Original research

Applied performance analysis practices in women's football

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Abstract
The aim of this study was to investigate the applied performance analysis (PA) practices within women's football. An online survey was developed to assess PA practices (team, individual and opposition match analysis, training analysis, coach behaviour analysis, best practice analysis, talent identification and recruitment, and game insights), use of technology, and considerations for PA practices within women's football. Thirty-nine participants (female n = 13; male n = 26) responsible for delivering PA within women's football completed the online survey between January and August 2023. Participants worked across different competitive levels of women's football (international n = 11; senior domestic top tier n = 12; senior domestic second tier n = 7, senior domestic third tier and below n = 9; youth (<U23) domestic n = 10), including seven participants who worked across multiple levels of competition. Participants predominantly conducted team (100%), individual (79%) and opposition (84%) match analysis, and training analysis (74%). Data collection and analysis, feedback mechanisms, and application of insights gained from PA practices typically varied across competitive standards. A wide variety of software were reported for data collection (e.g. HUDL, Veo), storing and managing data and/or video (e.g. HUDL, Veo), conducting statistical analysis (e.g. Microsoft Excel, R), and providing feedback (e.g. Microsoft PowerPoint, HUDL) across competitive standards. Thirty-one respondents identified specific considerations or challenges faced when implementing PA (e.g. limited resources (42%), data availability (19%), facilities (19%)). The findings of this survey can be used to inform and develop applied PA practices in women's football, education, and development opportunities for current and aspiring performance analysts.

Keywords
Coach behaviour, female soccer, game insights, player monitoring, talent identification

Introduction

Performance analysis (PA) in football is a discipline which intersects applied and theoretical fields of coaching, sports science, and data analytics. Early PA research almost exclusively conducted on men's elite football, focussed on quantifying performance from physical and technical-tactical perspectives.[1,2] Recent advancements in technology and consequent availability of performance data have ensured match analysis remains a prominent research area.[3,4] Whilst this research has developed our understanding of performance, it has been suggested that collectively, we must broaden the scope of research beyond match analysis (and men's elite football) if we want to enhance our understanding of the evolving discipline of PA in football.[5]

It is widely accepted that PA is an integral aspect of modern coaching processes[6] and has perceived importance for both coaches[7,8] and players.[9,10] Despite the widespread use of PA and its perceived efficacy,[11] it remains challenging to tangibly measure its effectiveness.[12] Due to confounding variables (e.g. opposition, scoreline, formation),[13] it is

difficult to attribute changes in performance to PA. Furthermore, applied intervention studies are unlikely to include a control group which makes it challenging to discriminate experimental and random effects. Instead of focusing on effectiveness, attention has turned to capturing the applied practices of analysts within sporting environments (e.g. men's football,[12] Gaelic sports,[8] Olympic and

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Paralympic populations[14,15]), or understanding the social dynamics involved in applied PA practices.[16] The findings from such studies demonstrate that whilst some similarities in the components of practice and expertise required exist between sports, there are also large variations.[17]

Despite the abundance of football-specific PA research, limited information exists regarding the role of the performance analyst within football environments.[12] A contemporary examination of PA job advertisements[18] provided some insight into recently advertised roles and responsibilities of a performance analyst, and the knowledge, understanding and skillset deemed important within the respective applied environment. However, it is important to be cognisant that job advertisements may not be reflective of the roles and responsibilities, practices and competencies required of applied performance analysts. Further, collating this information via secondary sources is unlikely to capture the true essence and extent of the performance analyst's role. Previously, Wright et al.[12] conducted a survey with performance analysts operating within elite male football environments. The authors reported that analysts were responsible for activities such as pre-, live, and post-match analysis and feedback, talent identification and recruitment, trend analysis and developing motivational footage. However, this study relates to the applied practices being conducted within these environments over 10 years ago. Given the increased importance of and access to data,[3] it is likely that the current role of the analyst is markedly different to previously reported.[12] Therefore, there is a need for contemporary research investigating the applied practices of the football performance analyst. Furthermore, whilst we have some knowledge of the role played by analysts within men's football,[12,18] no study has yet focused on PA in women's football. Due to known contextual differences in infrastructure and support systems between men's and women's sport,[19,20] as well as population differences (e.g. biological attributes),[21] it is necessary to undertake population-specific research as opposed to transposing findings from men's football to women's football.

Developing a clear understanding of applied PA practice is necessary to determine the knowledge, understanding and competencies aspiring applied practitioners need to be successful.[22] Acquiring this in-depth understanding is crucial to help frame education and professional development opportunities. Furthermore, understanding how practices may vary within and between different sporting environments is important for tailoring the design and delivery of such opportunities (e.g. developing knowledge, understanding or competencies required for applied PA practices within specific populations or contexts). Therefore, the aim of this study was to investigate the applied PA practices within women's football. This will provide a contemporary investigation into applied PA practices within football, and be the first to describe applied PA practices within women's football. Furthermore, by adopting a cross-environmental approach, this study will provide insight into current practices within differing levels of competition which can inform education and development opportunities for current and aspiring performance analysts working with different women's football populations.

Methods

Survey design and data collection

A cross-sectional online survey, describing the current applied PA practices in women's football was developed (Qualtrics, Provo, USA). The survey comprised of two preliminary sections; 1) participant information, 2) consent form, and six main sections; a) eligibility check, b) participant characteristics, c) PA practices (eight sub-sections; team match analysis, individual match analysis, opposition analysis, training analysis, coach behaviour analysis, best practice analysis, talent identification and recruitment, game insight), d) technology, e) considerations and challenges for PA practices in women's football, and f) debrief. An explanation for the terms best practice analysis (i.e. 'to observe and learn from examples of high-quality performance') and game insight (i.e. 'to understand wider performance trends in leagues and competitions') were provided, whilst all other PA practices were considered common terminology. Sub-sections and questions within the PA practices section were informed by previous research,[6,11,12,17,23] and practitioner-expertise within the research team. The participant characteristics, technology, and considerations and challenges for PA practices in women's football sections of the survey were adapted from a previous survey assessing applied strength and conditioning practices in women's rugby codes.[19]

The survey was piloted by experienced performance analysts (>5 years; n = 5) currently working within football environments but were ineligible for participation in the final survey (i.e. working within men's football) and were recruited via convenience sampling. Pilot participants assessed the content and face validity of the survey,[19,24] providing written feedback which resulted in only typographical amendments to questions. The final survey can be found in Supplementary Material.

The survey was circulated between January and August 2023, with all anonymous responses collected using Qualtrics[TM] software. Due to the descriptive and exploratory nature of this research, no sample size calculation was conducted for this study, rather the research team aimed to distribute the survey as widely as possible.[25] Therefore, the research team contacted representatives from women's football continental (e.g. UEFA) and national governing bodies (e.g. Irish Football Association, Scottish Football Association), domestic clubs and academics from their global research, academic and applied network, via email, to assist in survey distribution to practitioners within women's football. The survey was also

circulated via social media (e.g. X). Based on the sampling approach adopted, it is not possible to estimate the number of organisations, teams or practitioners invited to participate.

