Performance Considerations in Women's Football

Naomi Datson[1] and Katrine Okholm Kryger[2,3]

[1]Institute of Sport, Nursing and Allied Health, University of Chichester, Chichester, UK; [2]Faculty of Sport, Allied Health and Performance Science, St Mary's University, Twickenham, London UK; [3]Sport and Exercise Medicine, Queen Mary University of London, Sport and Exercise Medicine, London, UK

INTRODUCTION

Fédération Internationale de Football Association (FIFA) has defined women's football as the leading opportunity for growth in football[1]. With the recent advances in popularity, women's football looks set to only increase its already upward investment and development path. However, the Fédération Internationale des Associations de Footballeurs Professionnels (FIFPro; World Players Union) recently reported more investment and support was needed if players and subsequently the women's game are to develop to their full potential[2]. As such, women's football seems to hold a complex position with both opportunities and challenges on the horizon. To aid the development, research needs to follow the current high pace of progression within the game, to support evidence-based practice across all fields of women's football. A recent review scoped peer-reviewed literature published in a FIFA language to understand the current quantity of research on women's football and found 442 papers on elite women's football and a steep upward trend in research interest[3]. The volume of new information is therefore vast, and this article aims to guide readers towards key up-to-date evidence-based performance considerations in elite women's football.

PHYSICAL DEMANDS OF MATCH PLAY

Current Knowledge

General physical demands

Total distance covered provides an overview of the physical demands of match-play and is arguably the most frequently cited physical performance metric. Research has shown that female players cover approximately 9-11 km per match and data from the most recent FIFA World Cups for men (Russia 2018) and women (France 2019) highlighted similarities in team total distances between the sexes (men: 104.6 km and women: 104.3 km)[4].

Whilst total distance provides a broad indication of a player's movement demands, it is often considered more meaningful to sub-divide total distance into activity categories or speed zones. Qualitative descriptors such as low-speed running, high-speed running and sprinting are often applied to these activity categories to aid interpretation. There has been debate in the literature regarding activity classifications in female match-play and the appropriateness of certain speed thresholds. However, regardless of the approach taken, low-speed and high-speed activity account for approximately 75% and 25% respectively of the total distance covered in female match-play. Although elite male players cover more distance in higher speed thresholds compared to elite female players[5], recent evidence highlights the increase in intensity in the women's game, with players covering ~30% more distance in the highest speed zone (> 23 $km.h^{-1}$) in the 2019 FIFA Women's World Cup compared to the 2015 tournament[4].

As well as considering locomotive activities, it is also important to study sport-specific movements (e.g., accelerations, decelerations, and changes of direction) and actions (e.g., heading, tackling, and running with the ball) so as not to underestimate the true workload for a player. Elite female players change activity approximately 1500 times per match and undertake ~850 accelerations/decelerations > 2 $m.s^{-2}$ [6].

Position Specific Match Demands

Physical match performance profiles differ distinctly across playing positions (see Figure 1). Central midfielders typically produce the highest total distances, and central defenders the least. High-speed running and sprinting distances are generally highest in wide midfielders and lowest in central defenders. The physical match profile of goalkeepers is less well studied, but clearly their tactical role signifies a different physical profile to outfield players. The recovery duration between isolated and repeated high-speed actions also varies with playing position; longer recovery durations are more common in central defenders and shorter recovery durations more common in central and wide midfield players[7].

****Figure 1 near here****

Variations in Performance

Match physical performance typically varies throughout a match. Researchers have often illustrated a reduction in total and high-speed running distances within the last 15 minutes compared to the first 15 minutes of match-play[4]. These changes in a player's physical performance within a match are typically attributed to fatigue, however, full consideration of contextual factors (i.e., playing formation, score line etc.) is needed prior to forming conclusions. For example, teams often try to establish tactical superiority at the start of a match which may lead to artificially increased values for high-intensity activities during the first 15-minutes.

