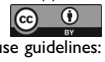
Original research article

International Journal of Sports Science & Coaching

International Journal of Sports Science & Coaching
1–14



DOI: 10.1177/17479541251396338
journals.sagepub.com/home/spo


Supporting player development during the youth-to-senior transition process: A mixed-methods case study of a complex adaptive system in professional soccer

Patrick Mannix[1,3], Simon J Roberts[1,2], Martin A Littlewood[1,2], and Kevin J Enright[1,2]

Abstract

Through a Complex Adaptive Systems (CAS) framework, this study aimed to [1] quantify the seasonal physical loading of a Major League Soccer (MLS) homegrown player (age = 18 y; stature = 1.73 m; body mass = 68.7 kg; position = fullback) undergoing the youth-to-senior transition and [2] explore club sport scientists' perspectives on the working dynamics of the player's training program during the transition process. A mixed-methods single case study design was adopted, integrating external load data (total duration of activity, total distance covered, and distance running at 14.4–19.7 km/h, high-speed running at 19.8–25.1 km/h, and sprinting at >25.1 km/h) from both the player's club and national federation using global positioning systems (GPS) technology, alongside semi-structured interviews with sport science practitioners from the player's MLS organization. Descriptive statistics were used to summarize the GPS data, while hierarchical content analysis was used to formulate categories. Findings addressed relevant features of a CAS within this youth-to-senior transition process, detailing a complex developmental pathway to first team (FT) soccer. The player's physical loading exhibited large variability during the preseason (Coefficient of Variation; CV = 19–58%) and in-season (CV = 25–50%) phases, reflecting the influence of contextual factors such as squad-shifting, international call-ups, and extensive travel when oscillating between disparate training environments. Practitioners also highlighted the dual role of the reserve team (RT), providing the player consistent competitive match exposure to support his individual development. Overall, this study demonstrates the value of a holistic, systems-level approach to better understand optimizing long-term player development initiatives.

Keywords

Association football, career, external load, global positioning system, running, training

Introduction

Major League Soccer (MLS) has undergone a notable evolution since its inception, increasing in the number of clubs and modernizing its "professional player pathway".[1] As a result, more homegrown players from Canada and the United States (US) are signing professional first team (FT) contracts. Despite MLS' investment into its player development initiatives, including the establishment of a new youth league and third tier professional league for its youth academies (YA) and reserve teams (RT), respectively, the transition from the YA to the FT remains an exceptionally challenging period. Transition demands such as adapting to greater training intensities and/or incurring greater training loads have been cited as critical barriers to a successful transition.[2,3] However, while these debilitating factors have been measured in quantitative research and highlighted in qualitative research,[2,4] there has been a dearth of contextual depth pertaining to the complex realities associated with the systematic training programs that

Reviewers: Daryl Cowan (University of West Scotland, UK)
Francisco García-Angulo (University of Murcia, Spain)
Will McCalman (Deakin University, Australia)

[1]Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK
[2]Football Exchange, Liverpool John Moores University, Liverpool, UK
[3]High Performance Department, United States Soccer Federation, Chicago, IL, USA

Corresponding author:
Patrick Mannix, High Performance Department, United States Soccer Federation, 303 E Wacker Dr, Chicago IL, 60601, USA.
Email: p.a.mannix@2020.ljmu.ac.uk

transitioning players must often endure when progressing into a professional FT soccer environment.

Player transitions as a complex adaptive system

The youth-to-senior transition process can be conceptualized as a complex adaptive system (CAS), comprising of multiple interrelated components that dynamically interact with other components in the system and the system as a whole, producing complex, emergent phenomena.[5] Within the organizational structure of a club, players and staff function as the system's components, or adaptive agents, who operate across these interconnected sub-systems (i.e., FT, RT, YA) and respond to local conditions, often in unpredictable ways.[6] The interactions between these agents are multiple, rich, and non-linear, such that small actions or decisions at the local, sub-system level (i.e., individual team objectives) can produce disproportionate effects on system-level outcomes (e.g., progressing homegrown talent into the FT).[7]

In this system within MLS, adolescent YA players (i.e., 14–18 y) identified as exceptional talents are often signed directly to FT homegrown contracts. Promoting a young player directly to the FT places them in volatile, complex, adaptive environment where they may develop through exposure to senior-level challenges.[8] To support their development, clubs frequently employ an organizational strategy known as "squad-shifting",[9] whereby the young professional trains in the FT during the week before temporarily shifting down to the RT to compete in the third-tier domestic league, MLS Next Pro (MLSNP). This ensures more consistent playing time as opportunities in the FT are often extremely limited.[10] However, these interactions, although short in nature,[7] render outcomes such as RT contracted players losing playing time or promising YA players being denied higher level competition. Such aspects of the youth-to-senior transition process reveal vulnerabilities inherent in a CAS. Further, when transitioning players oscillate between the FT and RT, they may encounter differing training objectives and methodologies.[9] In CAS terms, this reflects adaptive tension, where competing constraints within the system create inefficiencies that may impede player development.[11]

Further complexity is introduced when FT homegrown players are selected to join their respective youth national teams (NTs) for domestic and/or international camps (i.e., the club-to-international transition), requiring a temporary transition from their club to a NT program with distinct priorities and performance demands.[12] These transitions necessitate boundary spanning,[13] whereby club stakeholders mediate across organizational settings to maintain system coherence.[14] When divisions exist between a club and federation, disruptions to physical preparation and recovery may negatively impact players' training adaptations and physical performance.[15] These outcomes resemble those observed in other complex systems, such as healthcare, during the clinical handover of patients between health professions.[16]

A homegrown player regularly shifting between multiple team settings exemplifies other characteristics of a CAS. For example, emergent properties, such as unintended fluctuations in physical loading when moving between disparate training environments, cannot be attributed to a single component, but arise from the ongoing interplay between the player and various internal and external elements of the club's organizational structure, as well as the greater MLS and US soccer ecosystem. Consequently, the dynamic and non-linear nature of the youth-to-senior transition can give rise to imperfect periodised training structures or extraneous cumulative physical loads, which may significantly influence both short-term performance and long-term development. Addressing these challenges requires leveraging the self-organizing properties of CAS through the design of performance support systems that foster adaptability, collaboration, and shared learning among stakeholders.[17]

Despite the recognized challenges and complexity of career transitions in professional soccer, limited empirical research has examined the seasonal physical loading of adolescent professionals navigating multiple team settings (i.e., FT, RT, NT) during the transition process. A case study informed by a CAS framework is therefore needed to explore how interactions between the different sub-systems within professional soccer may influence career transition processes and outcomes. Conceptualizing the youth-to-senior transition process as a CAS provides a more comprehensive understanding of this critical phase of player development and highlights how effective transition planning must balance the dynamic tensions between stability and adaptability across interconnected training environments.