Participants

Participants were included if they were responsible for delivering PA (i.e. "use video or data/statistics to support coaching") within women's football, at any competitive level. This also included individuals who had other responsibilities alongside PA duties. Practitioners responsible for overseeing the delivery of performance support services (e.g. sport science, strength and conditioning) within a women's football club/team (e.g. technical director, performance manager) were also invited to complete the survey if there was no PA provision within their club/team. Questions within the eligibility criteria directed these respondents to alternative questions exploring reasons why the club/team does not currently use PA. This study was approved by the University of Essex Research Ethics Committee (reference ETH2223-0324). All participants provided informed consent prior to participation.

Data analysis

All responses were exported from Qualtrics™ software and exported to Microsoft Office 365 Excel (v2202; Microsoft Corporation, Redmond, WA, USA) for analysis. Quantitative data from close-ended questions were presented as frequencies and percentages with respect to the total number of responses or competitive standard when grouped (e.g. international and top tier senior domestic (INT & DOM1), second senior domestic tier and below (DOM2+), youth (<U23) domestic). Qualitative data generated from open-ended questions were analysed using inductive content analysis, which involved raw data familiarisation, open coding, grouping, and categorisation to generate higher-order themes.[26] Deductive analysis confirmed raw data themes were represented.[26] Qualitative analyses were performed independently by two researchers with subject-specific expertise in performance analysis (AHA, ND), and reviewed by another member of the research team with extensive expertise in qualitative analyses (RL).

Results

The online survey had 97 responses, of which 58 were excluded due to incomplete data/responses (40% completion rate).

Participant characteristics

Thirty-nine participants completed the survey (Table 1). All respondents were responsible for delivering PA within women's football. Twenty-eight participants (72%) were performance analysts (head of PA n = 1; lead performance

Table 1. Participant characteristics.

	Frequency [n (%)]
Gender	
Female	13 (33)
Male	26 (67)
Age (yrs)	30 ± 7
Level of Competition	
International: senior or youth age-groups	11 (28)
Senior domestic: top tier	12 (31)
Senior domestic: second tier	7 (18)
Senior domestic: third tier or lower	9 (23)
Youth domestic: U18 – U23 age-groups	5 (13)
Youth domestic: U16 age-groups or younger	5 (13)
Geographical Location	
United Kingdom	33 (85)
Australia	2 (5)
Belgium	1 (3)
Italy	1 (3)
Portugal	1 (3)
USA	1 (3)
Employment	
Full-time	17 (44)
Part-time	15 (38)
Paid Internship	2 (5)
Unpaid Internship or Volunteering	5 (13)
Time in Current Role	
<1 year	16 (41)
1–3 years	12 (31)
3–5 years	5 (13)
≥5 years	6 (15)
Time in Applied Sport	
<1 year	3 (8)
1–3 years	10 (26)
3–5 years	10 (26)
≥5 years	16 (41)
Highest Level of Education	
Doctoral Degree (e.g. PhD, DProf)	1 (3)
Master's Degree (e.g. MSc, MRes)	24 (62)
Bachelor's Degree (e.g. BSc, BA)	11 (28)
High School or equivalent	3 (8)

analyst n = 5; performance analyst n = 21; PA intern n = 1). Eight participants (21%) were coaches responsible for delivering PA as part of their role, whilst three participants (8%) were responsible for the delivery of PA as a component of wider performance support. Seven participants (18%) worked within more than one level of competition. For twenty-six participants (67%), this was their first role within women's football.

Of the 36 participants who held higher education degrees, educational specialisation was predominantly within PA (n = 16; 44%), sports coaching (n = 8; 22%), or sport science (n = 4; 11%), whilst two participants held data science and analytics degrees. Only 5 respondents (13%) were accredited performance analysts (International

Society of Performance Analysis of Sport (ISPAS); levels 2–4). Twelve participants (31%) held industry-standard PA certifications (HUDL Academy, International Professional Scouting Association (IPSO), Professional Football Scouts Association (PFSA), Prozone, StatsBomb, Stats Perform, VizRT Football Telestration, and national governing body (NGB) PA courses). Thirty-five respondents (90%) held football-specific coaching qualifications (A-licence: n = 4, 10%; B-licence: n = 15, 38%; C-licence n = 5, 13%; NGB Level 1 n = 11, 38%).[a] Thirteen (33%) respondents reported other qualifications relevant for their role (talent identification (PFSA, NGB), scouting/recruitment (IPSO, PFSA), coaching qualifications in other sports, drone driver licence, Tableau).

Match analysis: Team performance

All participants reported using PA to analyse their own team's performance, predominantly using a combination of video and data/statistics (n = 38; 97%), whilst one respondent used video only (DOM2+). Most respondents collected data for all matches, regardless of playing standard (Table 2). However, a greater proportion of INT and DOM1 respondents conducted live analysis during matches compared to other playing standards. Four respondents provided a rationale for how matches were selected for analysis; for respondents working with youth teams (n = 2) selections were based upon time constraints or the importance of fixture, whilst the preference of the head coach determined match selection for respondents working with international teams (n = 2). Most respondents (n = 33; 85%) used multiple formats to deliver feedback to coaches (mean = 3 formats; range = 2–5 formats) and players (mean = 3 formats; range = 2–7 formats). Performance improvement was the primary application for team performance data, regardless of competitive standard.

Match analysis: Individual player performance

Thirty-one participants (79%) reported using PA to analyse individual player performances during matches (Table 3), of which the majority collected video and data/statistics (n = 25; 81%). Regardless of competitive standard, individual player performances were predominantly analysed post-match. The selection of games was based upon; coaching request (n = 5), time constraints (n = 2), quality of opposition (n = 2), number of available analysts (n = 1), player input (n = 1), or match outcome (n = 1). Twenty-one (68%; mean = 2; range = 2–5) and twenty-four respondents (78%; mean = 3; range = 2–5) reported using multiple feedback mechanisms to share insights with coaches and players, respectively. Insights primarily informed individual player development practices across all competitive standards.

Match analysis: Opposition analysis

Thirty-four respondents (87%) conducted opposition analysis (Table 4). Two respondents (DOM2+) collected neither video nor data on their opposition due to lack of accessible/available data, relying instead on subjective observations of opposition matches. Respondents working within INT and DOM1 primarily chose to analyse their opposition's most recent fixtures. Of the 34 respondents who conducted opposition analysis, most used multiple feedback formats for coaches (n = 29, 85%; mean = 3; range = 2–5) and players (n = 20, 59%; mean = 2; range = 2–4). Across all competitive standards, the primary reason for conducting opposition analysis was to inform match-strategies.

