

Elite women's football: Evolution and challenges for the years ahead

1 | INTRODUCTION

The first recorded women's football international match happened in Easter Road, Edinburgh in 1881, between the sides of Scotland and England. The women's game has evolved slowly since, though experiencing an important growth with the First World War because most men joined the military and women took their place in factories and also at the pitch.¹ A major setback happened in December 1921, when women were banned from playing by the Football Association, in England. Other countries, such as France in 1932 and Germany in 1955 also banned women's football. In most countries, it was still possible for women to play but in some countries, such as Brazil, the ban lasted until 1979.² The first international FIFA men's World Cup was held in 1930, while the first FIFA World Cup for women took place 61 years later in 1991.³ Since then women's football has experienced a constant growth. This increase in popularity has accelerated in the last decade. The last World Cup in France 2019 was the most watched Women's World Cup ever with more than 993 million viewers, a 30% increase from the 2015 edition in Canada.⁴ The increase in popularity has attracted more scientists into the field.^{5,6} Indeed, the number of studies on women's football has grown from 20 in 2000 to 400 in 2020 of which about 10% focus on elite women's football.⁵

The aim of this editorial was to discuss challenges that women's football may face in the short and the longer term. The realization of such challenges will allow practitioners and scientists to work more effectively in finding solutions to overcome them.

To fulfill the aim above, we adopted an integrated performance health management and coaching model.⁷ According to this model, all stakeholders (eg, players, coaches, sports science and medicine staff, and club management) can have a say in the decision-making with regards to sports science- and medicine-related issues. Though, in the current editorial, we provided a shared opinion of several sports scientists, a top-class woman football player, an experienced elite women's

football coach, and a team physician working in elite women's football.

Our methodology included the following steps: (1) idea conception: The initial idea was discussed between two senior sports scientists; they developed the first draft and invited other stakeholders to contribute; (2) stakeholders contribution: This was on a voluntary basis, and colleagues commented on the first draft and either rejected the idea(s) or accepted and added their comments; and (3) document finalization: Following a number of emails exchange and amendments, the final draft was approved by all co-authors; authors were free to add or delete comments at any stage during the process.

Overall, we believe there are four main challenges with regards to elite women's football:

- Challenge 1: We must better understand the needs of players and coaches. Some of the physiological and psychological demands of training and match play are somewhat different between women and men.^{8–10} Though, more research has been acknowledged regarding the physical and physiological demands of women's football.¹⁰ Also, mental and psychological factors are influenced by personal and football-specific variables, and it is important to raise awareness among players and support staff regarding mental health problems in female players.¹¹ Therefore, to make impactful research, scientists should include opinions from players and coaches who should highlight the questions of priority. Though, some of the main topics from the players and coaches provided to scientists and practitioners nowadays (and we assume in future) are and would be:
 - a. Does football play stress the metabolic systems differently in women compared to men? If yes, and given that the scientific body of knowledge so far is mostly based on men's data, we should reconsider training and conditioning strategies. Previous research has shown that muscle glycogen declines by 43%–70% following a friendly games in men, with 47%–70% of muscle fibers being completely or almost empty of glycogen.^{12–14} Recently, Krustup et al.¹⁵ reported a

42% decline in muscle glycogen pre- to post-match in elite women's football match. In addition, 80% of type I fibers and 69% of type II fibers were almost empty or completely empty of glycogen in those players. Taking into consideration that women players cover similar total distances but less distances at higher intensities compared with men,^{15,16} this may reflect a high aerobic metabolite efficiency but low-anaerobic capacity for the elite women players. Clearly, more research is needed regarding the patterns of high-intensity and sprinting actions, and the contribution of football-specific movements to the overall metabolic load and fatigue pattern for a better understanding of the women's game.¹⁰

