prolonged submaximal exercise and delays the onset of fatigue.
- Sprint performance is better maintained during prolonged intermittent high-intensity exercise when a well-formulated carbohydrate solution (sports beverage) rather than water is ingested throughout exercise.
- A high-carbohydrate pre-exercise meal combined with drinking a well-formulated sports beverage during submaximal exercise improves endurance capacity beyond what can be achieved with a high-carbohydrate pre-exercise meal alone.
- If pre-exercise muscle glycogen stores are high before beginning prolonged, intermittent, high-intensity exercise, ingesting a well-formulated sports beverage during exercise improves endurance capacity beyond what can be achieved with high pre-exercise muscle glycogen stores alone.
- Drinking a well-formulated carbohydrate beverage before and during 90 min of intermittent high-intensity exercise retains soccer passing and goal-shooting skills more effectively than is achieved while ingesting only water.
- Consuming a high-carbohydrate diet during a 24-hour recovery period restores exercise capacity during prolonged, intermittent, high-intensity exercise, whereas this is not achieved with an isocaloric mixed diet.

RECOMMENDATIONS FOR COACHES

- Soccer players should have a habitual diet that includes a wide variety of foods in sufficient quantity to cover their energy expenditure.
- Encourage players to consume a high-carbohydrate diet [roughly 8-10 grams of carbohydrate per kilogram of body mass (4-5 grams per pound)] during the 2-3 days before a match to ensure optimum storage of muscle and liver glycogen. This will help players maintain high work rates throughout the game.
- Educate players about the fact that failure to start a match with adequate glycogen stores will lead to the early onset of fatigue, i.e., an inability to fully engage in the match play for the entire 90 minutes.
- Encourage players to drink a well-formulated sports beverage during training and competition to help offset severe dehydration, maintain normal blood glucose, contribute to muscle metabolism, and perform at higher work rates throughout the game. Players should be encouraged to drink enough fluids so they lose less than about 2% of their body weight during the training session or competition.
- To accelerate the recovery of muscle glycogen after hard training or a match, encourage players to consume a well-formulated sports drink beginning immediately after the event and continuing until the post-training/post-match high-carbohydrate meal:
 - The sports drink should provide about 1-1.2 grams of carbohydrate per kilogram of body mass per hour.
 - Typically, the drink volume will be about 1.0-1.5 liters per hour.
- When soccer players have only 24 hours to recover between training or matches, their food intake should be prescribed to ensure that they consume between 8-10 grams of carbohydrate per kilogram of body mass in that period in order to optimally replace their muscle glycogen stores.
- Be aware of the fact that when players report muscle soreness after training or competition, it is probable that they will take longer than 24 hours to replace their muscle glycogen stores and recovery fully.



Scientific and Medical Considerations



GSSI Scientific Conference
May 17–20 Baveno, Italy

Michael Gleeson, PhD

Current Employment:

- Professor of Exercise Biochemistry, School of Sport and Exercise Sciences, Loughborough University, Loughborough, UK

Soccer (Football) Experience as a Player:

- Recreational player at school and university

Other Experience in Soccer:

- I have conducted several studies since 2001 that have examined immune responses to soccer training and competition in professional players in the English Premier League.

Other Soccer-Related Activities:

- Guest Lecturer for Football Association Fitness Trainers Award, 2000 to date
- Invited lecture "Football – Strengthening the immune system" for FA / Royal College of Surgeons, 16th International Conference on Sports Injury, 2004
- Invited keynote lecturer "Immunological status of soccer players" at the European Sports Medicine Congress, Hasselt, Belgium, 2003
- Invited lecture "Immune function in footballers" at the British Psychological Society, Cardiff, 2006

Key Soccer-Related Publications:

- Bishop, N.C., A.K. Blannin, P.J. Robson, N.P. Walsh, and M. Gleeson (1999). The effects of carbohydrate supplementation on immune responses to a soccer-specific exercise protocol. *J. Sports Sci.* 17(10): 787-796.
- Bishop, N.C., M. Gleeson, C.W. Nicholas, and A. Ali (2002). Influence of carbohydrate supplementation on plasma cytokine and neutrophil degranulation responses to high intensity intermittent exercise. *Int.J. Sport Nut. Exerc. Metab.* 12(2):145-156.
- Gleeson M (2005) Editor. *Immune Function in Sport and Exercise*. Edinburgh: Elsevier ISBN 0443101183.
- Gleeson, M. (2003). A (very) common cold. *Medicine Matters* 8:10-11, UEFA Direct.
- Maughan, R.J. and M. Gleeson (2004). Chapter 6: The Games Player. In: *The Biochemical Basis of Sports Performance*. Oxford:Oxford University Press ISBN 0199269246.