Training analysis

Twenty-nine respondents (74%) analysed training sessions (Table 5). Where respondents selected training sessions to analyse, selection was dependent upon session content (n = 10), ad-hoc coach requests (n = 3), or the perceived importance of an upcoming fixture (n = 1), whilst two participants did not provide selection criteria. Insights were primarily shared with coaches and players via video-based mechanisms by respondents working within INT and DOM1, and mainly informed the design and delivery of training sessions.

Coach behaviour analysis

Four participants (10%; INT & DOM1: n = 1, DOM2+: n = 1; Youth DOM: n = 2) used video to quantify and analyse coach behaviours during selected training sessions. All participants used video to provide reflective and developmental opportunities for the respective coach for coaching qualifications or other CPD activities, therefore training sessions selected for analysis aligned with these activities. However, all participants reported sharing video (and microphone audio; n = 2) for coaches to conduct their own analysis, with no further analyses conducted by respondents. One respondent highlighted the challenges faced attempting to integrate coach behaviour analysis:

> "The coach had requested it as part of a coaching qualification they were undertaking. This is something I would like to engage in much more often, however coaches are very reluctant to engage in the process"

Best practice analysis

Nineteen participants (50%) used PA for best practice analysis (Table 6), predominantly utilising examples of their own team's performance via video and/or data/statistics. Respondents analysed examples of best practice during; pre-season planning and end-of-season reviews (n = 3; 8%), transfer windows (n = 1; 3%), international breaks/camps (n = 3; 8%), pre-match preparations (n = 3; 8%), post-match reviews (n = 10; 26%), pre-training briefs (n =

Table 2. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of team performance during matches, and application of insights gained.

	INT & DOM1 (n = 20)	DOM 2+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
All matches analysed			
Live analysis for insights to be used in match	13 (65)	8 (53)	1 (14)
Live analysis for insights to be used post-match	14 (70)	8 (53)	2 (29)
Post-match analysis	16 (80)	15 (100)	5 (71)
Selected matches analysed			
Live analysis for insights to be used in match	1 (5)	-	-
Live analysis for insights to be used post-match	2 (10)	-	-
Post-match analysis	1 (5)	-	2 (29)
Feedback Mechanisms			
To coaching staff			
Video analysis	16 (80)	13 (87)	4 (57)
Review meetings	14 (70)	11 (73)	2 (29)
Coach-led analysis task(s)	9 (45)	5 (33)	1 (14)
Reports or data outputs	7 (35)	6 (40)	3 (43)
Access to match footage	6 (30)	3 (20)	3 (43)
Radio feed	-	1 (7)	-
Not specified	-	1 (7)	1 (14)
To players			
Team review meetings	16 (80)	11 (73)	4 (57)
Unit review meetings	3 (15)	3 (20)	-
Individual review meetings	5 (25)	4 (27)	1 (14)
Video analysis	15 (75)	10 (67)	4 (57)
Access to match footage	10 (50)	2 (13)	2 (29)
Player-led analysis task(s)	9 (45)	6 (40)	2 (29)
Individual player clips	5 (25)	5 (33)	-
Reports or data outputs	2 (10)	4 (27)	2 (29)
Social media – group chats	-	1 (7)	-
No player feedback provided	1 (5)	-	-
Not specified	1 (5)	-	1 (14)
Application of Insights			
Performance improvement	13 (65)	8 (53)	4 (57)
Individual player development	9 (45)	5 (33)	2 (29)
Performance reviews	7 (35)	7 (46)	2 (29)
Inform match-strategies	7 (35)	3 (20)	-
Inform training sessions	5 (25)	3 (20)	1 (14)
Enhance tactical understanding	2 (10)	-	-
Support transition between age-groups	1 (5)	-	1 (14)
Player/team monitoring	-	2 (13)	1 (14)
Create best practice database	1 (5)	-	-
Coach development	-	-	1 (14)
Motivational videos	-	-	1 (14)
Not specified	-	1 (7)	-

5; 13%), post-training reviews (n = 3; 8%), or player-led analysis tasks (n = 1; 3%). Best practice analysis insights inform performance benchmarking (n = 16; 41%), or player engagement and motivation strategies (n = 3; 8%).

Talent identification and recruitment

Sixteen respondents (41%) used PA for talent identification and recruitment (INT & DOM1: n = 8; 40%; DOM2+: n =

8; 53%). Data collection and analysis focussed predominantly on external players, with 13 respondents (33%) collecting and analysing video (n = 13; 33%) or data/statistics (n = 10; 26%). Eight respondents utilised video (n = 7; 18%) or data/statistics (n = 5; 13%) from other age-groups or teams within their own club, whilst four respondents utilised video (n = 2; 5%) or data/statistics (n = 4; 10%) from their own team. Analysis typically occurs; during the off-season and transfer window periods

Table 3. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of individual player performances during matches, and application of insights gained.

	INT & DOM1 (n = 20)	DOM2+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
Individual player analysis conducted	18 (90)	10 (67)	6 (86)
Video footage	18 (90)	10 (67)	6 (86)
Data/statistics	13 (65)	9 (60)	6 (86)
All matches analysed			
Live analysis for insights to be used in match	6 (30)	3 (20)	2 (29)
Live analysis for insights to be used post-match	6 (30)	3 (20)	1 (14)
Post-match analysis	11 (55)	8 (53)	5 (71)
Selected matches analysed			
Live analysis for insights to be used in match	1 (5)	-	-
Live analysis for insights to be used post-match	3 (15)	-	-
Post-match analysis	5 (25)	2 (13)	1 (14)
Feedback Mechanisms			
To coaching staff			
Video analysis	7 (35)	7 (46)	3 (43)
Access to match footage	6 (30)	1 (7)	1 (14)
Player-led analysis tasks or review meetings	6 (30)	-	2 (29)
Review meetings	5 (25)	3 (20)	-
Reports or data outputs	5 (25)	6 (40)	2 (29)
Coach-led analysis tasks	4 (20)	1 (7)	1 (14)
Video clips	3 (15)	-	-
Not specified	-	1 (7)	1 (14)
To players			
Video analysis	10 (50)	6 (40)	3 (43)
Individual video clips	8 (40)	1 (7)	-
Individual player review meetings	8 (40)	6 (40)	3 (43)
Player-led analysis tasks	8 (40)	1 (7)	2 (29)
Access to match footage	6 (30)	3 (20)	2 (29)
Report or data	2 (10)	2 (13)	-
Team review meetings	2 (10)	-	1 (14)
Unit review meetings	-	1 (7)	-
No player feedback provided	1 (5)	1 (7)	-
Application of Insights			
Individual player development	12 (60)	8 (53)	4 (57)
Performance improvement	6 (30)	-	1 (14)
Performance reviews	3 (15)	1 (7)	-
Enhance tactical understanding	2 (10)	2 (13)	-
Player monitoring	-	2 (13)	1 (14)
Inform training sessions	-	1 (7)	1 (14)
Player wellbeing	1 (5)	-	-
Increase player's transfer value	1 (5)	-	-
Support transition between age-groups	1 (5)	-	-
Enhance player motivation and engagement	-	1 (7)	-
Best practice database	-	-	1 (14)
Not specified	1 (5)	-	-

(n = 6; 15%) or on an ad-hoc basis (n = 7; 18%), as opposed to regularly in-season (e.g. weekly, monthly; n = 4; 10%). Feedback is provided via; video analysis (n = 9; 23%), reports or data outputs (n = 7; 18%), review meetings (n = 5; 13%), or sharing access to video/database (n = 2; 5%). Insights inform talent identification and recruitment practices, specifically; informing recruitment strategies (n = 6; 15%), identifying (n = 5; 13%) and evaluating (n = 7; 18%)

prospective players, assessing potential fit within the club (n = 4; 10%), managing perceptions of prospective players (n = 1; 3%) and evaluating financial investments (n = 1; 3%).