- b. Which priorities should be given in training and testing women players? Women may show different physiological adjustments and adaptations to exercise and genetic, endocrine, and body composition may explain some of these differences.¹⁷ Women may improve physical capacities by getting involved in conditioning training programs,¹⁸ and special focus should be given to intermittent high-intensity drills and repeated-sprint activities aiming to prevent potential reductions in performance during match play.¹⁹ However, specific training methods might need to be adapted accordingly, and more research should be devoted to training interventions that promote the development of physical capacities and assess dose-response differences and specific testing features in women players.
- c. Do women recover faster from training sessions and match play compared with men? This has to be linked with the specific physical and physiological demands of the women's game, but if the pattern of recovery is different between men and women, we should possibly consider separate recovery strategies for women. Although this question still needs to be elucidated, there are indications that women may present better fatigue resistance compared with men during endurance events.²⁰
- d. What is the injury epidemiology in women's football? We need to in detail classify the injury incidence, severity, and burden and determine if a certain type of injury is more common and/or more severe in women. A recent meta-analysis showed that ACL injury incidence is higher in women compared to men in football,²¹ but this might not be the case for all type of injuries.²² These data followed the general finding in sports showing that women are 2–10 times more likely to suffer an ACL injury compared with men practicing the same sport.²³ The UEFA Elite Club Injury Study is currently being replicated in women's teams and preliminary data showed that women had a similar ACL injury incidence compared to men but twice as much concussions.²⁴ Much remains to be known as conflicting results are common in the injury domain. Generally, the anatomical and biomechanical differences, as well as menstrual cycle hormones-related effect, are commonly believed to play a role in the ACL injury rates in women football players.²³ The complexity of potential impacts of menstrual cycle hormones-related effect and a potential addition of hormonal contraceptives on injury risk is much debated, yet strong evidence is lacking.²⁵ Overall, more research is needed to better understand the incidence and prevalence, as well as the burden and the actual causes of injuries in women football players.
- e. What is the role of the hormonal milieu on performance and risk of injury? Do various phases in the menstrual cycle play a role in relation to performance and/or injury risk? The lack of research in this area has been already acknowledged²⁶ and guidelines have been published.^{27,28} A recent study concluded that injuries in eumenorrheic football players occurred twice as much in the late follicular phase, as compared to early follicular and luteal phases.²⁹
- f. Which injury prevention programs are working better in women? A recent meta-analysis, that has included 12 studies on the topic, concluded that there is low evidence that multicomponent, exercise-based training programs can substantially reduce the possibility of ACL injuries in women.³⁰ This highlights the need for more research in this field. A recent paper showed that a higher compliance to injury prevention programs resulted in stronger prevention effect in men but not in women athletes.³¹
- g. Should injury rehabilitation in women players be conducted the same way as in men? The treatment guidelines and return to sport estimates that are currently used are derived from studies and expert opinion mainly based in men. Do we need to reframe the way we treat women, regarding medication, modalities, clinical exercise, manual therapy, orthobiologics, etc? Do we need to rethink the timing of rehabilitation phases in the women football players? There might exist differences between women and men players in the timing for return to play after an ACL repair. In a study,³² at 10 months, all men players were back to training but only 79% of the women players were back. At 12 months, 79% of the women players were back to play compared to 89% of their men counterparts.³²
- h. How do women respond to psychological pressure before competitive matches at domestic level, which for most are not stressfull, compared to international

level, which are for most extremely stressful as per the coaches opinion? Interestingly, mood has been unrelated to performance in female players, but little is known regarding psychological approaches that enhance optimal readiness for average as well as more stressful matches.³³ Though, there is evidence that the psychological characteristics and experience at high level of elite women football players may play a role for optimal state anxiety before important matches.³⁴ However, pressure from external factors (eg, media) may augment the players' reactions, but it is noteworthy that high level women players tend to score higher on mental toughness, conscientiousness, and executive functions, and present lower levels of anxiety.³³ Also, coaches should be aware that enjoyment and a perceived mastery climate may enhance performance and perceived competence of women players.³³

- Challenge 2: Research in women's football must be intensified. After identifying the needs and having more women studied, scientists should intensify research efforts in the field. This will be facilitated with better cooperation among stakeholders. More funding should be allocated by the governing bodies and the clubs toward this direction. Also, a collaborative environment between stakeholders is vital. The building of a collaborative environment between universities, football federations, clubs, coaches, and players is key to success.
- Challenge 3: Knowledge must be disseminated effectively. This can be achieved by engaging more coaches and players in research question development. A previous study showed that coaches' buy-in is key in knowledge implementation in the field.³⁵ Also, football federations can play a leading role in knowledge transfer. Some good examples of knowledge transfer platforms exist in Denmark and Portugal. Both the Danish and the Portuguese Football Federations have launched platforms aiming to improve evidence-based knowledge dissemination.³⁶
- Challenge 4: Change the practice for the benefit of players and coaches. Knowledge implementation and adoption should be facilitated in order to achieve results that will improve the health and performance of players. For this purpose, it is vital that football coaching education embraces more women's football-specific contents, to elevate the quality and knowledge of women's football coaches. We believe ensuring evidence-based practice using relevant data from women's football is key for better coaching and the ultimate development of the game.

In this editorial, we have captured some of the concerns with regards to the women's football development from the sports science and sports medicine perspective. We have

attempted to be as inclusive as possible, by including opinions from different stakeholders. One of the strengths of our approach is that we have involved an active elite player and a coach in addition to sports science and medicine experts. The bottom line is that there is a large knowledge gap in evidence-based practice in women's football. An increase in research output, based on players' and coaches' needs-driven questions, is vital. A collaborative atmosphere between stakeholders (eg, players, coaches, clubs' management, federations, researchers, sports science, and medicine staff) is key for the creation and dissemination of knowledge for the benefit of the game and player's health.

