

Female Soccer: Part 2—Training Considerations and Recommendations

Ellena Turner, BSc (Hons), Allan. G. Munro, BSc (Hons), and Paul Comfort, MSc, CSCS*D
Sport Exercise and Physiotherapy, University of Salford, Salford, Greater Manchester, United Kingdom

SUMMARY

PART 1 OF THIS ARTICLE IDENTIFIED THE DEMANDS OF FEMALE SOCCER AND THE SPECIFIC AREAS OF DEVELOPMENT REQUIRED TO OPTIMIZE PERFORMANCE AND REDUCE THE RISK OF COMMON INJURIES. INCREASES IN AEROBIC CAPACITY, STRENGTH, AND LOWER LIMB CONTROL WERE REQUIRED TO IMPROVE PERFORMANCE AND REDUCE THE RISKS OF COMMON INJURIES. THE AIMS OF PART 2 ARE TO PROVIDE EXAMPLES OF EVIDENCE-BASED INTEGRATED STRATEGIES TO ADDRESS THE ISSUES IDENTIFIED IN PART 1 AND TO ENSURE NOT ONLY ENHANCED PERFORMANCE BUT ALSO A REDUCED INCIDENCE OF COMMON INJURIES IN FEMALE SOCCER PLAYERS.

INTRODUCTION

Soccer consists of high-intensity decisive activities, which contribute to the crucial moments, performance, and the outcome of a game (7,8,43,54). Many of these soccer-specific actions (striking the ball, turning, jumping, changing pace, cutting, and accelerating and decelerating the body) are forceful and explosive and require near-maximum levels of muscular force and power production (24,41,53,54,74). These actions play a part in more than 1,300 changes in activity (corresponding to a change

in match activity every 4 seconds), including maximal sprinting (20–30 times per game) and high-intensity running (125–154 times per game) contributing to 0.5–1.2% and 4.4–6% of match duration, respectively (2,61,62). However, to perform these actions at a high-intensity throughout the whole duration of a match (90 minutes), a high level of endurance is important to recover and replenish energy substrates from each high-intense bout. A high aerobic capacity is also essential to permit the athletes to effectively complete the distances covered (9.1–11.9 km) at an average of 84–86% maximum heart rate (MHR) during a game (1,2,23,35, 48,49,61). Although the data presented in this article represent a collection of studies using senior female athletes, the conditioning required for younger age groups is similar but needs to be applied as part of a long-term athlete development plan, with an initial focus on provision of movement.

From the summary of Part 1: “Needs analysis for female soccer,” it is suggested that female soccer players need to improve anaerobic aspects in both match performance and laboratory-based controlled assessments. The needs analysis showed that the majority of female soccer players lacked in conditioning, resulting in:

- A high occurrence of anterior cruciate ligament (ACL) injuries resulting from increased knee valgus during deceleration activities (landing from jumps, cutting, decelerating) because of poor neuromuscular control.

- Lower countermovement jump height and slow sprint times (20, 30, and 40m), which are likely to be a product of low lower-body strength.
- Reduced distances covered in a game, which is likely a result of the relatively lower $\dot{V}O_{2\max}$.
- Low total sprint distances and high-intensity distance covered in a competitive match, which may be attributable to both the relatively lower $\dot{V}O_{2\max}$ and lower-body strength.

INJURY CONCERNS

Myer et al. (63) and Ford et al. (25) identified that female athletes with significantly lower hamstring strength and neuromuscular control, and greater knee valgus may be more likely to suffer an ACL injury than male athletes. The majority of ACL injuries are highly associated with valgus movement combined with anterior tibial shear forces during rapid deceleration-type movements, such as landing and changing direction, which typically occur during soccer competition (11,55,77). Appropriate neuromuscular control, strength, and power training, however, have been shown to reduce knee valgus torques by 28–50% (18,31,34,64). Although strength training alone may not bring about a reduction in knee valgus motion (30), studies have demonstrated that the improvements in lower-limb strength and control can reduce the number of

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lower-limb injuries (4,52). Plyometric training decreased knee valgus and ground reaction forces, and increased hamstring strength while also improving performance (31–34,42). In addition, training programs that aim to improve lower-limb neuromuscular control using a combination of balance, plyometric, and strength training have been shown to decrease knee valgus motion and improve performance during hopping and jumping tasks (9,64). With further reports suggesting that neuromuscular training decreases the neuromuscular differences between male and female athletes (34), these findings highlight the importance of muscular conditioning within soccer and the need to include strength, power, and neuromuscular training within a player's training regimen to help reduce injury risk while aiding performance.