Game insights

Twelve participants (31%) conducted game insight analysis, predominantly those working within INT & DOM1

Table 4. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of opposition analysis, and application of insights gained.

	INT & DOM1 (n = 20)	DOM2+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
Opposition analysis conducted	18 (90)	13 (87)	4 (57)
Video footage	18 (90)	11 (73)	4 (57)
Data/statistics	12 (60)	7 (46)	1 (14)
Other	-	2 (13)	-
Selection criteria			
Opposition's most recent fixture(s)	13 (65)	8 (53)	-
Opposition matches against comparable teams	7 (35)	4 (27)	-
Opposition quality	6 (30)	1 (7)	-
Availability of opposition match footage	-	2 (13)	1 (14)
Previous fixtures against opposition	-	3 (20)	-
Location of opposition matches	-	2[a] (13)	-
Importance of upcoming fixture	1 (5)	-	1 (14)
Opposition playing style	1 (5)	-	-
Time constraints	1 (5)	-	-
No specific criteria	1 (5)	1 (7)	2 (29)
Feedback Mechanisms			
To coaching staff			
Video analysis	15 (75)	5 (33)	1 (14)
Review meeting	11 (55)	2 (13)	2 (29)
Report or data output	10 (50)	4 (27)	-
Coach-led analysis task	8 (40)	8 (53)	1 (14)
Access to match footage	8 (40)	7 (46)	1 (14)
Not specified	1 (5)	1 (7)	1 (14)
To players			
Video analysis	12 (60)	6 (40)	1 (14)
Team review meeting	11 (55)	7 (46)	2 (29)
Access to match footage	4 (20)	3 (20)	1 (14)
Report or data output	4 (20)	5 (33)	-
Player-led analysis tasks	2 (10)	1 (7)	-
During training sessions	-	-	1 (14)
Not specified	2 (10)	-	2 (29)
Application of Insights			
Inform match strategies	17 (85)	12 (80)	3 (43)
Inform training sessions	2 (10)	1 (7)	2 (29)
Not specified	1 (5)	1 (7)	1 (14)

aBased only on respondents who travel to observe opposition matches.

populations (Table 7). Within this competitive standard, respondents primarily used reports or data outputs to communicate their findings (n = 7; 35%), informing performance benchmarking or match-strategies, for example:

> "*This allows a much better understanding of the bigger picture and where your performances sit within the wider league for example. It helps to keep you more grounded in where you are progressing and keeps you updated on how other teams are being successful, particularly with how the women's game is growing at the moment*"

Other applications of performance analysis

Three participants (8%) detailed alternative applications for PA beyond those previously discussed, including; quality assurance processes (n = 1; 3%), psychological applications in collaboration with sport and exercise psychologists (n = 1, 3%; individual interventions, motivational videos), and injury assessment processes in collaboration with medical staff (n = 1; 3%).

Performance analysis technology

The software used for data collection, storing and managing data and/or video, conducting statistical analysis, and providing feedback by respondents across competitive standards can be seen in Figures 1 and 2. HUDL and Veo software were the most prominent for both data collection and storing and managing data and/or video. Of the 20 respondents working within INT & DOM1 populations;

Table 5. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of training analysis, and application of insights gained.

	INT & DOM1 (n = 20)	DOM2+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
Training session analysis conducted	18 (90)	9 (60)	4 (57)
Video footage	18 (90)	8 (53)	4 (57)
Data/statistics	3 (15)	4 (27)	4 (57)
All training sessions analysed			
Live analysis	4 (20)	4 (27)	2 (29)
Post-session analysis	4 (20)	5 (33)	3 (43)
Selected training sessions analysed			
Live analysis	3 (15)	3 (20)	-
Post-session analysis	11 (55)	1 (7)	-
Feedback Mechanisms			
To coaching staff			
Video analysis	13 (65)	7 (46)	1 (14)
Access to training footage	6 (30)	2 (13)	3 (43)
Review meetings	5 (25)	1 (7)	-
Coach-led analysis task	5 (25)	2 (13)	3 (43)
Report or data outputs	2 (10)	4 (27)	2 (29)
Team review meetings	1 (5)	1 (7)	-
Not specified	1 (5)	-	-
To players			
Access to training footage	9 (45)	2 (13)	-
Video analysis	6 (30)	6 (40)	1 (14)
Player-led analysis task	4 (20)	-	-
Team review meetings	4 (20)	3 (20)	-
Report or data outputs	3 (15)	4 (27)	2 (29)
Unit review meetings	-	1 (7)	-
Individual player review meetings	-	1 (7)	-
No player feedback	3 (15)	1 (7)	-
Not specified	-	-	2 (29)
Application of Insights			
Inform training sessions	10 (50)	5 (33)	3 (43)
Inform match-strategies	7 (35)	2 (13)	-
Individual player development	5 (25)	1 (7)	1 (14)
Enhance tactical understanding	4 (20)	1 (7)	1 (14)
Player monitoring	1 (5)	2 (13)	3 (43)
Coach development	-	-	1 (14)
Not specified	2 (13)	2 (13)	-

10 (50%) used multiple software for data collection (mean = 3: range = 2–5), 7 (35%) used multiple software for storing and managing data and/or video (mean = 3; 2–5), 11 (55%) used multiple software for statistical analysis (mean = 2; range = 2–3), and 14 (70%) used multiple software for designing and delivering feedback (mean = 3; range = 2–6).

Considerations and challenges for performance analysis within women's football

Thirty-one respondents (79%) identified specific considerations or challenges faced when implementing PA (Table 8), whilst two respondents (5%) reported no female-specific considerations for PA practices in women's football. One male respondent (3%) reported logistical challenges for implementing PA:

"… limited my interactions with the teams as I was working with U16 women's teams being a male accessing coaches or players on match days in the changing rooms was out of the question so I couldn't provide feedback at half time or immediately post-match"

Whilst one respondent highlighted availability of centralised PA provision by their NGB and external data providers to be sufficient for their PA.

Table 6. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of best practice analysis.