KEYWORDS

elite soccer, sports medicine, sports science, women

CONFLICT OF INTERESTS

The authors have no competing interest to declare.

George P. Nassis^{1,2} 

João Brito³ 

Rita Tomás³

Kenneth Heiner-Møller⁴

Pernille Harder⁵

Katrine Okholm Kryger^{2,6,7}

Peter Krstrup^{2,8,9} 

¹Physical Education Department, College of Education (CEDU), United Arab Emirates University, Al Ain, Abu Dhabi, United Arab Emirates

²Department of Sports Science and Clinical Biomechanics, Faculty of Health Sciences, SDU Sport and Health Sciences Cluster (SHSC), University of Southern Denmark, Odense, Denmark

³Portugal Football School, Portuguese Football Federation, Oeiras, Portugal

⁴The Danish Football Association, Dansk Boldspil-Union (DBU), Brøndby, Denmark

⁵Chelsea Football Club, London, UK

⁶Faculty of Sport, Allied Health and Performance Science, St Mary's University, Twickenham, London, UK

⁷Sports and Exercise Medicine, Barts and The London School of Medicine and Dentistry, Queen Mary University of London, London, UK

⁸Danish Institute for Advanced Study (DIAS), University of Southern Denmark, Odense, Denmark

⁹College of Sport Health Sciences, University of Exeter, Exeter, UK

Correspondence

George P. Nassis, Physical Education Department, College of Education (CEDU), United Arab Emirates