The role of performance staff

Within a professional club, sport science practitioners are responsible for supporting the design and delivery of a training program by advising on training methodologies and employing technology, such as Global Positioning Systems (GPS). This technology facilitates the monitoring of training and match loads at both an individual and team level, aligning with systems thinking approaches by providing continuous inputs to the CAS.[18] Real-time feedback derived from GPS data can inform decision-making aimed at mitigating injury risk and preventing performance decrements in young players transitioning to FT soccer.[9] Sport scientists can play a critical role then in communicating information to coaches, their peers within a multidisciplinary team (MDT), and players, thereby acting as boundary spanners who reduce the risk of conflicting priorities and training-related errors that could otherwise disrupt long-term development.[19] Therefore, obtaining insights from

these practitioners on how training programs are managed to help support the development of transitioning players can provide valuable contextual knowledge on the youth-to-senior transition process.

The current study

Quantifying an MLS homegrown player's seasonal physical loading across multiple team settings offers valuable context for understanding the complex and dynamic nature of the transition process to professional FT soccer. This complexity reflects the non-linear interactions and emergent properties of a CAS, where seemingly minor changes in one part of the system can significantly influence long-term developmental outcomes for a transitioning player. Exploring the perspectives of sport scientists further enriches this understanding by capturing how they manage training programs for transitioning players. Through the integration of external load monitoring and collaborative working practices, these practitioners can contribute to the system's resilience by preparing players for the increased physical demands they will face in a FT training environment. Accordingly, this mixed-methods single case study used quantitative (i.e., external load) and qualitative (i.e., multi-perspective interviews) methods to examine an MLS club's approach to transition planning. Therefore, this study aimed to [1] quantify the seasonal physical loading of an MLS homegrown player undergoing the youth-to-senior transition and [2] explore club sport scientists' perspectives on the working dynamics of the player's training program during the transition process. Collectively, these two aims will help elucidate some of the components, interrelations, and emergent properties that will contribute to a better understanding of the youth-to-senior transition process as a CAS within professional soccer.[7]

Methods

Pragmatic study design

Considering the dual aims of this study, a pragmatic research philosophy was adopted to examine the youth-to-senior transition process within an MLS organization.[20] In keeping with this alternative philosophical and methodological paradigm tradition, a mixed-methods single case study design, specifically a convergent design variant (i.e., the parallel-databases variant), was selected so that parallel strands of quantitative and qualitative data could be collected and analysed to provide two sets of results, enabling this study to examine facets of the transition process for a homegrown player in MLS.[21] Accordingly, quantitative and qualitative data were collected and analysed independently before utilizing the discussion, first, to provide a descriptive summary of the case (i.e., a transitioning homegrown player's first season in MLS), and second, to synthesise a more nuanced, practical interpretation of the complexity in managing a transitioning homegrown player's training program.[21] Acquiring greater contextual knowledge surrounding this adolescent homegrown player's training program by retaining different data sources subsequently produces an enhanced description and analysis of the physical demands facing transitioning players. This can also potentially lead to informing future research projects that are more ecologically valid and applicable to both coaches and sport scientists responsible for transition planning within a club.[22,23]

Participants

Player participant and single case selection. Prior to collating data, the study received full ethical approval from an institutional ethics committee (23/SPS/028). Next, a tier 4,[24] professional soccer player (age = 18 y; stature = 1.73 m; body mass = 68.7 kg; position = fullback) undergoing the youth-to-senior transition provided written consent granting the principal investigator access to his external load data from both his club and federation. Shortly after the commencement of the MLS season under investigation, the participant had signed his first professional contract as a FT homegrown player with an MLS organization that also operated a professional RT in MLSNP. Additionally, the recruited participant was a US youth international soccer player selected to participate in both a domestic training camp and a major youth international tournament whilst quantitative data collection was being completed.

Performance staff participants. To explore the youth-to-senior transition process within this specific MLS organization, two sport science practitioners employed by the club were recruited. Both the FT head of sport science [Tobias] and RT physical performance coach [Gabriel] agreed to participate and were thus purposively sampled.[25] At the time of conducting qualitative data collection, Tobias, an accredited United Kingdom Strength & Conditioning Coach and Gabriel, a Certified Strength & Conditioning Coach, had two- and four-years' experience, respectively, at the club. Prior to conducting interviews with each practitioner, both provided verbal consent, following the provision of a participant information sheet and an opportunity to pose any questions regarding the study.

Data collection

External load. Pitch-based training and match loads were measured using GPS technology (Apex, STATSports, Newry, Northern Ireland). Two separate GPS devices were assigned to the player by his club and federation. Both devices operated at a sampling rate of 18 Hz, providing information on positioning and time to calculate velocity and distance.[26] These devices have demonstrated *excellent* inter-unit reliability along with valid and reliable

estimates of distance and velocity (<2% typical error of measurement).[27,28] In each training environment, the device was activated 15–30 minutes before data collection commenced to allow acquisition of satellite signal and synchronize the GPS clock with the satellite's atomic clock. Next, it was inserted into a tight-fitting, manufacture made vest worn by the player. GPS data were collected for 40 weeks, including the preseason (6 wk), in-season (33 wk), and postseason (1 wk) phases. A total of 34 official matches, 4 non-official matches (i.e., scrimmages), 148 training sessions, and 7 post-match compensatory sessions were included in the subsequent analysis. Following each of these pitch-based events, GPS data were downloaded using the manufacturer's software (Apex Software, STATSports, Belfast, UK) and clipped accordingly.[29]