Hamstring injuries are also common in soccer, with most through noncontact mechanisms (27,28,76,80–82), highlighting that the risk of injury is intrinsic and may be offset through appropriate conditioning. The literature suggests that there are 2 noncontact mechanisms responsible for hamstring strain; 1 resulting from high-speed running (82,83), and the other during stretching movements (including kicking at end of

range) carried out by extreme range of motion (4–6), both resulting in high velocity eccentric loading (14,50). The strain is most likely to occur during 2 stages of the running cycle; late forward swing and toe off (73) as, at this stage, the hamstrings decelerate hip flexion and knee extension resulting in large eccentric loads (39,40). In terms of injury prevention, these common mechanisms of injury have implications for conditioning. It is essential that the hamstrings are conditioned through not only the “normal” concentric emphasized exercises but also through eccentric muscle actions with exercises such as “Nordic hamstring lowers,” which have been shown to decrease the risk of hamstring injury (3,426). It is also essential to progress on to higher velocity eccentric exercise, such as plyometrics (deceleration training), which has also been shown to have a beneficial effect in preventing and rehabilitating hamstring strain injuries (13,14,44,68). The integration of plyometric drills to reduce the risk of ACL and hamstring injuries is also likely to reduce the incidence of ankle injuries, especially with improved lower-limb control.

ANAEROBIC QUALITIES

The level of relative lower-limb control and conditioning is very important

within soccer as soccer-specific actions such as changing direction, running, sprinting, and jumping and landing can involve relative forces between 1.65 and 4.22 times body mass (BM) (10,57,71,78). Greater lower-limb relative strength may improve an individual's ability to accelerate and decelerate during actions such as sprinting and turning, thereby reducing injury risk and performance decrement (21,38,56), especially when combined with good lower-limb control.

Improving physical attributes is likely to result in an improved level of play, as le Gall et al. (51) identified higher level players (professional and international) possessed significantly greater maximal anaerobic power, counter-movement jump height, and sprint performance than lower standard players (amateur) at youth level. In addition, Hori et al. (38) found that athletes with stronger (relative to BM) hang-power clean performance possessed a significantly greater jump and sprint performance than less strong athletes. McBride et al. (56) reported similar findings showing athletes with greater relative back-squat strength (>2.10 times BM) had significantly faster sprint times than the less strong athletes (<1.90 times BM).

Table 1
Example strength endurance program

Microcycle 1				Microcycle 2			
Exercise	Reps	Sets	Intensity (% 1RM)	Exercise	Reps	Sets	Intensity (% 1RM)
Back squat	10–15	2–3	70–80%	Front squat	10–15	2–3	70–80%
Forward lunge	10–15	2–3	70–80%	Reverse lunge	10–15	2–3	70–80%
Unilateral RDL	10–15	2–3	70–80%	Deadlift	10–15	2–3	70–80%
Drop landings (bilateral)	10*	2–3	30 cm box	Nordic curls	3	2–3	Body weight
CMJ	10*	2–3	Body weight	Drop landings (unilateral, alternating legs)	10*	2–3	30 cm box

*Although 10 repetitions are suggested, if velocity and/or technique deteriorate, then terminate the set early, rest for 30 seconds, and continue until the required number of repetitions have been completed.

It is suggested that the strength endurance program be performed 2 d/wk (alternating between the microcycles) with 48–72 hours between sessions or before a game.

CMJ = countermovement jumps; RDL = Romanian deadlift.

Table 2
Example strength program

Microcycle 1				Microcycle 2			
Exercise	Reps	Sets	Intensity (1RM)	Exercise	Reps	Sets	Intensity (1RM)
Back squat	2–6	4–6	85–95%	Front squat	2–6	4–6	85–95%
Lunge	2–6	4–6	85–95%	Mid-thigh clean pull	2–6	4–6	85–95%
RDL	2–6	4–6	85–95%	Nordic curls	3	3	Body weight
Depth jumps (bilateral)	10*	3–4	30 cm box	CMJ (unilateral)	10*	3–4	Body weight
CMJ	10*	3–4	Body weight	Depth jumps (bilateral)	10*	3–4	30 cm box

*Although the number of repetitions is prescribed, if velocity and/or technique deteriorate then terminate the set.

It is suggested the strength program be performed 2 d/wk (alternating between the microcycles) with 48–72 hours between sessions or before a game.

CMJ = countermovement jumps; RDL = Romanian deadlift.

Many studies have demonstrated the positive effects of strength and power training and the influence they have on soccer-specific performance variables, such as sprinting, agility, and jump performance (17,59,60,66,67,70,72,79). However, inconsistent results exist within these studies including methodological aspects such as the subject training status and intervention training protocols. Chelly et al. (16) and Ronnestad et al. (69) reported different

increases in 1 repetition maximum squat score after 7–8 weeks of strength training (35% versus. 25%). It is possible Ronnestad et al. (69) may have obtained smaller increments than Chelly et al. (16) because of the soccer player's higher training status (relative strength) pretraining (2.3 versus. 1.8 times BM); irrespective of this, however, both studies showed substantial increases in maximal squat strength after only 7–8 weeks.