Recent research has moved away from considering the match in fixed epochs, i.e., 0-15, 15-30 mins etc. and has instead focused on examining the peak demands of match play to better understand the intermittent nature of the game. The most demanding 1-minute period in elite female match-play for total distance covered has been shown to be 168 $m.min^{-1}$ and 47 $m.min^{-1}$ for high-speed running[8]. These peak periods have been promoted as a useful indicator for training session design, however, in reality, understanding the most challenging period of match play is complex, with a need to consider contextual factors and multiple variables concurrently.

Practical Implications

- Understanding the demands of match-play is fundamental for practitioners and coaches to aid the development of appropriate training strategies.
- As the women's game is continuing to evolve, with increases in high-speed running and sprinting distances, it is important that training strategies also evolve to reflect the increased demands.

- Training programmes should ensure players are able to cope with the requirement to cover relatively large distances (9-11 km) whilst producing intermittent bursts of high-speed activity with variable recovery between actions.
- Coaches and practitioners should consider the needs of different positional groups and structure training sessions accordingly.
- Studying total match performance fails to appreciate the stochastic nature of match-play and may underestimate the true match demands.
- Examining peak demands of match-play may better represent the intermittent profile of the match but caution should be taken to ensure the multiple contextual factors are duly considered.

Where Next?

Analyses of the physical demands of match-play need to be regularly undertaken to ensure the availability of contemporary data which reflects the progressing status of the game. It is also important that we gain a more detailed understanding of the demands of match-play for youth players, as a lot of focus has previously been on senior players. Furthermore, the match demands research should be reflective of contemporary tactical formations by the inclusion of specific positional analyses. For example, using the generic positional group 'central midfielders' may fail to capture any tactical and physical differences between 'central attacking midfielders' and 'central defensive midfielders'. A greater awareness of the physical demands for goalkeepers during training and match-play will allow creation of a more bespoke training programme for these players. Finally, the physical demands of match-play need to be considered in line with tactical/technical and contextual factors.

TRAINING CONSIDERATIONS

Current Knowledge

In elite football, the primary aim of a fitness training programme is to ensure the player is injury free and capable of playing one or two competitive matches per week throughout the season. Consequently, it is important to focus on developing a player's athletic ability, but this should be implemented alongside recovery and injury risk management strategies[9]. Training programmes should be reflective of the match demands (see previous section; 'physical demands of match play') and therefore multiple components of fitness must be included. In addition to the physical requirements, players also need to develop technical, tactical, and cognitive aspects of their performance and consequently a global approach to training whereby training sessions focus on multiple outcomes is often implemented in elite environments. It is beyond the scope of this article to provide a detailed review of the literature regarding fitness development for football players. Instead, this section will focus on specific training considerations for the female player.

Fatigue and Recovery Considerations

There is evidence which suggests females demonstrate greater resistance to fatigue and have a superior ability to recover metabolically than males during repeated, maximal-intensity intermittent sprinting[10,11]. This disparity between the sexes is likely due to differences in muscle mass, muscle fibre type distribution, and/or differences in metabolic activity. Males typically have an increased muscle mass and have a proportionally larger cross-sectional area of type II muscle fibres, whereas females have lower resting phosphagen stores, lower glycolytic capacity, and increased fat oxidation.

Metabolic Considerations

Recent research has shown during elite female match-play, glycogen values were lowered to critical levels during the second half, with 80% of type I fibres and 69% of type II fibres very low on glycogen following the match[12]. However, this level of glycogen utilisation was less than previously witnessed in male players, which may be a result of sex differences in metabolic activity. During intense periods of match-play, females had lower lactate accumulation and phosphocreatine utilisation compared to those observed in males. Considering female players cover similar total distances but less distance at high intensity compared to males, this may indicate a high aerobic metabolite efficiency but a lower anaerobic capacity in women compared to men.

Menstrual Cycle Considerations

Throughout the menstrual cycle there are large variations in hormone concentrations and theoretically these hormonal fluctuations might positively or negatively influence performance. However, caution must be exhibited in this area due to limited research. This topic is discussed in more detail in the next section ('medical considerations').