Semi-structured interviews. Before conducting qualitative semi-structured interviews, a provisional guide was developed and based on relevant literature concerning the talent pathway and youth-to-senior transition within MLS.[1,30] The final interview guide was organized into two sections. The first section focused on the broader youth-to-senior transition process within the club. Topics included perceived barriers to successful transitions and strategic approaches adopted by the organization. The second section was case specific, concentrating on the management and development of the featured player. To help foster a deeper, richer discussion with participants, the interviewer employed a graphic elicitation technique in which both of the practitioners were presented with visual representations (i.e., monthly calendars) summarizing the homegrown player's training and match schedule.[31] This elicitation technique provided not only a more illustrative representation of the case, but it also assisted the interview process by stimulating practitioner recall.[32] The two separate interviews with Tobias (54 minutes) and Gabriel (40 minutes) were conducted over video call (Microsoft Teams, Microsoft, Redmond, WA).

Data analysis

Quasi-statistical analysis. Quantitative analysis was employed to determine both the player's training and match exposures across the three different team settings. The former is the total number of training minutes, and the latter is the total number of match minutes played.[33] For the player's seasonal physical loading, descriptive statistics were used to present mean ± SD, minimum, maximum and the coefficient of variation (CV) for weekly (i.e., Monday to Sunday) external loads. The external load variables selected for the analysis were duration (minutes), total distance (km), and three different speed categories that were organized into the following thresholds: running (14.4–19.7 km/h), high-speed running (19.8–25.1 km/h), and sprinting (>25.1 km/h). These speed categories have been previously used in research within the adult men's game.[29]

Hierarchical content analysis. The interviews were transcribed verbatim, and a hierarchical content analysis (HCA) was conducted that incorporated movement back and forth between inductive and deductive approaches, whereby an unconstrained and evolving matrix enabled categories to be generated.[34,35] The aim of a HCA is to systematize, reduce, and interrogate the content of the qualitative data by coding it, identifying consistencies, or patterns, to develop smaller and larger categories into a hierarchical structure that enables researchers to coherently describe their findings.[36] To prepare the HCA, the lead investigator [PM] immersed himself in the data, reading the interview text line-by-line on several occasions. Meanwhile, he was also tagging raw data during this immersion phase, jotting down notes and headings, and beginning to detect and establish codes. Next was the process of abstraction, which means a general description of the qualitative data capture is formulated by generating categories.[37] This entailed the lead investigator clustering codes together to create meaningful categories, using content-characteristic words to produce the names of each category.[34] Categories were then organized into larger, more comprehensive categories. The reliability of the sub-categories was cross-checked with the raw data, while the grouping of the sub-categories under both the generic and main categories was re-examined on multiple occasions by the lead investigator. Next, the analysis was turned over to two members of the research team [ML, SR], who hold significant experience and engagement in qualitative research in professional soccer, for confirmation. This process of confirmation supports the trustworthiness of the analysis, as these researchers were not involved in the video data capture and instead serve as an independent check on the integrity of the analytic framework.[36] Thus, they reviewed the coded data and category structure, critically examining the alignment between tagged raw data, illustrated exemplar quotes, and represented categories, before providing feedback on the coherence and interpretative clarity of the analysis. The qualitative results are presented in a table format and contain quantitative counts for each category.

Results

Training and match exposures

The MLS homegrown player's training and match exposure from the preseason, in-season, and postseason phases across the three different team settings are presented in Table 1. The distribution of training types by match day code for each team setting is presented in Figure 1. The homegrown player recorded a total of 49 tapering sessions (i.e., MD −1), 31 acquisition sessions (i.e., MD −4 and MD −3

Table 1. Training and match exposures across three phases. Values posted in square brackets under the training and match exposure columns denote post-match conditioning sessions and scrimmages, respectively ('-' denotes zero).

		Training exposure								*Match exposure*							
		First team		Reserve team		National team		Sum totals		First team		Reserve team		National team		Sum totals	
Training phase	Calendar month	Session	Min	Session	Min	Session	Min	Session	Min	Match	Min	Match	Min	Match	Min	Match	Min
Preseason	Jan	8	542	-	-	6	540	14	1082	[1]	41	-	-	[1]	41	[2]	82
	Feb	10	786	-	-	-	-	10	786	3	195	-	-	[1]	45	3 [1]	241
In-season	Feb	3	232	-	-	-	-	3	232	1	79	-	-	-	-	1	79
	Mar	16	1167	2	131	-	-	18	1298	2 [1]	177	1	47	-	-	3 [1]	224
	Apr	16 [2]	1052	-	-	-	-	16 [2]	1052	5	239	1	64	-	-	6	303
	May	13 [2]	676	2	128	-	-	15 [2]	804	1	10	4	366	-	-	5	347
	Jun	1	27	2	139	13 [1]	899	16 [1]	1065	-	-	1	99	3	254	4	354
	Jul	10	571	2	106	-	-	12	677	2	56	2	196	2	129	6	381
	Aug	13	721	6	395	-	-	19	1117	-	-	3	293	-	-	3	293
	Sep	12 [1]	814	2	102	-	-	14 [1]	916	-	-	3	291	-	-	3	291
	Oct	5 [1]	313	1	98	-	-	6 [1]	411	-	-	-	-	-	-	-	-
Postseason	Oct	4	273	1	91	-	-	5	364	-	-	-	-	-	-	-	-
Totals		**117**	**7173**	**18**	**1190**	**20**	**1439**	**155**	**9803**	**16**	**798**	**15**	**1327**	**7**	**470**	**38**	**2595**