The load applied to the muscle has been found to contribute the most to strength increases (16). The force/load is also a contributor to power (force applied over time); therefore, without increasing strength effectively, power may not improve (16); both the aforementioned studies demonstrate that even strong athletes can increase strength in a relatively short training period (16,69). Nimphius et al. (65) supports this finding showing strong

Table 3
Example power training program

Microcycle 1				Microcycle 2			
Exercise	Reps	Sets	Intensity (% 1RM)	Exercise	Reps	Sets	Intensity (% 1RM)
Mid-thigh power clean	3–6	3–5	60%*	Mid-thigh clean pull	3–6	3–4	60%*
Squat jump	2–5	3–5	0–10%*	Hang split clean	3–6	3–4	60%*
RDL	2–6	2–4	85–95%	Nordic curls	3	3	Body weight
Depth jumps (bilateral) 1-m between boxes	10†	4–6	30 cm box	Diagonal hops (unilateral)	4–6 per leg	3	Body weight
Multiplanar depth jumps (bilateral) onto boxes	10†	4–6	20 cm box	Alternate leg bounds (focus on height and distance)	4–6 per leg	3	Body weight

*Repetitions, sets, and loads are all recommendations from NSCA (2008) with exceptions of: Mid-thigh clean pull (19,20,46), Mid-thigh power clean (19,20,46), squat jumps (% of 1-RM Back Squat) (12,22,75).

†Although the number of repetitions is prescribed, if velocity and/or technique deteriorate, then terminate the set.

It is suggested that the power program be performed 2 d/wk (alternating between the microcycles) with 48–72 hours between sessions or before a game.

CMJ = countermovement jumps; RDL = Romanian deadlift.

Table 4
Example of interval training program

Training phase	Type of interval training	Interval protocol
Week 1–8	Uphill running and inclined treadmill running	4 × 4 minutes of high-intensity work (90–95% MHR) separated by 3-minute recovery periods (60–70% MHR). Performed twice a week for 8 weeks (29)
Week 10–17	5v5 SSGs	4 × 4 minutes of high-intensity work (90–95% MHR) separated by 3-minute recovery periods (70% MHR) performed twice a week for 8 weeks (58)
Week 19–25	4v4 SSGs	4 × 4 minutes of high-intensity work (90–95% MHR) separated by 3-minute recovery periods (70% MHR) performed twice a week for 8 weeks (15)
Weeks 1–8 to be performed in conjunction with the strength endurance mesocycle.		
Weeks 10–17 to be performed in conjunction with the strength mesocycle.		
Weeks 19–25 to be performed in conjunction with the power mesocycle.		
Weeks 9, 18, and 26 are unloading weeks, where no additional structured aerobic exercise is to be performed.		
MHR = maximum heart rate; SSG = small-sided games.		

significant correlations ($r = 0.70\text{--}0.93$) between both speed and changing direction ability and relative strength after 20 weeks of strength training.

Power-based exercises including variations of the Olympic-style lifts and plyometric exercises (depth jump, box jumps, etc.) are beneficial to improve soccer-specific variables like sprinting and jumping because they biomechanically replicate the similar lower-limb angles. Although beneficial, many inconsistencies exist across research regarding power clean loads, the optimal load has suggested to range from

30 to 80% 1RM (power clean) (22,46), whereas other studies have found no statistically significant differences between 50 and 90% 1RM (45,47).

The findings of Kawamori et al. (46) suggest that lighter loads (30%) may be more preferable than heavier loads (60%), during the mid-thigh power clean, to increase the velocity of the movement for the second clean pull because it reflects the velocity of soccer actions more closely. In addition, Comfort et al. (19,20) demonstrated greater power, force, and rate of force development during the mid-thigh power clean

compared with the hang power clean and power clean. Stone et al. (75) reported similar results when assessing peak power output within squat jumps at loads ranging from 10 to 100% 1RM and found the lightest load (10% 1RM) expressed significantly greater peak power, whereas later research suggested that body weight (0% 1RM) squat jumps achieved greater peak power (12,22).

