Soccer requires a blend of extraordinarily diverse athletic capabilities ranging from aerobic endurance to explosive power and repeated sprint ability. These athletic abilities must be combined with technical proficiency, tactical awareness, psychological robustness, and fatigue resistance in order to attain high levels of success. Adequate and appropriate development of these abilities are challenging alone, but also may require a strength and conditioning coach capable of addressing these facets within specific periods of the competitive cycle (16). This article will examine the physical demands of soccer players and discuss why repeated sprint ability (RSA) is considered highly important in the performance of these athletes.

**PHYSIOLOGICAL DEMANDS OF SOCCER**

Quantifying key performance variables is comparatively straightforward in sports such as track and field or cycling. However, in soccer a complex array of performance elements interact on individual and team levels (8). Soccer demands have been assessed by monitoring player work rates and physiological responses. The resultant statistical data is consistently used to guide training prescription; however, the potential variability that exists in data collection should warn practitioners about the reliability of single observations and the small sample sizes that are commonly found (8).

Evidence indicates overall intensity across a 90-min match for elite-level soccer players is close to lactate threshold or around 80 – 90% maximum heart rate with total distances covered in the 10,000 – 11,000 m range (about 10,900 – 12,000 yards) (11). In addition, VO\textsubscript{max} testing indicates that most players measure in the 55 – 65 ml/kg/min range (11). Although analysis of elite-level soccer players has measured a range of important factors in soccer performance, the overall impact of specific high-intensity movements, particularly the constant deceleration and acceleration, requires a better understanding still (18).

Even though metabolic analysis suggests a high reliance on aerobic metabolism, critical game moments are often characterized by explosive activities, including sprinting, acceleration, deceleration, change of direction, turning, and jumping (12). In addition, speed and power are critical performance factors. Although high-intensity efforts represent only around 10% of the distance covered, these efforts are often key in the decisive moments (10). As a result, intermittent high-intensity endurance and, in particular, RSA are considered of high importance in competitive soccer (5).

**DEVELOPING REPEATED SPRINT CAPABILITY**

Repeated sprint exercise (RSE) is characterized by short, maximal-intensity efforts interspersed with periods of incomplete recovery, and has been described as sprints of 10 s or less with recovery bouts of 60 s or less (1). Decreases in running speed over repeated efforts are normally used to assess repeated sprint performance of this kind. Effective performance of repeated sprints requires an individual to quickly generate explosive power and then to sustain this over several efforts (1). Repeated power output of the lower
limbs is also associated with sprint performance in soccer (15). Most protocols currently used to train RSA use predetermined sprint durations, repetitions, and recovery periods, which are not sensitive to the individual or position of the player (15). Furthermore, many of these RSA protocols lack support in the research literature (2).

Alternative approaches using sprint training with complete recovery between efforts may also develop RSA. In consideration of the change of direction demands of soccer, developing combined sprint and agility training may also prove effective (3). Resistance training has demonstrated effectiveness in improving single sprint performance and early evidence suggests training with a high metabolic training rather than maximal strength training may also positively affect RSA (2).

High-velocity (i.e., explosive) strength training is commonly used to improve the neuromuscular qualities associated with athletic performance, and both explosive exercise and RSE training can enhance RSA (3,4). Production of power and explosive ability is dependent on a variety of structural, neural, and coordinative factors. Consequently, training using the application of ballistic resistance training, plyometrics, and weightlifting should all be considered in overall programming (20). Additionally, improved aerobic endurance and greater VO2max may also improve RSA (7,14). This may be related to its influence on recovery between efforts in combination with enhanced lipid utilization, which can delay the onset of fatigue (7,9). Therefore, the benefits of training to improve aerobic endurance should not be overlooked.

Based on the practice methods of elite sprint coaches, an interest in submaximal sprint efforts has been explored as a possible option for improving RSA. Initial findings using 90% of maximum intensity still support the need for maximal efforts to improve RSA; however, this approach warrants further exploration (9). Small-sided games (i.e., competitive, focused races/contests that replicate the demands of the sport, but are scaled down for training purposes) may be effective in developing some aspects of soccer conditioning, and it may be interesting to explore how this setting can be manipulated to include a specific RSA component.