University, Al Ain, Abu Dhabi, United Arab Emirates.
Email: gnassis@uaeu.ac.ae

ORCID

George P. Nassis  <https://orcid.org/0000-0003-2953-3911>

João Brito  <https://orcid.org/0000-0003-1301-1078>

Peter Krstrup  <https://orcid.org/0000-0002-1461-9838>

REFERENCES

- Burke P. Patriot games: women's football during the first world war in Australia' Football studies. *Football Studies*. 2005;8(2):5-19.
- Votre S, Mourão L. Women's football in Brazil: progress and problems. *Soccer Soc*. 2003;4(2-3):254-267.
- Williams J. Women's football, Europe and professionalization 1971-2011. UEFA Res Rep. 2011. Accessed August 27, 2021. <https://dora.dmu.ac.uk/xmlui/bitstream/handle/2086/5806/Woman's%20football,%20Europe%20&%20professionalization%201971-2011.pdf?isAllowed=y&sequence=1>
- Fédération Internationale de Football Association. FIFA Women's World Cup 2019 watched by more than 1 billion (Press release). Accessed August 27, 2021. <https://www.fifa.com/tournaments/womens/womensworldcup/france2019/news/fifa-women-s-world-cup-2019tm-watch-ed-by-more-than-1-billion>
- Kirkendall DT, Krstrup P. Studying professional and recreational footballers: a bibliometric exercise. *Scand J Med Sci Sports*. 2021; <https://doi.org/10.1111/sms.14019>. Online ahead of print.
- Okholm Kryger K, Wang A, Mehta R, Impellizzeri FM, Massey A, McCall A. Research on women's football: a scoping review. *Sci Med Football*. 2021;1-10. <https://doi.org/10.1080/24733938.2020.1868560>
- Dijkstra HP, Pollock N, Chakraverty R, Alonso JM. Managing the health of the elite athlete: a new integrated performance health management and coaching model. *Br J Sports Med*. 2014;48(7):523-531.
- Datson N, Hulton A, Andersson H, et al. Applied physiology of fetal soccer: an update. *Sports Med*. 2014;44(9):1225-1240.
- Milanović Z, Sporiš G, James N, et al. Physiological demands, morphological characteristics, physical abilities and injuries of female soccer players. *J Hum Kinet*. 2017;60:77-83.
- Randell RK, Clifford T, Drust B, et al. Physiological characteristics of female soccer players and health and performance considerations: a narrative review. *Sports Med*. 2021;51(7):1377-1399.
- Junge A, Prinz B. Depression and anxiety symptoms in 17 teams of female football players including 10 German first league teams. *Br J Sports Med*. 2019;53(8):471-477.
- Krstrup P, Mohr M, Steensberg A, Bencke J, Kjaer M, Bangsbo J. Muscle and blood metabolites during a soccer game: implications for sprint performance. *Med Sci Sports Exerc*. 2006;38(6):1165-1174.
- Krstrup P, Ørtenblad N, Nielsen J, et al. Maximal voluntary contraction force, SR function and glycogen resynthesis during the first 72 h after a high-level competitive soccer game. *Eur J Appl Physiol*. 2011;111:2987-2995.
- Mujika I, Halson S, Argus C, Krstrup P. Recovery from training and matches. In: *Science and Soccer*. Routledge; 2012:65-81. ISBN9780203131862.
- Krstrup P, Mohr M, Nybo L, et al. Muscle metabolism and impaired sprint performance in an elite women's football game. *Scand J Med Sci Sports*. 2021;Jun 25 <https://doi.org/10.1111/sms.13970>
- 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. *Hum Mov Sci*. 2014;33:159-171.
- Bassareo PP, Crisafulli A. Gender differences in hemodynamic regulation and cardiovascular adaptations to dynamic exercise. *Curr Cardiol Rev*. 2020;16(1):65-72.
- Ramirez-Campillo R, Sanchez-Sanchez J, Romero-Moraleda B, Yanci J, Garcia-Hermoso A, Clemente FM. Effects of plyometric jump training in female soccer player's vertical jump height: a systematic review with meta-analysis. *J Sports Sci*. 2020;38(13):1475-1487.
- Gabbett TJ, Wiig H, Spencer M. Repeated high-intensity running and sprinting in elite women's soccer competition. *Int J Sports Physiol Perform*. 2013;8(2):130-138.
- Tiller N, Elliott-Sale KJ, Knechtle B, Wilson PB, Roberts JD, Millet GY. Do sex differences in physiology confer a female advantage in ultra-endurance sport? *Sports Med*. 2021;51(5):895-915.
- Zech A, Hollander K, Junge A, et al. Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. *J Sport Health Sci*. 2021; <https://doi.org/10.1016/j.jshs.2021.04.003>. S2095.
- López-Valenciano A, Raya-González J, Garcia-Gómez JA, et al. Injury profile in women's football: a systematic review and meta-analysis. *Sports Med*. 2021;51:423-442.
- Marmura H, Bryant DM, Infographic GAM. Infographic. Sex differences and ACL injuries. *Br J Sports Med*. 2021;55(22):1313-1314. <https://doi.org/10.1136/bjsports-2021-104134>
- Hallén A. Updates from UEFA Champions League Studies - Women are more than equal: first insights from the women's Elite Club Injury Study. The Isokinetic Conference Voyage, webinar.
- 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. *Orthop J Sports Med*. 2017;5(7):2325967117718781.
- Bruinvels G, Burden RJ, McGregor AJ, et al. Sport, exercise and the menstrual cycle: where is the research? *Br J Sports Med*. 2017;51(6):487-488.
- Sims ST, Heather AK. Myths and methodologies: reducing scientific design ambiguity in studies comparing sexes and/or menstrual cycle phases. *Exp Physiol*. 2018;103(10):1309-1317.
- De Jonge XJ, Thompson B, Han A. Methodological recommendations for menstrual cycle research in sports and exercise. *Med Sci Sports Exerc*. 2019;51(12):2610-2617.
- Martin D, Timmins K, Cowie C, et al. Corrigendum: Injury incidence across the menstrual cycle in international footballers. *Front Sports Act Living*. 2021;3:745792.
- Crossley KM, Patterson BE, Culvenor AG, Bruder AM, Mosler AB, Mentiplay BF. Making football safer for women: a systematic review and meta-analysis of injury prevention programmes

- in 11 773 female football (soccer) players. *Br J Sports Med.* 2020;54(18):1089-1098.
31. Åkerlund I, Waldén M, Sonesson S, Lindblom H, Hägglund M. High compliance with the injury prevention exercise programme Knee Control is associated with a greater injury preventive effect in male, but not in female, youth floorball players. *Knee Surg Sports Traumatol Arthrosc.* 2021; <https://doi.org/10.1007/s00167-021-06644-2>
 32. Waldén M, Hägglund M, Magnusson H, Ekstrand J. Anterior cruciate ligament injury in elite football: a prospective three-cohort study. *Knee Surg Sports Traumatol Arthrosc.* 2011;19(1):11-19.
 33. Pettersen SD, Adolfsen F, Martinussen M. Psychological factors and performance in women's football: a systematic review. *Scand J Med Sci Sports.* 2021; <https://doi.org/10.1111/sms.14043>
 34. Madsen EE, Hansen T, Thomsen SD, et al. Can psychological characteristics, football experience, and player status predict state anxiety before important matches in Danish elite-level female football players? *Scand J Med Sci Sports.* 2020; <https://doi.org/10.1111/sms.13881>
 35. Akenhead R, Nassis GP. Training load and player monitoring in high-level football: current practice and perceptions. *Int J Sports Physiol Perform.* 2016;11(5):587-593.
 36. Portugal Football Observatory. How to recruit more and retain better in women's football. Accessed August 27, 2021. <https://indd.adobe.com/view/b42a8285-e762-44f1-bb07-bbd3d6643e40>