	INT & DOM1 (n = 20)	DOM2+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
Best practice analysis conducted	12 (60)	5 (33)	3 (43)
Data collected and analysed			
Video footage (own team)	12 (60)	5 (33)	2 (29)
Video footage (different age-group, own club)	2 (10)	2 (13)	2 (29)
Video footage (same age-group, other clubs)	6 (30)	1 (7)	-
Video footage (different age-group, other clubs)	-	-	-
Data/statistics (own team)	8 (40)	3 (20)	2 (29)
Data/statistics (different age-group, own club)	3 (15)	-	-
Data/statistics (same age-group, other clubs)	1 (5)	1 (7)	-
Data/statistics (different age-group, other clubs)	3 (15)	-	-
Identifying examples of best practice			
Integrated with wider analysis practices	6 (30)	3 (20)	1 (14)
Comparable playing philosophy or style	3 (15)	1 (7)	2 (29)
Analysing high-performing teams	2 (10)	-	-
Using commercial data providers	1 (5)	1 (7)	-
Not specified	1 (5)	-	-
Updating examples of best practice			
1–3 times per season	3 (15)	2 (13)	1 (14)
4–6 times per season	1 (5)	-	1 (14)
>6 times per season	3 (15)	1 (7)	1 (14)
Ad-hoc	5 (25)	2 (13)	-
Timing of analysis			
Pre-match preparations	1 (5)	1 (7)	1 (14)
Post-match reviews	6 (3)	3 (20)	1 (14)
Pre-season	1 (5)	1 (7)	-
End-of-season review	1 (5)	-	-
International breaks	-	1 (7)	-
Start of training camps	1 (5)	-	-
Between training camps	1 (5)	-	-
Pre-training briefs	2 (10)	2 (13)	1 (14)
Post-training reviews	-	1 (7)	2 (29)
Player-led analysis tasks	-	-	1 (14)
Transfer window	1 (5)	-	-
Feedback Mechanisms			
Report or data	2 (10)	1 (7)	-
Video analysis	5 (25)	2 (13)	-
Review meetings	8 (40)	2 (13)	1 (14)
Access to video database	6 (30)	-	1 (14)
Player-led analysis tasks	-	-	1 (14)

Discussion

This study aimed to investigate the applied PA practices in women's football. Thirty-nine participants responsible for delivering PA within women's football completed the survey, which is comparable to previous research in men's football (n = 48).[12] Respondents predominantly used PA for team (100%) and individual (79%) match analysis, opposition (84%) and training analysis (74%). However, practices relating to data collection and analysis, feedback mechanisms, and application of insights gained from respective PA processes varied between competitive standards. Most respondents (79%) reported considerations

or challenges faced when implementing PA in women's football, the most frequent of which was limited resources (n = 13; 42%). This is the first study to describe PA practices within women's football, providing insight into current practices within differing levels of competition which can inform applied practices, and education and development opportunities for current and aspiring performance analysts.

Of the thirty-nine respondents, the majority were performance analysts (72%), and the remainder were coaches responsible for delivering PA as part of their role (21%), or practitioners responsible for the delivery of PA as a component of wider performance support (8%). The range of

Table 7. Frequency [n (%)] of practices relating to the data collection, analysis and feedback of game insight analysis, and application of insights gained.

	INT & DOM1 (n = 20)	DOM2 & 3+ (n = 15)	YOUTH DOM (n = 7)
Data Collection & Analysis			
Game insights analysis conducted	9 (45)	2 (13)	1 (14)
Data collected and analysed			
Video footage (own team)	2 (10)	-	-
Video footage (different age-group, own club)	1 (5)	-	1 (14)
Video footage (different team/club)	5 (25)	-	1 (14)
Data/statistics (own team)	3 (15)	2 (13)	-
Data/statistics (different age-group, own club)	1 (5)	1 (7)	-
Data/statistics (different team/club)	6 (30)	1 (7)	-
Frequency of analysis			
1–3 times per season	2 (10)	1 (7)	-
4–6 times per season	2 (10)	-	1 (14)
>6 times per season	1 (5)	1 (7)	-
Ad-hoc	2 (10)	-	-
Not specified	2 (10)	-	-
Feedback Mechanisms			
Reports or data outputs	7 (35)	1 (7)	-
Video analysis	4 (20)	-	-
Review meetings	2 (10)	-	-
No feedback provided	-	-	1 (14)
Not specified	-	1 (7)	-
Application of Insights			
Inform match-strategies	4 (20)	-	-
Performance improvement	3 (15)	1 (7)	-
Performance benchmarking	4 (20)	1 (7)	-
Analyst development	-	-	1 (14)

roles held may be reflective of the range of competitive levels which respondents worked within (e.g. senior international to youth domestic). Most respondents held higher education qualifications (95%), which aligns with previous research in men's football (85%)[12] and recent recruitment expectations in PA.[18] Reflective of the range of roles, participants held a variety of higher education qualifications, whilst only sixteen specialised in PA (41%; undergraduate = 5%; postgraduate = 36%). This may be consequential of the sample (i.e. only 44% of participants worked full-time, and therefore roles may not be suitable/attractive roles for postgraduate-qualified applicants) or reflect current recruitment expectations for PA roles within women's football (i.e. postgraduate specialisation is not essential). However, this emphasises the importance of sport degree curriculums in developing sufficient breadth and depth of interdisciplinary knowledge, understanding and competencies to facilitate a graduate's pursuit of a variety of disciplines/roles within applied sport environments.[27] For example, undergraduate sports coaching curriculum should embed teaching, learning and assessment relating to the quantification, analysis, interpretation, and feedback of performance data (i.e. areas of expertise, components of PA practice),[17] contextualised to informing the coaching process. Such opportunities to develop areas of