Pregnancy and Training

Pregnancy and childbirth cause physiological, musculoskeletal, and psychological adaptations, with some of these effects lasting 12 months postpartum. Consequently, it is important to consider how to individualise training and support players postpartum. In general, there is a lack of evidence available to provide best-practice guidelines for pregnant and postpartum players. However, players are generally guided through this process by the experiences of medical/performance professionals and a multidisciplinary approach which matches the individual player's needs is highly recommended.

Dual Career Considerations

Training programmes should be designed which are cognisant of an individual player's specific commitments. For example, not all countries have professional women's leagues and therefore some players may need to balance football with work commitments. Similarly, many young players must balance football with their academic commitments. The combination of a playing career with work and/or education is known as a 'dual career'. Dual careers can present potential challenges for female players, such as: limited time and increased travel commitments which must be factored into a player's individual training programme. Therefore, optimal load management strategies may prove challenging but are crucial for the female player.

Practical Implications

- Training programmes should be designed to meet the demands of match-play and adapted regularly to reflect the evolving nature of the game.
- Training programme should be cognisant of the individual player's specific situation, e.g., dual career, family commitments etc.
- Females typically recovery from high-intensity exercise quicker than males and therefore the training stimulus and/or recovery duration may need to be modified to optimise training adaptation.

- Females tend to demonstrate a different profile for recovery, muscle damage and muscle soreness following match activity compared to males. Therefore, the scheduling of training should be mindful of this, and it is suggested that women could return to training earlier than men following match-play.
- Women must adapt (reduce volume, intensity, and consider safety) their training activities during and after pregnancy to minimise adverse effects on maternal and foetal health outcomes and reduce their risk of injury.

Where Next?

More research into the specific training considerations for female football players is needed. It is only recently that research has begun to focus specifically on female athletes, with much of our previous knowledge being derived from research involving male participants. Understandably it is problematic to rely on data from research in males due to the known biological differences between the sexes. A recent publication on the methodological considerations for studies with women as participants provides an excellent resource for researchers and practitioners to aid experimental design development which is considerate of female specific factors such as the menstrual cycle, hormonal contraceptive use, and pregnancy[13].

MEDICAL CONSIDERATIONS

Current Knowledge

How much do we know?

Women's football has unique injury incidence and burden trends, making it essential to manage injuries with the specific population requirements and challenges in mind[14]. In addition, female-biased conditions believed to impact injury risk exist including hormonal fluctuations during the menstrual cycle and disordered eating[15]. We, therefore, need a holistic understanding of injuries from a descriptive, reactive, and proactive perspective to optimise evidence-based injury management in elite women's football (Figure 2). However, nearly half (N = 226; 45%) of all studies addressing injuries in women's football have been related to descriptive epidemiology[3]. Further, these descriptive epidemiological studies predominantly focused on the whole body (N = 117; 52%), head or face (N = 40; 18%) and knee (N = 34; 15%)[3], highlighting clear trend of 'hot topics' in women's football injury research, whilst also flagging that certain injury topics are neglected.

**** Figure 2 near here****

Common injuries in women's football

Systematic reviews on injury epidemiology in elite women's football exist[16] however, it is questionable how correctly a systematic review of current literature (published year 1991-2018) exposes current tendencies in football due to the rapid physical and tactical development occurring with the professionalisation of the women's game[4]. Hence, caution with the interpretation of older research is needed. With that in mind, an estimated incidence rate for adult elite women players in domestic club football has been shown to be 5.7/1000 hours (total), 19.5/1000 hours (match) and 3.1/1000 hours (training; data from studies published year 2005-2018)[16]. Whilst data polled from international tournament matches

showed a much higher incidence rate of 55.7/1000 hours (year 1999-2004)[16]. Based on the same review, knee, thigh, and ankle are the most common injury sites in elite domestic club football and ankle followed by head/face/neck were the most common in elite tournament football.

The head and knee are the most researched body parts[3], whilst anterior thigh or ankle have received less research attention despite also demonstrating the highest injury incidence rates. A limited amount of research is still available for medical staff to make a quality decision for sports medicine related practices on the most injured locations[17]. It should, of course, be acknowledged that some generic research can be used across sports, though sports specificity is needed in areas such as injury mechanism or return to play.