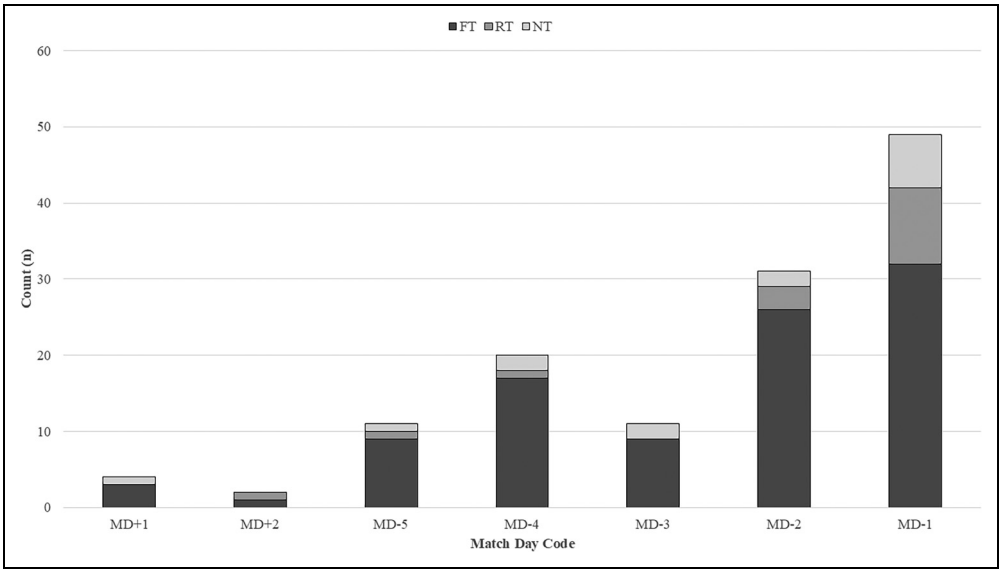


Figure 1. The frequency of session types during three training phases according to their match day code for the three different team settings.

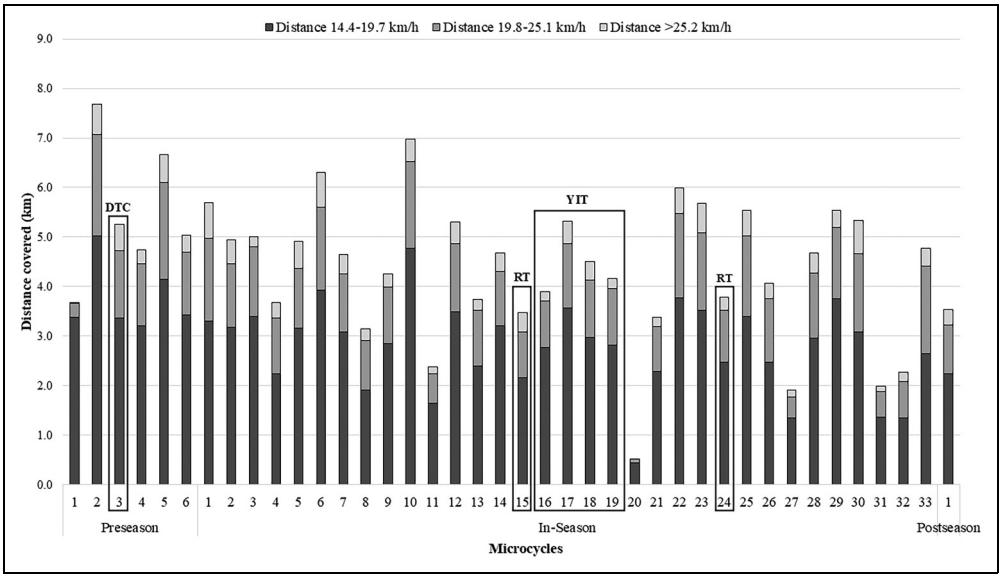


Figure 2. The MLS homegrown player's total weekly running (14.4–19.7 km/h), high-speed running (19.8–25.1 km/h), and sprinting (>25.2 km/h) distances across three training phases. Notes. In addition to attending two NT camps during the preseason and in-season phases, the homegrown player also completed two training microcycles exclusively within the RT setting. DTC = domestic training camp; YIT = youth international tournament.

combined), and six compensatory sessions (i.e., MD +1 and MD +2 combined) across the three team settings during three phases of training.

Seasonal physical loading

Figure 2 illustrates the mean weekly running, high speed running, and sprinting distances across three phases of MLS. The preseason and in-season GPS data are summarized in Table 2, which provides the mean ± SD, minimum, maximum, and CV of weekly external loading. Additionally, the total duration, total distance, running, high-speed running, and sprinting distances covered during the preseason and in-season phases are included and is representative of both training and match loads combined. External load data from the postseason was not included as it only comprised a single training microcycle.

Table 2. Descriptive data of preseason and in-season mean weekly external loads (m). Total external loads accumulated during the preseason and in-season phases are posted in the gray column (km).

Phase	Parameters	Mean ± SD	Min	Max	CV	Total
Preseason	Total distance (m)	27,040 ± 5889	17,074	33,116	22	162.2 km
	Running (m)	3761 ± 702	3215	5027	19	22.6 km
	High-speed running (m)	1357 ± 632	284	2050	47	8.1 km
	Sprinting (m)	389 ± 226	7	604	58	2.3 km
In-season	Total distance (m)	22,515 ± 5689	4536	31,068	25	743 km
	Running (m)	2780 ± 894	438	4770	32	91.7 km
	High-speed running (m)	1185 ± 402	87	1762	34	39.1 km
	Sprinting (m)	354 ± 177	0	715	50	11.7 km

Formulated categories

The HCA generated two main categories, six generic categories and 26 sub-categories (Table 3). Both Tobias and Gabriel addressed their club's organizational aims (69 codes) and the provision of sport science support (55 codes). The former entails an overarching club strategy and structure, which employs various player development strategies aimed at supporting those transitioning into the FT whilst balancing the management of the squad that is training on a regular basis within the FT setting. The latter encompasses staff alignment, which ensures the integration between members of the MDT, particularly sport science and medicine practitioners, whose collaboration can help safeguard player health and performance. Further, the employment of planning and periodization strategies were key areas of practice for the two sport science practitioners given that their club operates two professional entities, including the FT and RT in MLS and MLSNP, respectively. Technology and data management were also deemed vital for knowledge dissemination to coaches and members of the MDT who together are responsible for designing and delivering training programs to support talented young players transitioning to the FT.