In collision sports such as rugby league, repeated sprint and effort ability have been identified as two distinct qualities; this may also be true to soccer, even though it may be to a lesser degree because of the lower instances of collisions (13). Repeated sprint efforts may involve jumps, changes of direction, collisions, coming up from the ground to sprint, and sprinting to tackle and then sprinting again. Implementing specifically designed RSE drills that integrate these factors may prove beneficial for soccer players.

**PRACTICAL PROGRAM DESIGN CONSIDERATIONS**

Approaches to conditioning training for soccer can be broadly categorized as follows:

- **General training** is characterized by work of varying types and intensities without a ball.
- **Specific training without a ball** reflects specific characteristics of the game such as work-to-rest interval patterns but does not include a ball.
- **Specific training with a ball** reflects the demands of the game and includes a ball in all sessions.
- **Combination training** includes elements of specific work with and without the ball, combining both aspects of specific training.

Repeated sprint work with turns and small-sided games are common approaches currently used to address aerobic and anaerobic performance as well as recovery ability (6). Though small-sided games can be manipulated and organized to provide an excellent conditioning environment, the need for specific interventions to target key abilities is still highly important in developing the soccer player (18). There is a need for conditioning coaches to develop modified drills involving game-like simulations specific to each player that target the relevant physical abilities needed. These drills will involve combinations of speed work, ball work, technical demands, and varying intensities and recovery bouts in line with the positional demands and development objectives of each player (17). Match-based work-to-rest ratios, which are influenced by level of competition and playing position, should also be considered (20).

It is important to develop a long-term approach for soccer RSA that is managed within the overall player development program and considers the competitive schedule of the team and individual (2). Across most levels of the game, the training year can be divided into off-season, pre-season, and in-season periods, with the competitive period between 9 and 11 months in duration. This is dependent on the level of the player and the overall success of the team, which may extend the season via cup competitions or playoff scenarios.

A periodized plan that includes each approach individually across training blocks or multiple approaches in single blocks are two potentially viable options for strength and conditioning coaches. RSA appears difficult to develop when applied concurrently in-season on top of the other training modes required of a soccer player.

**SUMMARY AND RECOMMENDATIONS**

In an analysis of soccer performance, it can be very difficult to differentiate the various physical factors due to significant crossover and inter-reactions between abilities. Combined with the unpredictability of the game, its competitive schedule, and the prevalence of injury, strength and conditioning for soccer creates unique program design challenges for coaches.

Current understanding of the various interactions between metabolic, neural, and mechanical factors involved in RSA makes specific training guidelines elusive. However, general recommendations include:
• Training to improve maximal sprint speed (i.e., specific sprint drills or resistance training approaches).
• Inclusion of high-intensity interval running sessions with shorter recovery periods.
• Inclusion of traditional RSA training with repeated maximal sprint efforts and limited recovery.
• Training for high-velocity (i.e., explosiveness) where appropriate; ballistic resistance work, plyometrics, and weightlifting drills could also be implemented.
• Using small-sided games of varying configurations (e.g., 1 versus 1 and 2 versus 2).
• Ensuring that aerobic conditioning is well trained.

It is important to remember that in game situations, RSE are often combined with an array of technical and decision-making skills. In addition, the impact of fatigue on tackling, jumping, ball contact, dribbling, and ball striking need to be understood better (18). Backward and lateral movements, often omitted from training programs, are important in defensive situations and should be prioritized for relevant players (19).

Use of small-sided games in differing sized areas with varying participants (i.e., 1v1, 2v2, 3v3, up to 5v5) provides an opportunity to target a conditioning adaptation while providing some degree of sport specificity. Guidelines for appropriate volume and duration of both RSA and small-sided games sessions need to be carefully planned and managed.

REFERENCES
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Gary Stebbing studied sport and exercise science as an undergraduate and sport and performance psychology at the postgraduate level (PGDip). He has been certified as a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA) for 13 years. He trains clients for challenging objectives such as ultra-endurance and multi-day events. Since 1995, Stebbing has been a trainer and freelance performance and conditioning coach, including practicing, writing, and lecturing on coaching psychology, training, and conditioning for sport in the United Kingdom and Australia. Prior to this, he was a professional soccer player, spending 11 years in English leagues and captaining England at the U18 and U19 levels.

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