Menstrual cycle

A common concern flagged by both players, medical staff and researchers is the hormonal fluctuation seen in females around their menstrual cycle. Theoretically these hormonal fluctuations might positively or negatively influence performance. Hormonal fluctuations could provide advantageous windows of opportunity for training adaptations or indeed detrimental symptoms impacting on an individual's training programme.

However, research in this area is currently limited both in terms of the quality and quantity of articles and at present insufficient evidence exists to warrant systematic modification of training programme content in relation to menstrual cycle phases. Reviews have identified that exercise ability may be trivially reduced during the early follicular phase[18], ligament laxity appears to increase in the preovulation and ovulation phase and hence injury risk of ACL ruptures slightly[19]. However, these tendencies are not seen in females using hormonal contraception[19]. Furthermore, within a team a natural diversity in menstrual cycle will be seen due to variation in period length, heaviness of bleeding, signs/symptoms associated, hormonal contraception usage and effect of medical conditions and medication. Adaptation of training and offloading of players around the menstrual cycle can therefore be challenging, if not impossible.

Current recommendations are therefore, that a personalised approach based on the individual's situation should be prioritised. Some players may need special attention, whilst others have no challenges which need to be considered. Communication between the player and the medical practitioner is vital, this can be done verbally, through wellness scores or menstrual cycle tracking applications.

Practical Implications

- Female football injury research is predominantly composed of epidemiological research.
- Discrepancies in research focus is seen between body regions with knee and head/face attracting the most attention.
- Less research focuses on management of commonly faced injuries dealt with in day-to-day practice - e.g., thigh strains and ankle sprains.
- It is challenging for clinicians to evidence-base injury prevention and management strategies of certain injury types due to lack of research.

- The menstrual cycle should be tracked on an individual player basis to enable a proactive approach to the management of symptoms and the optimisation of performance and recovery

Where next?

Research needs to expand the focus on injuries beyond epidemiology and the 'hot topics' concussion and ACL research. More primary reactive and proactive research (Figure 2) is needed before systematic reviews and meta-analysis can attempt to summarize on optimal injury management strategies. Research groups and practitioner scholars should focus research efforts on understanding injury mechanisms and risk factors, informing design and execution of preventive strategies and guiding the return to play process of injuries in women's football at all levels and in all age groups. Collaboration between team through data sharing will strongly help support this process.

CONCLUSION

Women's football is at an exciting stage of development in terms of participation, professionalism, and research. It is crucial to recognise and appreciate the similarities as well as differences between the male and female game, to provide tailored support strategies when aiming to optimise performance. This article has provided an overview of current knowledge, practical implications, and future directions to hopefully benefit those interested in tailoring strategies and, hence, optimising the women's game.

FIGURE TITLES

Figure 1. *Physical match performance in elite female football players (adapted from[4]). Goalkeepers (GK), central defenders (CD), full backs (FB), central midfielders (CM), wide midfielders (WM), forwards (FWD). The bars represent total distance covered and the circles represent the distance covered > 13 km/h.*

Figure 2. *Football injury research topics[3] (permission sought to republish)*

REFERENCES

1. FIFA. Setting the Pace. FIFA Benchmarking Report Women's Football. 2021. Available from:https://digitalhub.fifa.com/m/3ba9d61ede0a9ee4/original/dzm2o61buenfox51qjot-pdf.pdf

2. FIFPro. Raising Our Game. Women's Football Report. 2020. Available from: https://fifpro.org/media/1n4mp3ht/fifpro-womens-report_eng-lowres.pdf

3. Okholm Kryger K, Wang A, Mehta R, Impellizzeri FM, Massey A, McCall A. Research on women's football: a scoping review. Science and Medicine in Football. 2021 Jan 8;1–10.

4. FIFA. Physical analysis of the FIFA Women's World Cup France 2019.2019. Available from: https://digitalhub.fifa.com/m/4f40a98140d305e2/original/zijqly4oednqa5gffgaz-pdf.pdf

5. Bradley PS, Dellal A, Mohr M, Castellano J, Wilkie A. Gender differences in match performance characteristics of soccer players competing in the UEFA Champions League. Human Movement Science. 2014 Feb;33:159–71.