Discussion

From the analysis of the quantitative and qualitative data sources, this study's findings have been organized into two sections. Each section provides a summary and interpretation of the homegrown player's training program, addressing relevant features of the CAS identified within this case study concerning the youth-to-senior transition process. The first section examines the player's seasonal physical loading, detailing the preseason and in-season phases in separate subsections. Next, the second section examines the working dynamics behind the provision of match play in MLS and MLSNP for the homegrown player, highlighting the club's strategic use of its professional RT to bolster the player's match exposure in the latter third division domestic league to support his individual development. Across both sections, relevant quotes from Tobias and Gabriel provide contextual evidence pertaining to the club's organizational aims and their sport science provision, which together contributed to the overall management of the homegrown player's training program during the course of his first MLS season.

Physical loading during the preseason and in-season phases

The first aim of this single case report was to quantify the seasonal physical loading of an MLS homegrown player transitioning to FT soccer. The player's GPS data revealed greater weekly external load volumes were recorded during preseason versus the in-season phase, while a large within-subject variation was also observed for both phases across all external load measures. These findings concerning seasonal physical loading are examined further in the following subsections, while analyses are also provided on the player's training program whilst he shifted between the FT, RT, and NT. For the postseason phase, insufficient data was available to draw inferences due to an early elimination from the MLS playoffs.

Preseason phase: first team and national team training environments. The physical demands during preseason are generally acknowledged to be greater than any other phase of training as the primary objective during this period is to develop players' fitness in order to prepare them for the impending competitive season.[38] Accordingly, all external load measures collected in this study, including duration, total distance, running, high-speed running, and sprinting demonstrated greater mean weekly volumes during preseason compared to the in-season for the adolescent homegrown player (Table 2). Gabriel also noted that *FT training opportunities* available during this period were particularly

Table 3. Categories related to the youth-to-senior transition process within an MLS organization from the perspective of its sport science practitioners.

Main categories	Generic categories	Sub-categories	Supporting Quotes
Organizational aims (69)	Club strategy and structure (12)	RT aims (2)	**Gabriel**: "We were working with the FT, supporting them and they were supporting us."
		Results driven (2)	**Tobias**: "But again, it's a results business. If they feel like he's the best player, they wanna play them."
		Talent development pathway (2)	**Tobias**: "the American model compared to the European model, it isn't the same."
		Training site setup (1)	**Gabriel**: "We don't train on the same fields, but we train at the same time."
		Transfer market (1)	**Tobias**: "Looking at the wider picture of the league, clubs are looking to cash in on exciting young players and sell them."
		YA aims (4)	**Tobias**: "The goal is get players ready for the FT, but that's not the focus of a lot of academies. The focus [instead] is just winning games."
	Player development strategies (30)	Educational interventions (4)	**Gabriel**: "We are educating these players every year as we evolve."
		Growth and maturation assessment (1)	**Tobias**: "The academy is measuring peak height velocity and taking performance metrics, but I'm not sure that it really moved the needle in terms of decisions made on players"
		Holistic development (4)	**Tobias**: "For me, a lot of it is looking out for them holistically rather than just a playing perspective."
		Lifestyle management support (3)	**Gabriel**: "It's not only two hours of their day coming into [train]… I think these players need to learn there's also a recovery process to it."
		Match play opportunities (9)	**Tobias**: "If he's not going to be part of a FT game, then he will definitely be part of the RT game."
		Physical development (9)	**Gabriel**: "I think my role is to definitely help them enhance themselves physically. We speak about it all the time here at the club … make sure these players are technically, mentally and physically ready."
	Squad management (27)	FT needs (6)	**Tobias**: "There's always going to be an aspect of what positions do we need if we're trying to play 11v11."
		FT training opportunities (6)	**Tobias**: "Sometime it may only be one session for some, but in preseason, we had the first and second team together to start."
		Managing shifting players (15)	**Gabriel**: "One of the challenges is the communication … obviously communication is key when these players move up and down."
Sport science provision (55)	Planning and periodization (37)	Individualized programming (4)	**Gabriel**: "We set the guidelines of what each player's schedule will look like, whether they have gym post-training or pre-training."
		Injury risk analysis (5)	**Tobias**: "That would be the biggest debates. Like what time is the game the next day? Are we gonna put him at unnecessary risk because of lack of sleep?"
		Match exposure (5)	**Tobias**: "You never know exactly how many minutes they're gonna play. And so a lot of the challenges would be around schedule."
		Microcycle structure (4)	**Gabriel**: "The FT would always deal with his [training] microcycle and know what his month would look like"
		Planning process (8)	**Gabriel**: "We understood that we always had to have a Plan B and a plan C just in case plan A didn't go. It was us adapting to what the FT wanted."
		Rest and recovery (5)	**Tobias**: "These things are incredibly taxing, so we just shut him down for the weekend"
		Travel demands (6)	**Gabriel**: "Some of the challenges [for]the player is coming

(continued)

Table 3. Continued.

Main categories	Generic categories	Sub-categories	Supporting Quotes
			back from a [long] weekend of travel or coming back from an international camp."
	Staff alignment (10)	Coach communication (4)	**Gabriel**: "We make sure that we know which players are moving up and down. We communicate with head coaches to [confirm] when any RT players needs to move up to the FT and vice versa."
		Multidisciplinary team communication (6)	**Tobias**: "We have morning meetings before training with our first and second team performance and medical staff"
	Technology and data management (8)	Centralized information (4)	**Tobias**: "The AMS comes in [handy], being able to, at all times, have a complete record, so we know where they're trending, given the different coaching styles"
		Physical performance testing (4)	**Gabriel**: "The coaching staff like to compare any performance testing we do with these players"

demanding for the homegrown player and other young professionals, stating that "for a lot of these players, it becomes a long preseason… guys like him and some of the [other] second team players get exposure to the FT environment. I think the mental fatigue is [something] we have to deal with." Similar to this practitioner's perspective, it was reported that when RT players participated in a FT preseason, they incurred higher external and internal loads and experienced increased fatigue and stress compared to their previous RT preseason.[39] These findings reinforce the importance of monitoring the load and response of adolescent players on an individualized basis. Moreover, the absence of established methods concerning how best to integrate young professionals into the FT setting, combined with a dearth of objective training guidelines for adolescent players participating in adult team sport, emphasizes the need to adopt tailored approaches.[40]

