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## TRAINING FOR PERFORMANCE: DEVELOPING ELITE FEMALE FOOTBALL PLAYERS

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## SUMMARY

This text discusses the physical match demands for elite female football players in international games, the physical qualities required to reach elite levels in female football, and how to develop young talents to become top international players.

### TAKE-HOME MESSAGES:

- The physical development of an elite female football player, which includes developing muscular strength and aerobic and anaerobic fitness, is a long process and should progress slowly over time.
- A high incidence of anterior cruciate injuries in young female players highlights the importance of training programs for knee stability when developing young talents.
- Elite female players must follow demanding training schedules to optimally prepare for the high physical demands in international matches.
- Elite players should especially aim to improve their ability to work at a faster pace on the field, because the international game is becoming faster. They can improve this capacity by including speed and agility training in their training sessions on a regular basis.
- Recovery strategies should be carefully incorporated into training schedules so that players can train, play and develop without injuries.



## MATCH DEMANDS IN ELITE FEMALE FOOTBALL

Today, elite female football is professional or semi-professional in a number of countries, for example, the USA, Germany, Sweden, Russia and France. Many players are able to train fulltime and prepare for games in an optimal way. Consequently, the quality and the intensity of the games are increasing, as are the physical demands on the players. In the last decade, the physical workload for elite female players during games has been described, including movement analysis and heart rate profiles. Top elite players cover approximately 10 km during a 90-minute game. The work pattern is intermittent and players make between 1336–1529 activity changes in a game, corresponding to about one activity change every four seconds. A large proportion of the game time is spent in low-speed activities; approximately 16 % of the game time is spent standing, 44% walking, and 34% low-speed running (8–12 km/h). The remaining 6% is spent high-speed running (> 15 km/h), including 1–2% of sprinting (> 25 km/h).

Although only a small proportion of the total game time, the distance covered in high-speed running has been suggested as the most significant factor in game performance—the higher the competition level, the longer the distance covered at high speeds by players in both men's and women's games. Top-class female players have been reported to cover 1.5–2.0 km at high speeds during international games. Thus, an elite female player must develop her fitness in order to run intermittently at high speeds frequently during a game.

Reports on the heart rate profile of female players during games confirm that football is aerobically demanding, despite a large proportion of the games consisting of low-intensity activities. The average heart rate during an international game is reported to be about 85–90% of maximal heart rate (HR max), that is, about 161–171 beats per minute (bpm). This rate corresponds to approximately 70% of maximal oxygen uptake ( $VO_2 \text{ max}$ )<sup>1</sup> and is similar to that previously reported for male players. Peak heart rate can reach 97% of HR max during games (Figure 1).



**Figure 1.** A typical heart rate curve for an elite female football player during an international football game. The average heart rate for the first half of the game was 89% of HR max and, for the second half, 85% of HR max (author's unpublished data).

Thus, a female football player needs to develop good aerobic fitness to play for 90 minutes, and good anaerobic fitness to repeatedly sprint and run at high speeds. In addition, she must be able to perform technically difficult tasks with the ball and make demanding decisions at high speed.

<sup>1</sup>

## THE MATCH AND TRAINING SEASONS

Similar to other elite athletes, female players in professional football leagues are active all year round. The structure of the competitive season is such that the players have to perform in multiple games throughout a year, which differs from the pattern in many individual sports where players have only a few major competitions per year. The competitive season in the Swedish league lasts about 7–8 months and involves 24 domestic league games and a number of domestic cup games. The top teams also participate in international cup games (the UEFA Women's Champions League). Consequently, players sometimes have more than one game per week during certain periods of the season. In addition, there are several international games every year for the national team players, especially in years with a major tournament such as the World Cup, the European Cup or the Olympic Games. Thus, the top international players may compete in a total of 50–60 games during a major international tournament year.

The development of an elite female player should therefore include optimal training volume and intensity to meet the physical demands of participating and competing during a season. A football season is generally divided into three major phases throughout the year: offseason, preseason (early & late) and competitive season (which includes a summer break).