expertise and foundational competencies of PA practice through higher education curriculum, could be supplemented with sport-specific education and development opportunities focussed on context-specific application and considerations for PA within (women's) football. Only twelve respondents held industry-standard PA certifications, and five were accredited (ISPAS). Yet the majority held football coaching qualifications, a higher proportion than previously reported in men's football (92% vs 58%[12]). Whilst we cannot determine the underpinning reasons, this may reflect the evolving role of PA within applied football environments (i.e. sport-specific expertise, importance of translation of football-specific knowledge),[7,17,18] or increasing availability, accessibility and/or uptake of formal coaching education opportunities, during the time-period since Wright et al.[12] investigated the applied PA practices within men's football in 2013.[12] Additionally, contemporary coaching qualification curricula tends to include performance analysis components (e.g. UEFA Pro Licence,[28] UEFA A-licence[29]), which may have led to contemporary football coaches having greater PA competencies and subsequently, conducting applied PA practices. Regardless, there is scope for education opportunities for practitioners within women's football, and NGBs/organisations should consider using the
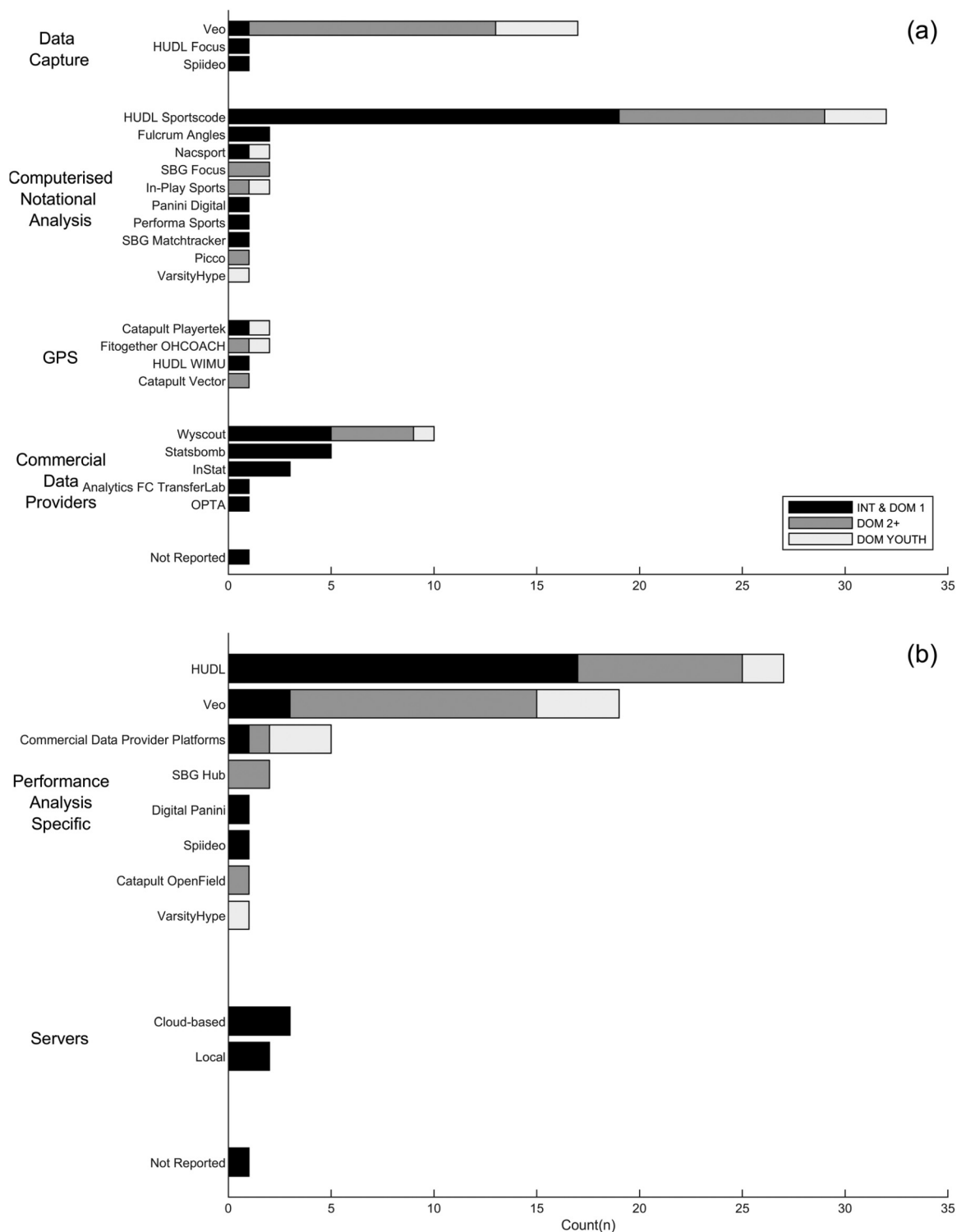
Figure 1. Software used for (a) data collection, and (b) storing and managing data and/or video.

findings of this study to inform the design and development of population-specific opportunities.

Whilst there has been a recent emergence of specialised PA roles within applied sports environments (e.g. opposition, set-piece, pre-match, or training analysts),[18,30] of the 28 respondents in this survey who were performance analysts (72%), all held generic PA positions (e.g. head, lead, or performance analyst). The disparity of specialised roles may reflect the contextual differences between populations (e.g. financial investment, performance support
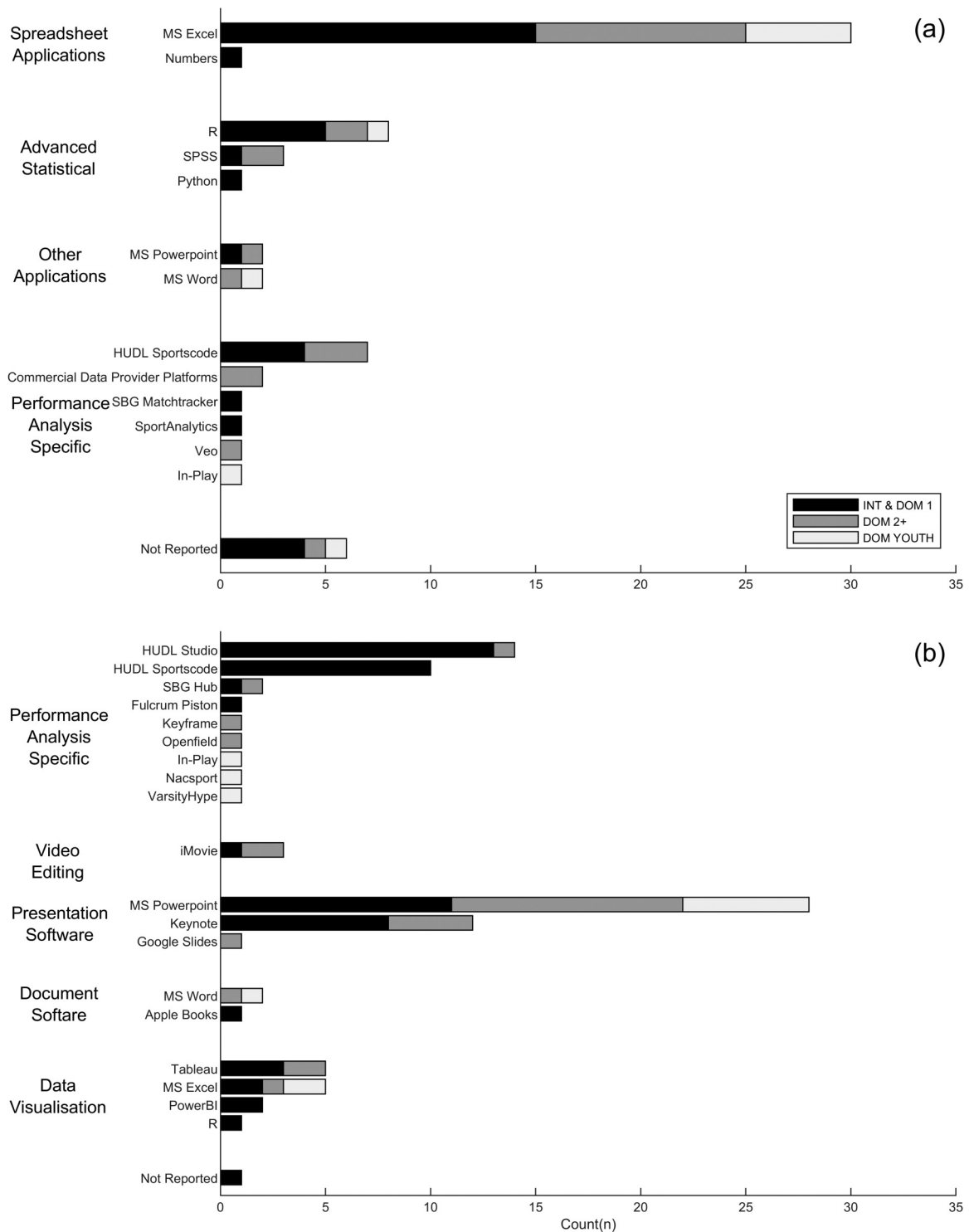
Figure 2. Software used for (a) conducting statistical analysis, and (b) providing feedback to coaches, performance staff and/or players.