Although the homegrown player successfully underwent a six-week preseason, the absence of internal loading, such as self-reported wellness response data, inhibits the ability to evaluate how well he coped with the demands. When appraising the substantial variability (CV = 19–58%) in preseason physical loading, it is important to consider the underlying circumstances. Specifically, the homegrown player engaged in two distinct training environments during this demanding period. Following the second training microcycle, which recorded the greatest volumes of running (5027 m), high-speed running (2050 m) and sprinting (604 m), the player temporarily transitioned from the adult FT setting to an age-restricted youth NT for a domestic training camp (Figure 2). Transitioning from club to country, particularly during preseason, reinforces important assertions made by applied practitioners advocating for greater transparency from both clubs and national federations when it comes to exchanging players' health and performance data,[41] as these data sharing practices serve as important, organized feedback loops to the agents within this CAS (e.g., sport scientists).[5] Further, a lack of data sharing may unnecessarily increase players' risk of injury and present a missed opportunity to optimize player development.[42] In the current study, the combination of a different playing system (i.e., technical and tactical demands) and a relatively younger training environment may have likely disrupted the club's prescribed physical loading for the homegrown player leading into the MLS season. Therefore, this club-to-international transition strengthens the point that sports scientists can serve as boundary spanners for their organizations, developing relationships and establishing networks between clubs and federations to facilitate the exchange of data,[43] which can help improve players' integration into different training environments by ensuring a more informed and tailored loading prescription is implemented.[44] Further, such data is invaluable, particularly for club practitioners during the preseason phase, as their responsibilities generally include integrating competition programming (i.e., the number of scrimmages and/or friendlies scheduled), intense conditioning, and technical and tactical sessions into a cohesive training program.[45]

In-season phase: first team, reserve team, and national team training environments. Similar to the preseason phase, a substantial within-subject variability in physical loading was also observed during the in-season phase (CV = 25–50%). While this variability may in part be due to changes that can occur in any player's weekly training structure within a single team setting, such as adjustments to frequency, density, intensity, and volume,[46] it may also be due to several contextual factors specific to this particular case study, which are related to the homegrown player's engagement in disparate training environments. Therefore, the first factor to consider is the club's use of a squad-shifting strategy, which can often result in surplus physical loading due to insufficient recovery pre- or post-

match.[9] In this study, the player frequently began his training microcycle in the FT, attending two or three sessions, before shifting to the RT and participating in one or two training sessions to prepare for the upcoming MLSNP opponent. In other instances, if the player was either an unused substitute or played for only a marginal number of minutes in the FT (i.e., ≤ 20 minutes), he was then allocated to the RT to be rostered for a match the following day when scheduling permitted. Afterwards, he returned to the FT for the ensuing training microcycle. While this transient state, involving regular movement back and forth between the FT and RT over multiple training microcycles, may have contributed to the homegrown player's in-season physical loading variability, Gabriel commented on the club's approach to *individualized programming*, stating "we made sure he was getting the [match] minutes he needed, but at the same time that his routine [for] recovery and preparation wasn't affected at all, whether he was with us or with the FT." This statement underscores the continuous inputs needed from agents to maintain system functioning while the homegrown player was shifting between training environments.[7]

The next factor to consider involves the *travel demands* within the MLS ecosystem (i.e., first and third division domestic leagues), as the geographical size of the US and Canada means players encounter trans-meridian air travel, extended hotel stays, and alterations to training schedules, which can subsequently impair their physical preparation for away competition.[47,48] In this study, the homegrown player was rostered for 16 away matches, including eight first division matches, seven third division matches, and one domestic cup match. Tobias spoke on the implications of travel, stating "the effects of travel, playing professional soccer in the US is huge… Travel is a big one, obviously. It impacts sleep, nutrition, training load…" This remark illustrates how MLS sport science practitioners must strategically plan training programs around protecting players' sleep, ensuring appropriate food and fluid intake, and synchronizing appropriate physical loads around travel, especially as the in-season phase progresses and the psycho-physiological toll of travel fatigue begins to accumulate.[49] Moreover, a league-wide retrospective study recently reported a small positive association between cumulative travel and high-intensity ($\geq$20.2 km/h) distance covered by away-teams.[50] While the study's authors note that the implications of these findings on applied practice are difficult to determine, practitioners in MLS may wish to consider monitoring squad-shifting players' accumulated travel distance, duration, and time away as a means of managing organizational stressors related to extensive travel. By collecting measures associated with travel, a club's MDT may better determine an appropriate balance between underloading and overloading, especially during periods when the player is regularly shifting between the subsystems (i.e., FT, RT, NT) of this CAS.

The final factor influencing the player's physical loading variability was the application of *rest and recovery*, particularly after his participation in a major youth international tournament in Central America during microcycles 16–19 with the NT. The weekly external load volumes recorded during these four training microcycles ranged between 2768–3571 m, 938–1301 m, and 193–451 m for running, high-speed running, and sprinting, respectively. Upon returning to his club, the homegrown player was prescribed a five-day rest period, during which he refrained from structured training and club activities entirely. This break, scheduled during microcycle 20, resulted in a substantial reduction in physical loading before full training was resumed in the subsequent microcycle (Figure 2). Tobias elaborated on the reasoning behind this decision.