NUTRITION STRATEGIES TO COUNTER PHYSICAL STRESS IN SOCCER PLAYERS

KEY SCIENTIFIC POINTS

- Prolonged bouts of strenuous exercise cause a temporary depression of immune function.
- Single sessions of soccer training and match play appear to have no effect on mucosal immunity, though some changes in immune function of soccer players have been reported during a competitive season.
- Exercise-induced immune changes are related to decreased carbohydrate availability and elevated blood levels of stress hormones. Oxidative stress may also contribute to some aspects of immunodepression.
- Nutritional strategies to limit exercise-induced immune function depression should be based on the principle of minimizing the stress hormone and oxidative stress responses to exercise.
- Carbohydrate ingestion during exercise (about 30-60 g of carbohydrate per hour) appears to be an effective means of minimizing the temporary post-exercise immunodepression.
- Antioxidant supplements can reduce the rise in blood cortisol in response to exercise.
- There is only weak evidence for any benefit of ingesting so-called immune-boosting supplements (e.g., glutamine, echinacea, probiotics).
- There is limited evidence that nutritional interventions can improve recovery from muscle-damaging exercise.

RECOMMENDATIONS FOR COACHES

- Be aware that players are particularly vulnerable to infection after training or competition, especially in the winter months.
- Diet is important for optimal immune function, and many vitamins and minerals are associated with the ability to fight infection, especially Vitamin C, Vitamin A and zinc. A good well-balanced diet sufficient to meet energy needs should provide all the necessary vitamins and minerals.
- Nutritional considerations should emphasize the need for adequate intakes of fluid, carbohydrate, protein and micronutrients. Ensuring the recovery of glycogen stores on a day-to-day basis and consuming carbohydrate during exercise (about 30-60 g of carbohydrate per hour) appear to be ways of minimizing the temporary immunodepression associated with an acute bout of exercise.
- Players should avoid getting a dry mouth, both during competition and at rest; this can be done by drinking at regular intervals and maintaining good hydration status.
- Players should never share drink bottles or eating utensils and they should drink only properly treated water. Good hygiene practice may limit transmission of contagious illnesses by reducing exposure to common sources of infection.
- Players should understand that there is only weak evidence for any benefit of so-called immune-boosting supplements (e.g., glutamine, echinacea, probiotics). However, there is some evidence that antioxidants may be effective in limiting stress responses to exercise and reducing infection risk.
- There appear to be no effective nutritional strategies for improving recovery from muscle damaging exercise.



Scientific and Medical Considerations



GSSI Scientific Conference
May 17–20 Baveno, Italy

Thomas Reilly, DSc

Current Employment:

- Professor of Sports Science
- Director, Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK

Soccer (Football) Experience as a Player:

- Recreational play and indoor football; competitive player, Gaelic football

Other Experience in Soccer:

- Coach at college level
- Honorary member of Football Association Coaches Association
- Physiological advisor, various Premier League football clubs

Other Soccer-Related Activities:

- Chair, International Steering Group on Science and Football
- Co-editor: *Insight: the FA Coaches Association Journal*
- Co-editor, Special Issue: Preparation and Training for Soccer. *J. Sports Sci.* June, 2005.
- Member, FIFA Consensus Meeting, 2005
- Keynote Lecturer, 3rd Int. Congress, Japanese Society for Science & Football

Key Soccer-Related Publications:

- Reilly, T. (2005). An ergonomics model of the soccer training process. *J. Sports Sci.* 23:561-572.
- Reilly, T. and B. Ekblom (2005). The use of recovery methods post-exercise. *J. Sports Sci.* 23:619-627.
- Reilly, T. and A.M. Williams (2003). *Science and Soccer*. London: Routledge.
- Reilly, T., J. Cabri, and D. Araújo (2005). *Science and Football V*. London: Routledge.
- Stratton, G., T. Reilly, A.M. Williams, and D. Richardson (2004). *Youth Soccer: From Science to Performance*. London: Routledge.

CONSIDERATIONS IN PROTECTING SOCCER PERFORMANCE: THERMAL, ALTITUDE, AND TRAVEL-RELATED STRESS

KEY SCIENTIFIC POINTS

- Heat, cold, altitude, and travel-stress may present unaccustomed physiological challenges to soccer participants. Performance expressed as work-rate is likely to be adversely affected, but scientifically based preparation can reduce the impairment in performance and increase tolerance levels.
- High ambient temperature raises core temperature response to exercise above normal values, causes increased losses of sweat, and reduces individual work-rates. Combined with high humidity, heat stress may compromise the safety of players.
- Thermal discomfort can be experienced when weather conditions are cold, and exacerbated when players become wet and cold. Those individuals with inadequate clothing and operating at low work-rates are at greatest risk of hypothermia.
- When playing at altitude, the oxygen transport system is impaired as a result of the decrease in ambient pressure, the decrease depending on the height above sea level. Fatigue is experienced at a lower absolute work-rate compared to performance at sea-level. Sleep disturbance may also contribute to day-time fatigue at altitude.
- Traveling across multiple time-zones disturbs the body clock. Exercise performance is likely to be impaired until the body clock adjusts to the new local time.