In the Nordic countries, the offseason generally lasts from late October to early December and includes one or two weeks of complete rest for the players. Following the rest period, the players start training, mostly individually through fitness programs in their clubs. The training comprises 4–6 sessions per week and incorporates various forms of aerobic training to maintain aerobic fitness. The program may also include 1–3 sessions of general strength training. The early preseason typically spans from December to early February (anywhere between 4 and 8 weeks). During this time, the team trains together for 6–8 training sessions per week consisting of 4–6 football sessions and two or three sessions of strength training. The football training during the early preseason focuses on improving aerobic fitness, while the strength training aims to develop maximal strength. The late preseason phase starts in early or mid February and lasts approximately 6–8 weeks. The football training in this phase incorporates 8–10 training sessions per week, which includes friendly matches. The focus in the late preseason is to develop the player's ability to run at high speeds and to continue developing her aerobic fitness. The strength training of one or two sessions per week develops her power and speed, and may include plyometric<sup>2</sup> and sprint exercises.

## DEVELOPING ELITE PLAYERS

The development of an elite player has many facets. In several countries, the football associations (FAs) have a 'player development plan' that defines how to educate talented players. The Swedish FA, for example, has a specific player development plan for female players. The progressive plan spans from the age of 15 to the senior-level team. Four aspects of development are addressed: technique, tactics, psychology and fitness. Fitness development is further divided into four components: general strength, explosive strength, football-specific fitness and recovery. The relative importance of these components varies according to the player's age and developmental progress. Usually, the most important

<sup>2</sup> *Plyometric exercises* are designed to link absolute muscular strength and the scope of the movement to produce explosive–reactive movements. Although the term often refers to jumping exercises, it also covers exercises that use the stretch reflex to produce an explosive reaction (T. Bompa, 1999, *Periodization, Human Kinetics*). See also *Explosive strength* later in this text.

quality to develop in younger athletes is general strength, while for senior players explosive strength and football-specific fitness are priorities.

### General strength

General strength refers to the strength of the whole muscular system. Training should develop sufficient muscle mass and strength to cope with the high training volume and intensity required for elite players. It is particularly important to develop general strength early to provide a sound strength base from which power and explosiveness can subsequently be developed, and to prevent injuries. To improve general strength, exercises that use the athlete's body weight can be included, for example, push-ups, hamstring exercises, lunges and various core exercises.

For younger players, developing knee strength and stability is also a priority because the incidence of anterior cruciate ligament (ACL) injuries appears to be higher among female players than among male players, especially in youthful players. Scientific evidence to explain the higher incidence of these injuries in women is lacking; however, high game frequency relative to age and differences in anatomy and biomechanics between women and men have been suggested as contributing factors. Importantly, scientific reports have shown that if specific programs to prevent knee injuries are included in training on a regular basis, the risk of ACL injury in young female players can be reduced. Various knee-stability programs are available, for example, the '11+' program of the International Federation of Association Football (FIFA) and a Swedish program called 'Knee Control' (Knäkontroll). The exercises in the various programs are similar. It doesn't really matter which program is used—compliance with the program is the most important factor in reducing the risk of ACL injuries.

### Explosive strength

The terms 'explosive strength' and 'power' have similar meanings in the Swedish FA's development plan: the ability to produce maximum muscle force in the shortest time possible. Power is the product of two physical abilities, strength and speed. These qualities take a long time to develop, especially for female players. Therefore, training focused on developing strength and speed should occur often and regularly during a season.

Explosive strength training (or power training) for football players can include weightlifting exercises, sprint exercises and plyometric exercises. These forms of exercise improve neuromuscular coordination and a player's agility, speed and maximal strength. Before beginning an explosive strength training program, however, it is vital that a player has sufficient general strength combined with correct weightlifting technique. Weightlifting techniques are introduced early in the player's development plan, while the explosive training is introduced later. The explosive weightlifting exercises may include Olympic lifts such as knee squats, clean and jerks, Romanian deadlifts and snatches.