provision).[20] Consequentially, practitioners in women's football may engage with a variety of data (e.g. technical, tactical, physical) for various applications of PA (e.g. match analysis, training analysis, talent identification and recruitment), which has practical implications. Firstly,

prioritising allocation of limited PA provision within applied environments. Stakeholders should engage with the practitioner in a collaborative process of; conducting a needs analysis contextualised to the aims/outcomes of the respective organisation, establishing service-level

Table 8. Considerations and challenges for PA within women's football.

Theme	Number of responses	Examples of raw data
Limited resources	13	1) "Lack of resources to recruit more than one analyst. Small staff team managing multiple roles so output is not as effective as it could be. Cost cutting and utilising poor software that makes processes more time consuming and less easy to better engage players/provide them with some individual accountability." 2) "Solo analyst trying to cover opposition analysis, game analysis, post-match analysis, training analysis and recruitment. Difficult to manage all areas and go into the depth we wanted too."
Data (un)availability	6	1) "It could be very difficult to gather data of some teams and plays. Most of the time, a few of their last games are missing or have incomplete data." 2) "Reliability and consistency of data available from external providers. Quality and quantity (different angles) of footage available for fixtures."
Facilities	6	1) "… we travel to a variety of football grounds so the footage is not always at the 'gold' standard we would expect which sometimes proves challenging." 2) "Gantries and stadiums are not the same standard as men's leagues and means footage and camera angles are fewer and poorer quality."
Integration of PA	5	1) "I find the analyst role can be hard for coaches to understand and know everything we can do. They just want footage to go through themselves for the players than allow the analyst to present their perspective." 2) "… although the buy-in for the PA by the coaches is great, I am not sure it is being used to the best of its capacity. Currently it is only shown to players of how we play at games and how the opposition plays, whereas in male teams I have worked for, every training session is shown to the players."
Female-specific practices	3	1) "Technical models created for use with the men's teams are not necessarily applicable." 2) "A different game to men's football, has to be analysed differently. Technical and tactical are viewed differently so it's adapting to what is needed."
Inequality of provision across women's game	3	1) "We are a team in the national league with very limited time and funding. We have professional clubs in our league – however no players or staff are paid for our team. This makes time for analysis very limited and has to be short and concise to have maximum effectiveness. We also do not have access to software similar to those teams around us in the league due to funding." 2) "With the international team I work with, there are two main challenges I face in my role. The first is that our squad is a mixture of amateur and professional players (and therefore their football experiences are different). The second challenge is that some players receive PA support at their club team and some do not (and therefore are not used to receiving PA support on a daily basis)."
(In)experience of the analyst	2	1) "I had only been involved in men's football so I needed to adjust my tactical understanding of the game to more closely align with the women's game." 2) "One of the hardest thing(s) is deciphering the high amounts of data provided post-game and putting it into a format that is easy to read and clear and concise to players and staff."
Limited research	2	1) "Limited research in performance metrics in women's football." 2) "There is limited research on female football as a whole, with specific monitoring load and fitness testing parameters needing more attention too."
Psycho-social considerations	2	1) "… Additionally, they are more forward in asking questions around why they are doing certain things, which means you have to be fully sure around all the work you do and present." 2) "Players often like to do analysis in small groups of individuals. Highlighting development areas in-front of whole group is not always best, especially in youth."

agreements to optimise potential impact of limited resource, and critically reviewing and evaluating this provision.[17] Secondly, practitioners need sufficient breadth and depth of expertise to implement the range of applied practices, in addition to the underpinning skills (e.g. adaptable, problem-solving, organisation, time-management) which enable effective delivery (and manage stakeholders expectations) of PA provision.[17,27] Thirdly, practitioners should explore how to be efficient with limited resources through opportunities for contemporary applications of PA

through interdisciplinary collaboration as highlighted by isolated respondents (e.g. team or individual interventions with the sport psychologist,[11,31–33] injury assessment processes with the medical staff[34]). This would be in contrast to men's football where we have typically observed a clear distinction of PA to focus on the investigation of technical-tactical performance.[35] This may also prevent the establishment of disciplinary silos which limits the potential impact of PA.[36] Lastly, whilst current challenges in women's football (i.e. limited resources) likely underpins generic PA roles, we anticipate the emergence of specialised roles in elite women's football populations in the future with continued growth, professionalisation and financial investment in/by women's football organisations.

Consistent with previous research in men's football,[12] respondents predominantly used PA for team (100%), opposition (84%) and individual (79%) match analysis, and training analysis (74%). Therefore, education and development curricula should aim to enhance (aspiring) analyst's knowledge, understanding and competencies required to facilitate these applications of PA. Interestingly, components of practices relating to data collection and analysis, feedback mechanisms, and application of insights gained appeared to differ according to the specific application (e.g. match analysis, training analysis) and competitive standards. Understanding the intricacies, facilitators and constraints leading to discrepancies in components of practice between and within applications would provide further context for applied practices.[17,22] Such information would be beneficial for informing education and development curricula, to support the development of analysts who can contextualise PA specific expertise using higher-order thinking skills (e.g. critical thinking, problem-solving). Therefore, future research is warranted which comprehensively explores the 'what', 'how' and 'why' of the components of PA practice within women's football populations.[22] For example, exploring how and why feedback mechanisms (e.g. video analysis or reports) differ between and within applications (e.g. team or individual match analysis) or according to the target audience (e.g. coaches or players).[11,14,37] Subsequently, research is also warranted which explores the engagement and perceptions of coaches and players regarding respective PA practices in women's football.[7,10] Lastly, research should also examine the specific processes of how data generated from PA are translated to inform different applied practices (e.g. how opposition analysis explicitly informs match-strategies),[38] or the effectiveness of PA on the intended application (e.g. effectiveness of player-led tasks for individual player development).