AEROBIC CAPACITY AND MATCH PERFORMANCE

A consistently successful protocol for improving aerobic endurance has been

Table 5
Example of neuromuscular training program

Training phase	Microcycle 1	Microcycle 2
Strength endurance	<i>Unilateral exercises:</i> Hop and holds, box jumps, drop landings (technique focused: 3 sets, 4–5 reps* on 15 cm box), Nordic curls (3 reps, 3 sets, body weight)	Bilateral exercises: box jumps, drop landings, depth jumps (technique focused: 2 sets, >10 reps* on 30 cm box)
Max strength	<i>Unilateral exercises:</i> Hop & holds, box jumps, drop landings, depth jump (technique focused: 1–2 sets, 5 reps* on 20 cm box), Nordic curls (3 reps, 3 sets, body weight)	Bilateral exercises: Lateral hurdle jumps, drop landings, depth jumps (technique focused: 1–2 sets, 5–10 reps* on 45 cm box)
Power	<i>Unilateral exercises:</i> Triple hop and hold (progressed onto triple cross-over hop and hold) depth jumps (technique focused: 2 sets, 5 reps* and 15 cm box for depth jump), Nordic curls (3 reps, 3 sets, body weight)	Bilateral exercises: lateral/multidirectional continuous-box jumps, depth jump with 1 m apart (box to box; technique focused: 2 sets, >10 reps on 30 cm box)

*Although prescribed specific reps, if velocity and / or technique deteriorates then terminate the set, rest for 30 seconds and then continue until the desired number of repetitions are completed.

demonstrated using the 4×4 -interval training format. Research has found that training at 4-sets of 4-minutes at a 90–95% MHR intensity separated with 3-minute recovery periods significantly ($p < 0.01$) improved $\dot{V}O_2\text{max}$ by 7.5–10.8% (15,29,36,37,58). It also appears that this magnitude of adaptation occurs irrespective of the time point within the season that the training is carried out and the type of training (e.g., running, small-sided games) involved within the intervals. For example, Helgerud et al. (29) carried out the intervention training within the competitive season, whereas McMillan et al. (58) performed the study within the off-season. Furthermore, Helgerud et al. (29) involved uphill/inclined running exercise, whereas Chamari et al. (15) and McMillan et al. (58) included small-sided game formats (4v4 and 5v5).

Only Helgerud et al. (29) investigated the transferability and effect these improvements had within match performance (11v11 match), demonstrating significant ($p < 0.01$) improvements in the distance covered (24%), number of sprints performed (100%), and number of ball involvements (20%). By relating aerobic improvements from laboratory-based testing to match performance, the findings of Helgerud et al. (29) demonstrate a true representation of the impact the intervention had on the performance of the soccer player. In addition, increased aerobic performance is also likely to delay the onset of fatigue, which may reduce the incidence of injury in the later stages of a game.

RECOMMENDATIONS

Resistance training, neuromuscular training, and interval training (4×4 format) have shown to improve anaerobic qualities and the aerobic capacity of individuals. Neuromuscular control training and hamstring-specific training have shown to reduce risks to lower-limb injuries within high velocity cutting sports like soccer (31,34,64). Moreover, for anaerobic qualities such as relative strength, power, speed, and agility, a resistance strength/power training program has

shown to significantly improve levels of performance across numerous intervention studies. Thus, with the aims of the female soccer players to improve overall conditioning levels (when compared with male soccer players), research-specific strength and power training, neuromuscular control, and interval training programs are illustrated (Tables 1-5). These training modes need to be integrated into a periodized training program, which is specific to the individuals' aims and the phases of the competitive season.

CONCLUSIONS

Helgerud et al. (29) identified that an aerobic endurance intervention can significantly improve aerobic variables by 10.8–16% within laboratory-based assessments ($\dot{V}O_2\text{max}$ and lactate threshold testing), which positively affected and transferred into a soccer match displaying a greater number of sprints (100%), total distance covered (20%), and number of ball involvements (24%).

Previous research has also shown that strength and power interventions significantly improve soccer-related performance in laboratory assessments, such as jump height, sprint, and agility speed (17,59,60,66,67,70,72,79), which is likely to transfer into soccer match performance.

To improve anaerobic qualities such as sprint, agility, jump, and maximum strength, based on the current research findings, it is important to carry out an evidence-based periodized training program (strength, maximum strength, and power phases, incorporating appropriate aerobic conditioning). Also, to address injury concerns related to female soccer players, it is recommended that neuromuscular and hamstring-specific training should be involved in the player's training schedule, possibly as part of their dynamic warm-up. However, it must be advised that each training program should be individualized to meet the needs and address the weakness of each player and the point in the competitive season.

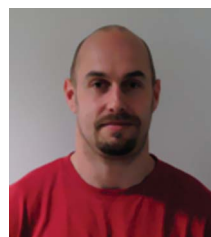
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Ellena Turner
is a Sports Scientist at the Manchester City FC Academy and a Doctoral candidate at the University of Salford.



Allan G. Munro
is Clinical Director at the Sports Rehab UK, Lecturer at the University of Derby and a Doctoral candidate at the University of Salford.



Paul Comfort
is the program leader for the MSc Strength and Conditioning at the University of Salford.

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