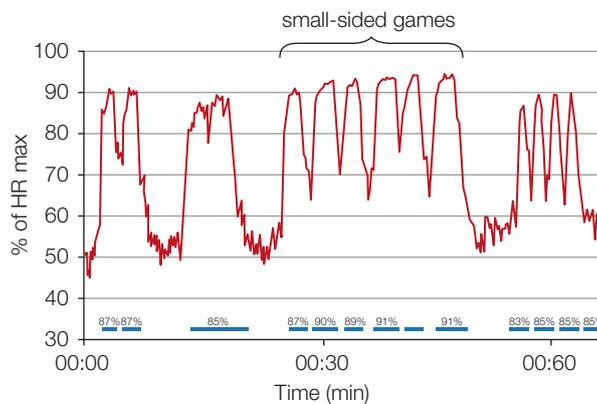
Sprint exercises for football players can be similar to exercises used in athletics, but can also include specific sprint exercises on the field that incorporate the football. Football players need to run fast, especially in terms of their starting reaction, acceleration phase and maximal speed over 10–20 metres. Thus, exercises that improve these qualities should take priority. Plyometric exercises develop speed, agility and strength; exercises useful in football training include jumping over low or high hurdles, drop jumps and other jump exercises that are more football specific (e.g. headers).

## Football-specific fitness

As already mentioned, both aerobic and anaerobic fitness are crucial for football players. The most effective way to train for football-specific aerobic and anaerobic fitness is to perform exercises specific to match play, hence the term ‘football-specific fitness’. Games with a small number of players per side have been shown to improve VO<sub>2</sub> max to a similar extent as interval running at the same intensity. Importantly, however, these games also train players’ technique, tactics and muscle-specific actions and players find this training more motivating than just interval running. Thus, fitness training using football-specific drills is more effective than interval running without the ball.

To improve the fitness of elite players, the football-specific drills should be performed at a high intensity—around 85–95 % of HR max. For example, figure 2 shows the heart rate curve of an elite female player during a small-sided game. During the effective play, her heart rate reaches 87–91% of her HR max. The player spent 27 minutes of the total training session at an intensity above 85% of HR max; of these 27 minutes, 13 were spent above 90% of HR max. If this type of training is performed regularly, it will likely improve the player’s football fitness.

To increase the speed and intensity of the training, female football teams sometimes incorporate male junior players (15–18 years old) in training. However, for this form of training to be effective, the male players must have similar, or slightly better, football skills than those of the female players, in addition to having faster speed. Therefore, the football skills of the male junior players must be assessed before incorporating them into training.



**Figure 2.** The heart rate curve of an elite female football player during a small-sided game in a high-intensity training session. The figure does not include warm-up and cool-down phases (author’s unpublished data).

Football-specific anaerobic fitness may also be developed using football-specific drills. This ‘football anaerobic fitness’ is divided into speed endurance training and speed training. Furthermore, there are two forms of speed endurance training, namely production training and maintenance training.

Published reports about anaerobic training for female players are limited. However, studies of male players show that production training is a very effective way to elicit adaptations in several physiological characteristics of the muscle and to improve performance in repeated high-intensity exercises. Production training involves bouts of exercise lasting 10–40 seconds at near-maximal speed that are separated by rest periods of 1–5 minutes (i.e. > 5

times the exercise duration). For example, 30 seconds of exercise would be followed by 3 minutes of rest.

Maintenance training has been shown to improve the ability to sustain intense exercise. It involves bouts of exercise lasting 5–90 seconds, with shorter resting periods than those of production training (> 1–3 times the exercise duration). For example, 30 seconds of work might be followed by 30 seconds of rest. These work-to-rest ratios can then be applied to a variety of exercises specific to particular football tactics or to the running patterns of a player's position.

### Recovery capacity

A player's recovery capacity is an important aspect of the development of elite football players. The term is adapted from the Australian FA and encompasses three components of recovery: the capacity to recover between high-intensity runs during a game; the ability to recover quickly between games; and the total recovery during a season.

Players are known to fatigue towards the end of games—they sprint less and perform fewer high-intensity runs than earlier in a game. Furthermore, players may fatigue temporarily during a game and their performance will be reduced after a period of intense exercise if they are unable to recover quickly. Thus, the ability to recover quickly between high-speed runs during a game seems crucial for performance and should be developed in elite female players. This recovery capacity during games is related to both the player's aerobic and anaerobic fitness, both of which can be improved with the training exercises described above.