In comparison to match and training analysis, fewer respondents utilised PA for best practice analysis (51%), talent identification and recruitment (41%), and game insights (31%). To the best of our knowledge, these applications have not yet been explored within scientific literature, and therefore, research is warranted to capture these

processes within applied environments (within and beyond women's football). Coach behaviour analysis was the least prevailing application (n = 4; 10%), likely consequential of limited resources (e.g. solo analyst) which prioritise player/team performance. Coach behaviour analysis occurred on an ad-hoc basis, and external to systematic processes to create knowledge and inform decision-making within their respective environment.[16] This presents an opportunity to diversify the potential impact of PA within women's football through introducing coach behaviour analysis (albeit, the extent of which may be constrained by limited resources). For example, developing a knowledge base of coach behaviours and activity structures during training to inform the design and delivery of coaching practice, coach education and development opportunities.[33,39,40] Furthermore, there is a relatively non-existent evidence-base investigating coach behaviours and activity structures within women's football[41,42] in comparison to men's football.[43–45] Therefore, future research is warranted which aims to quantify coach behaviours and understand the impact within women's football populations.[46]

A range of technology was utilised to facilitate data collection, data storage and management, conducting analysis and providing feedback. A number of timeline-based computerised notational analysis software were reported (e.g. Nacsport, In-Play Sports, Performa Sports), and consistent with previous research in men's football,[12] HUDL Sportscode was the most prominent (76%). Aspiring analysts should gain experience with a range of industry-standard software, applying underpinning PA concepts and principles whilst gaining exposure to different software (e.g. capabilities, nuances). It is also important to develop contextual awareness and ability to critically reflect on the appropriateness of software for specific populations or environments.[17] For example, in organisations with limited resources, is a relatively expensive PA software (e.g. annual subscription) effective use of financial resources? Therefore, education and development curricula should also aim to develop practitioners who are critical thinkers, open-minded and responsive to the needs and constraints of their environment, who are versatile and can adapt PA practices accordingly.[17,27]

Practitioners working with elite populations (INT and DOM1) were primarily those integrating data from external data providers (e.g. StatsBomb, Wyscout, Opta), likely consequential of the inaccessibility of data beyond this competitive level (i.e. data providers coverage of leagues; financial expenses). The availability of data was identified as a prominent challenge for PA within women's football. Consequently, there are several implications for applied practice and aspiring analysts. Firstly, the impact of the disparity of available data between competitive levels may be further compounded when considering practitioners working at lower competitive levels are likely also constrained by comparatively limited resources. Therefore, analysts are required to engage in time-intensive data

collection processes, resulting in less time to engage in other components of practice (e.g. analysis, facilitating feedback).[17] The potential impact of PA in informing applied practices are likely constrained by both internal and external resources, and therefore, a collaborative approach to generating data may be required beyond individual organisations (e.g. centralised league-wide data collection processes). Secondly, it is necessary for current and aspiring analysts to develop computational proficiencies beyond PA software (e.g. computerised notational analysis, telestration).[27,47] Specifically, programming to facilitate storing and managing data (e.g. SQL), data analysis (e.g. R, Python), and visualisation software (e.g. PowerBI, Tableau) to create effective data visualisations for facilitating feedback to stakeholders.[17,27] However, developing digital literacy is also important given that current practices (across competitive levels) relied on wider computer applications (e.g. Microsoft Excel/PowerPoint) to facilitate data analysis, and designing and delivering feedback to coaches and players via a range of different formats (e.g. video analysis, review meetings). Therefore, higher education curricula and professional development opportunities should ensure development of fundamental digital literacy skills and wider data science and analytics.[4]

Respondents identified a range of considerations and challenges when implementing PA with women's football, including those consequential of financial investment (e.g. limited resources, facilities). The precarious nature of financial investment within women's football, and the consequential impact and influence on perceptions of those within these environments have previously been observed.[48–52] Interestingly, the inequality in provision within women's football was highlighted as a key challenge for some respondents. Therefore, there are likely considerations and challenges applicable across women's football populations (e.g. limited external resources; data availability) but also additional challenges within specific environments which further compound the considerations and challenges faced by the wider population (e.g. limited internal resources; facilities). Further research is required to better understand; potential considerations and challenges across and within women's football populations, how these considerations or challenges may influence applied PA practices and integration within the wider coaching process, and how practitioners adapt to accommodate considerations or overcome such challenges when implementing PA practices.

Whilst the current study provides novel insights into PA within women's football, there are limitations to acknowledge. Firstly, the sample size is low (n = 39), although comparable to previous research utilising surveys to investigate applied practices within sport environments.[12,19] This may be consequential of the sampling method adopted in this study, reflective of the extent of performance analysis provision of performance analysis within applied women's football environments, and/or a low completion rate (40%). Further, length of the survey and/or survey fatigue may have contributed to this low completion rate, due to the survey design which was intended to ascertain a comprehensive but descriptive overview of the applied PA practices within women's football and who conduct these practices. Secondly, most respondents (85%) worked in the UK, which is likely consequential of a) the sampling approach adopted for the current study and b) the availability of the survey in the English language. Therefore, results may not be generalisable to wider women's football populations due to contextual differences (e.g. competition structures)[20] which occur in the sport in other parts of the world. Thirdly, where participants (n = 7) worked across multiple competitive levels (e.g. senior domestic second tier and youth domestic), competitive-level data could not be differentiated due to survey design, therefore, it was assumed that practices were consistent across respective competitive standards unless the respondent explicitly stated the differentiation within open-ended responses. Lastly, the survey was designed to assess the applied PA practices within women's football, and as such, questions focussed upon the 'what' and 'how' aspects of applied practice.[22] Future research is warranted to gain contextual insight into the underpinning reasons for applied PA practices in women's football (i.e. the 'why').

Conclusion

This study investigated the applied PA practices in women's football. Participants across all competitive standards predominantly conducted match and training analysis. However, practices relating to data collection and analysis, feedback mechanisms, and application of insights gained varied dependent upon the application of PA (e.g. match analysis, training analysis) and competitive standard. Most respondents identified considerations or challenges faced when implementing PA within women's football. The insights gained from this study can inform applied PA practices, and education and development opportunities for current and aspiring performance analysts. Further research investigating the underpinning rationale (i.e. the 'why') is required to aid interpretations of the findings of this study which relate to the 'what' and 'how' aspects of applied PA in women's football.

Data availability

The raw survey data has not been made available. As due to the uniqueness of the sample, it may be possible to determine

respondents' identities from the anonymised dataset based on responses to participant characteristics questions.

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Supplemental material

Supplemental material for this article is available online.

Note

1. Coaching qualifications are presented in hierarchical order, starting with the most advanced qualification reported (i.e. A-licence) to the introductory qualification (i.e. NGB Level 1).

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