> *We managed to give him time off in July. He was keen to get straight back into it… but he'd been away for four weeks… I've experienced those [international] environments, and you don't realize how demanding they are, and players can often have a little dip [in performance] afterwards.*

Due to the homegrown player's prolonged period away with the NT, resulting in 5 appearances and 383 minutes played, the club determined a conventional prescription of passive rest was appropriate as it entered the latter months of the MLS season. Ultimately, the multiple days of rest may have benefited the player's physical, psychological, and emotional recovery, subsequently enabling him to deactivate cognitions and emotions related to the international tournament,[51] while also mitigating any residual fatigue elicited by the cumulative impact of training, competition, and travel up to this point during the in-season phase.[49]

Match play provision to support player development

The second aim of this single case report was to explore the working dynamics behind the transitioning player's training program through the perspectives of two club sport scientists. The qualitative interviews revealed that a fundamental aspect of this MLS club's approach to transition planning was to ensure the homegrown player experienced regular match play, which is recognized as essential to any club's systematic training program aimed at developing young players.[52] Upon further examination of the total accumulative physical load (Table 2), GPS data revealed that the MLS homegrown player's in-season volumes were analogous to the seasonal physical loads of starters in an English Premier League club, including duration (10,678 $\pm$ 916 minutes), total distance (816.2 $\pm$ 92.5 km), running (91.8 $\pm$ 16.3 km), high-speed running (35.0 $\pm$ 8.2 km) and sprinting (11.2 $\pm$ 4.2 km) distances.[29] Such volumes recorded in the present study are likely due to the substantial match exposure the homegrown player accrued across the

three different team settings, particularly the professional RT.

Within this MLS club, technical leadership had earmarked *match play opportunities* as a key priority for young players, which Tobias highlighted when sharing his perspective on the club's approach to developing players transitioning to the FT.

> *I give the manager and assistant manager a lot of credit, they were very big on making sure these young [players] got as many minutes as they could. That was a big focus area… say, the MLS Next Pro side would play directly after [the FT], and if they didn't play major minutes, let's get them minutes… Let's get them the opportunity to go out there and play games, because that's how they're going to get better.*

However, playing time is never guaranteed for young players when they sign a contract with the FT, which can impact their sense of belonging with the team, raise their levels of stress, and leave them frustrated and feeling lonely by the lack of playing opportunities.[10,53,54] In the context of this case study, at the beginning of the season, the homegrown player was selected as a starter and substitute, logging nine appearances and 505 minutes played with the FT from February to May, but as the in-season phase progressed, the number of appearances and subsequent playing time in FT competitions abruptly declined (Table 1). Consequently, when opportunities in the FT became limited, the club adapted the homegrown player's transition plan, giving rise to emergent behaviors within this CAS,[7] whereby the agents within the club's sub-systems subsequently elected to utilize third division competition programming with the RT to ensure adequate match exposure was afforded to the homegrown player while he completed his transition to FT soccer.

Other practical solutions for managing transitioning players include designing individualized development plans and formalizing more direct communication.[10] The latter may alleviate stressors that can arise when players feel they are in a "gray period," whereby they do not understand what their standing is within the club.[10] Whilst the former is crucial, as it helps address players' specific developmental needs and prevents stagnation that can occur when reduced playing time coincides with a FT training schedule focused on recovery and preparation for competition, rather than individualized coaching and intensive training.[4,55] Furthermore, although compensatory training sessions can provide an adequate conditioning stimulus for non-starting players,[56] participation in competitive matches remain the most effective way to achieve high-intensity loads while also exposing players to realistic, soccer-specific stimuli essential for individual development.[29]

During the in-season phase, the homegrown player only completed seven compensatory sessions, or "top-up" sessions, immediately post-match and six compensatory sessions 24-to-48 hours post-match (Figure 1). At the conclusion of the in-season phase, the homegrown player's match exposure comprised a total of 26 appearances and 1796 minutes played in official competitions for his MLS club, including 11 (470 minutes played) and 15 appearances (1327 minutes played) for the FT and RT, respectively. The dynamic, non-linear interactions, albeit short in nature, between the RT and homegrown player seem to demonstrate that over the course of the parallel MLS and MLSNP seasons, the *aims of the RT* within this club's organizational structure render it holding different symbolic and strategical roles,[57] meaning it serves as both a development team and an extension of the FT.[30] As Gabriel explained, "we work hand in hand with the FT, supporting them… the goal for us is to support the FT and to have second team players ready to make the jump into the FT environment."

Practical implications

This case study highlights several important considerations for practitioners charged with designing, implementing, and monitoring the systematic training programs of transitioning adolescent homegrown players. First, physical loading may be highly variable across preseason and in-season phases, especially for players oscillating between disparate training environments (i.e., FT, RT, and NT). For a MDT working within a club, GPS technology is an important diagnostic tool during the transition process, informing tailored training interventions not only to progressively expose developing players to greater intensities that drive adaptations to meet the increased physical demands in the FT, but also to help mitigate a transitioning player's risk of injury, overtraining, and/or burnout. Thus, the GPS data serves as a feedback mechanism within this broader player development system, supporting data-informed practices throughout the transition process.[58] Second, travel demands related to domestic competition programming and international call-ups further underscore the need for strategic planning approaches to optimize players' performance and recovery.[49] Sport scientists and other MDT members (e.g., athletic trainers, physiotherapists, strength and conditioning coaches, etc.) can act as boundary spanners, fostering communication between clubs and national federations to facilitate data sharing and maintain continuity in load monitoring, which can ultimately support the adaptability of this CAS. Finally, coordinated squad-shifting policies should be guided by a clear understanding of the RT's dual role, serving as both a developmental environment and an auxiliary to the FT. Clubs explicitly defining this entity's role may better ensure alignment in objectives and communication between FT and RT staff, which can subsequently optimize development outcomes for transitioning players while also managing cascading effects across the wider RT roster.

Limitations and future directions

Despite the valuable GPS data and practitioner insights provided in this study, there exists limitations and opportunities for future research. First, given the homegrown player accrued 16 appearances (798 minutes played) with the FT, this study focused on what could be deemed a successful transition, which may overlook valuable information that could be gathered on players determined to be less talented or whose transitions were less effective. A comparative analysis of these contrasting transition experiences could have provided a more balanced understanding of the factors influencing the transition process. Additionally, while this single case offers greater contextual depth of a transitioning player's training program, conducting multiple case studies across multiple clubs would allow for broader generalizations and uncover systematic differences in transition planning that are employed by clubs across MLS. Future research should also consider employing longitudinal studies, tracking player transitions over multiple seasons, which would offer a more nuanced and complete understanding of long-term development trajectories and adaptations to transition planning. Finally, future research should consider including the perspective of players themselves, as well as national federation personnel, to capture a more holistic and multi-level understanding of how youth-to-senior transitions are navigated and supported across the broader sport ecosystem.