RECOMMENDATIONS FOR COACHES

- Prepare players for the environmental conditions to be faced. Preparation for exposure to unaccustomed conditions helps players to tolerate environmental stress.
- Acclimatize athletes to the heat, either by daily exposure to hot weather or to heat in a sauna or other artificial environment:
 - Acclimatization can be achieved relatively quickly, major adaptations occurring in 10-14 days.
 - Increase the emphasis on rehydration because improved heat tolerance involves increased sweat production.
- Protection against cold and inclement weather is best secured by donning appropriate clothing. This recommendation applies to training and match contexts.
- Acclimatize players to altitude to reduce the drop in aerobic performance capability that occurs at medium-moderate distances (2000 m) above sea-level:
 - Help players learn to pace themselves when playing in such conditions.
- Adjustments to behavior can accelerate the synchronization of body clock to local time when traveling across multiple time zones:
 - The best time for training and exposure to or avoidance of light will depend on the direction traveled.
 - Training should not be exhaustive for the first few days at altitude.
 - It is reasonable for travelers on short visits of 2-3 hours time difference to attempt to stay on the time-zone of departure.



Scientific and Medical Considerations



GSSI Scientific Conference
May 17–20 Baveno, Italy

Donald T. Kirkendall, PhD

Current Employment:

- FIFA Medical Assessment and Research Centre, Zurich, Switzerland
- Adjunct Assistant Professor, Department of Exercise and Sport Sciences University of North Carolina, Chapel Hill, NC
- Medical writer and editor
- Associate Editor, *Medicine and Science in Sports and Exercise*

Soccer (Football) Experience as a Player:

- Player for ~40 years at club, university, semi-professional, amateur, and master's levels
- Played on Ohio University NCAA quarterfinalist team, 1971
- Participated in US Olympic Trials, 1974

Other Experience in Soccer:

- US Soccer Federation coach, B-license, 1975
- Collegiate coach, 1972-1975
- Youth coach U10-U15, various years beginning in 1976
- Frequent speaker/clinician for US Youth Soccer Association and US National Soccer Coaches Association of America

Other Soccer-Related Activities:

- Program committee and faculty: FIFA FUTURO III Football Medicine Instructor's Course, 2005-present

Key Soccer-Related Publications:

- Guskiewicz, K.M., S.W. Marshall, S.P. Broglio, R.C. Cantu, and D.T. Kirkendall (2002). No evidence of impaired neurocognitive performance in collegiate soccer players. *Am. J. Sports Med.* 30:157-162.
- Kirkendall, D.T., S.E. Jordan, and W.E. Garrett (2001). Heading and head injuries in soccer. *Sports Med.* 31:369-386.
- Kucera, K.L., S.W. Marshall, D.T. Kirkendall, P.M. Marchak, and W.E. Garrett (2005). Injury history as a risk factor for incident injury in youth soccer. *Brit. J. Sports Med.* 39:462-466.
- Queen, R.M., P.S. Weinhold, D.T. Kirkendall, and B. Yu (2003). Theoretical study of the effect of ball properties on impact force in soccer heading. *Med. Sci. Sports Exerc.* 35:2069-2076, 2003.
- Yu, B, S.B. McClure, J.A. Onate, K.M. Guskiewicz, D.T. Kirkendall, and W.E. Garrett (2005). Age and gender effects on lower extremity kinematics of youth soccer players in a stop-jump task. *Am. J. Sports Med.* 33:1356-1364.

REDUCING INJURY RISK IN SOCCER

KEY SCIENTIFIC POINTS

- Injury prevention research follows a predictable model.
- Injuries in football are also predictable and are concentrated on the lower extremity.
- Most common injuries are contusions, sprains, and strains and are generally minor.
- Since 1998, there has been an average of 2.1 injuries per match in FIFA tournaments.
- Less than 10% of injuries lead to extended absence from play.
- Mechanisms of injury are predictable. Injuries may be caused by legal contact with another player, by mechanisms involving a single player, or by foul play.
- General injury prevention programs can reduce injuries.
- Specific programs show promise for minimizing ankle sprains, hamstring strains, and ACL injuries. Given the number of players worldwide, any reduction in injuries should have a public health impact.
- Modifying rules to include severe sanction on offending players can minimize foul play.
- Many player-related and environment-related risk factors for football injuries have been studied, but only a few appear to be strong risk factors:
 - Player-related factors include prior injury, flexibility, hamstring strength, and more.
 - Environment-related factors include training:match ratio, officiating, opponent behavior, and more.

RECOMMENDATIONS FOR COACHES

- Begin injury prevention programs when players are young—at puberty or earlier.
- Common injuries in soccer can be minimized:
 - To reduce the incidence of hamstring strains, incorporate hamstring strengthening routines in training plans.
 - To reduce the incidence of recurrent ankle sprains, encourage or require players to use ankle supports.
 - To reduce the risk of tearing the anterior cruciate ligaments, incorporate in training schedules plyometric routines, balance training, hamstring strengthening, and coordination training.
- Stress improvements in overall fitness and soccer skills and—very importantly—emphasis on fair play as major training goals that may minimize injuries.
- Avoid scheduling too many matches and not enough training, both of which can result in reduced fitness, skill, and tactical development that can lead to underperformance and injuries.
- Ensure proper maintenance of playing fields to reduce injuries caused by irregular field surfaces.
- Initiate and/or support efforts within football associations to improve officiating and to strengthen and enforce sanctions against those who engage in foul play.