6. Mara JK, Thompson KG, Pumpa KL, Morgan S. The acceleration and deceleration profiles of elite female soccer players during competitive matches. Journal of Science and Medicine in Sport. 2017 Sep;20(9):867–72.

7. Datson N, Drust B, Weston M, Gregson W. Repeated high-speed running in elite female soccer players during international competition. Science and Medicine in Football. 2019 Apr 3;3(2):150–6.

8. González-García J, Giráldez-Costas V, Ramirez-Campillo R, Drust B, Romero-Moraleda B. Assessment of Peak Physical Demands in Elite Women Soccer Players: Can Contextual Variables Play a Role? Research Quarterly for Exercise and Sport. 2022 Jan 13;1–9.

9. Walker GJ, Hawkins R. Structuring a Program in Elite Professional Soccer. Strength & Conditioning Journal. 2018 Jun;40(3):72–82.

10. Laurent CM, Green JM, Bishop PA, Sjökvist J, Schumacker RE, Richardson MT, et al. Effect of gender on fatigue and recovery following maximal intensity repeated sprint performance. J Sports Med Phys Fitness. 2010 Sep;50(3):243–53.

11. Hottenrott L, Möhle M, Ide A, Ketelhut S, Stoll O, Hottenrott K. Recovery from Different High-Intensity Interval Training Protocols: Comparing Well-Trained Women and Men. Sports. 2021 Mar 2;9(3):34.

12. Krustrup P, Mohr M, Nybo L, Draganidis D, Randers MB, Ermidis G, et al. Muscle metabolism and impaired sprint performance in an elite women's football game. Scand J Med Sci Sports. 2021 Jun 25;sms.13970.

13. Elliott-Sale KJ, Minahan CL, de Jonge XAKJ, Ackerman KE, Sipilä S, Constantini NW, et al. Methodological Considerations for Studies in Sport and Exercise Science with Women as Participants: A Working Guide for Standards of Practice for Research on Women. Sports Med. 2021 May;51(5):843–61.

14. Larruskain J, Lekue JA, Diaz N, Odriozola A, Gil SM. A comparison of injuries in elite male and female football players: A five-season prospective study. Scandinavian Med Sci Sports. 2018 Jan;28(1):237–45.

15. Waldén M, Knudsen MG, Lundblad M, Ekstrand J, Hägglund M. The Female Player: Special Considerations. In: Musahl V, Karlsson J, Krutsch W, Mandelbaum BR, Espregueira-Mendes J, d'Hooghe P, editors. Return to Play in Football [Internet]. Berlin, Heidelberg: Springer Berlin Heidelberg; 2018 [cited 2022 Apr 29]. p. 929–40. Available from: http://link.springer.com/10.1007/978-3-662-55713-6_72

16. Mayhew L, Johnson MI, Francis P, Lutter C, Alali A, Jones G. Incidence of injury in adult elite women's football: a systematic review and meta-analysis. BMJ Open Sport Exerc Med. 2021 Jul;7(3):e001094.

17. Ardern CL, Dupont G, Impellizzeri FM, O'Driscoll G, Reurink G, Lewin C, et al. Unravelling confusion in sports medicine and sports science practice: a systematic approach to using the best of research and practice-based evidence to make a quality decision. Br J Sports Med. 2019 Jan;53(1):50–6.

18. McNulty KL, Elliott-Sale KJ, Dolan E, Swinton PA, Ansdell P, Goodall S, et al. The Effects of Menstrual Cycle Phase on Exercise Performance in Eumenorrheic Women: A Systematic Review and Meta-Analysis. Sports Med. 2020 Oct;50(10):1813–27.

19. Herzberg SD, Motu'apuaka ML, Lambert W, Fu R, Brady J, Guise JM. The Effect of Menstrual Cycle and Contraceptives on ACL Injuries and Laxity: A Systematic Review and Meta-analysis. Orthopaedic Journal of Sports Medicine. 2017 Jul 1;5(7):232596711771878.