It is now known that changes occur in the physical performance and biochemical stress markers of elite female players immediately after a game. The results show that several neuromuscular qualities are reduced for some time (> 48 hours) and that stress markers are elevated (> 69 hours) after a football game. Additionally, studies have shown that a game induces increased production of free radicals, with a parallel increase in antioxidant levels and acute pro-inflammatory and anti-inflammatory responses. Together, these results indicate that a game leads to changes in several physiological parameters, some of which remain altered long after the game. Because the time between games in international tournaments is short (2–3 days), quick recovery between games is vital. Therefore, effective recovery strategies need to be developed in women's football.

Furthermore, the total recovery during a season is crucial for many female players, especially promising young players. Talented young players are commonly involved with several different teams in addition to their own club team. For example, they may play in school and district teams and perhaps the national youth team, and also train with the local senior team. Thus, total recovery during a season may be difficult for these young players; training and playing should be planned carefully to avoid acute and overload injuries. Also, although some female players are fulltime professional players, many women still have to combine a fulltime occupation or study and family commitments with fulltime training schedules. This hectic lifestyle may lead to suboptimal recovery.

Finally, recovery capacity is linked not only to aerobic and anaerobic fitness, but also to other factors such as mental recovery and the quality of sleep and nutrition. Therefore, a carefully planned recovery strategy should always be part of developing the elite player.

## FITNESS TESTS IN FOOTBALL

Publications on the physical characteristics of elite women footballers show that, on average, the elite female player is 20–30 years old, 162–171 cm tall, weighs 58–65 kg, and has an average maximal oxygen uptake ( $\text{VO}_2 \text{ max}$ ) between 49 and 55  $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ .

As discussed above, aerobic and anaerobic fitness is sport specific and several field tests for both types of fitness are available in football. A commonly used fitness field test is the Yo-Yo series of tests, which consists of three different tests: the Yo-Yo endurance test, the Yo-Yo intermittent endurance test (IE) and the Yo-Yo intermittent recovery test (IR). The IR test consists of repeated bouts of 2 x 20-metre runs at a progressively increasing speed that is controlled by audio bleeps from a CD-player. Between each running bout, the players have a 10-second rest period, during which 2 x 5-metre jogs are performed (in the IE test the rest period is 5 seconds and the distance is 2.5 metres). These tests have been validated for game performance, with the amount of high-intensity running a player does during a game correlated to the performance in the IE and IR tests. The best elite female players have been shown to run 1680–2240 metres in the IE test and about 2000 metres in the IR test.

Other fitness tests often used for football players are maximal sprints of 10, 20 and 30 metres, jump height, knee strength, core strength, certain upper body exercises and repeated sprint tests. The average 10-metre maximal sprint time for female footballers has been reported as 1.70–2.31 seconds, the average maximal countermovement jump height as 29–35 centimetres and maximal knee strength (1 repetition maximum squat) as about 85–90 kilograms (i.e. 1.2–1.3 times the bodyweight). However, jump heights of 49 centimetres and maximal knee strengths of 110 kilograms have been reported for goalkeepers, for whom these qualities are very important.

## THE FUTURE OF WOMEN'S FOOTBALL

The finals of the 2011 World Cup in Germany and the 2012 Olympic Games in London were played between Japan and the USA. The players in the two teams had good high-speed technique and good tactical performance, which indicates the future of the women's game. Similar to men's football, the women's game will probably become faster and physically tougher over time. Also, female goalkeepers' techniques have improved, and will likely improve further with the increasing ability to train fulltime.

One difference between women's and men's football is that some countries do not have competitive leagues for women, whereas most nations do have a men's domestic league. Surprisingly, the teams without a domestic league may have an advantage when preparing for international tournaments, because they are able to have a long preparation phase, especially in tactical and fitness training. On the other hand, teams from countries with a high-quality domestic competition (e.g. Germany and Sweden) can play many games during a season and become 'match fit' in preparation for an international tournament.

In addition, as the status of women's football is increasing in many countries, the financial situation for the players is improving. This will hopefully enable the players to better prepare for tournaments and lead to further improvements in the women's game.

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