Conclusion

To the authors' knowledge, this is the first study to quantify the seasonal physical loading of an adolescent homegrown player navigating the youth-to-senior transition process in MLS. This study highlights the complexity in managing a transitioning player's training program when shifting between multiple team settings, each with distinct objectives, training demands, and organizational constraints. Variability in physical loading across preseason and in-season phases reflected the influence of contextual factors such as squad-shifting, international call-ups, and extensive travel, underscoring the need to design tailored, adaptive strategies for effective transition planning. This study also reinforced the strategic importance that the RT can have in providing consistent match exposure for a developing homegrown player transitioning to FT soccer. The integration of GPS data and practitioner interview data further demonstrated how sport scientists act as key agents in maintaining coherence and resilience within the system. Overall, this study has provided an alternative approach to examining the youth-to-senior transition through a CAS framework. Identifying the dynamic, nonlinear, and emergent properties inherent in the transition process is essential for balancing immediate performance priorities with long-term player development goals. By embedding system-wide approaches that integrate monitoring, collaboration, and strategic alignment, clubs can more effectively support talented homegrown players as they progress into professional FT soccer.

Acknowledgments

Thank you to the participating player and club for their openness to collaboration and exchange of pertinent information to complete this study. Thank you to the participating practitioners for their valuable time and insightful contributions.

ORCID iDs

Patrick Mannix https://orcid.org/0000-0002-2556-0907
Simon J Roberts https://orcid.org/0000-0001-7370-0161
Martin A Littlewood https://orcid.org/0000-0003-1881-6035
Kevin J Enright https://orcid.org/0000-0003-1775-6392

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability

The data that support the findings of this study are available on request from the corresponding author (PM).

Supplemental material

Supplemental material for this article is available online.

References

1. Mannix P, Roberts SJ, Enright K, et al. The evolution of the talent pathway in Major League Soccer. *Soccer Soc* 2025; 26: 189–207.
2. Houtmeyers KC, Jaspers A, Brink MS, et al. External load differences between elite youth and professional football players: ready for take-off? *Sci Med Footb* 2021; 5: 1–5.
3. Lundqvist C, Gregson W, Bonanno D, et al. A worldwide survey of perspectives on demands, resources, and barriers influencing the youth-to-senior transition in academy football players. *Int J Sports Sci Coach* 2024; 19: 162–170.
4. Mitchell T, Gledhill A, Nesti M, et al. Practitioner perspectives on the barriers associated with youth-to-senior transition in elite youth soccer academy players. *Int Sport Coach J* 2020; 7: 273–282.
5. Carmichael T and Hadžikadić M. The fundamentals of Complex adaptive systems. In: M Hadžikadić AJ Collins, and Carmichael T (eds) *Complex adaptive systems: Views from the Physical, Natural, and Social Sciences*. Germany: Springer International Publishing, 2019, pp.1–16.

6. Talukder B, Schubert JE, Tofighi M, et al. Complex adaptive systems-based framework for modeling the health impacts of climate change. *J Clim Chang Health* 2024; 15: 100292.
7. Salmon PM and McLean S. Complexity in the beautiful game: implications for football research and practice. *Sci Med Footb* 2020; 4: 162–167.
8. Røynesdal Ø, Toering T and Gustafsson H. Understanding players' transition from youth to senior professional football environments: a coach perspective. *Int J Sports Sci Coach* 2018; 13: 26–37.
9. Martin-Garetxana I, Ortuzar I, Urkiza I, et al. Lost in transition: exploring injury risk in academy footballers shifting between the second and first teams. *J Sci Med Sport* 2024; 27: 154–159.
10. Swainston SC, Wilson MR and Jones MI. It's all about opportunity": from professional contract to first-team regular. *J Appl Sport Psychol* 2022; 34: 1251–1271.
11. Uhl-Bien M, Marion R and McKelvey B. Complexity Leadership Theory: shifting leadership from the industrial age to the knowledge era. *Leadership Q* 2007; 18: 298–318.
12. McKay A, Cropley B, Mullen R, et al. Psychosocial demands and situational properties of the club-to-international transition in male youth football. *J Appl Sport Psychol* 2022; 34: 1272–1294.
13. Long JC, Cunningham FC and Braithwaite J. Bridges, brokers and boundary spanners in collaborative networks: a systematic review. *BMC Health Serv Res* 2013; 13: 158.
14. Orth D, van der Kamp J and Button C. Learning to be adaptive as a distributed process across the coach–athlete system: situating the coach in the constraints-led approach. *Phys Educ Sport Pedagogy* 2019; 24: 146–161.
15. Silva JR, Buchheit M, Hader K, et al. Building bridges instead of putting up walls: connecting the "teams" to improve soccer Players' support. *Sports Med* 2023; 53: 2309–2320.
16. Manias E, Geddes F, Watson B, et al. Perspectives of clinical handover processes: a multi-site survey across different health professionals. *J Clin Nurs* 2016; 25: 80–91.
17. Davids K, Araújo D, Vilar L, et al. An ecological dynamics approach to skill acquisition: implications for development of talent in sport. *Talent Development & Excellence* 2013; 5: 21–34.
18. Bourdon PC, Cardinale M, Murray A, et al. Monitoring athlete training loads: consensus statement. *Int J Sports Physiol Perform* 2017; 12: S2–161-S2–70.
19. Nosek P, Brownlee TE, Drust B, et al. Feedback of GPS training data within professional English soccer: a comparison of decision making and perceptions between coaches, players and performance staff. *Sci Med Footb* 2021; 5: 35–47.
20. Giacobbi PR, Poczwardowski A and Hager P. A pragmatic research philosophy for sport and exercise psychology. *Sport Psychol* 2005; 19: 18–31.
21. Creswell JW and Plano Clark VL. *Designing and Conducting Mixed Methods Research*. Sage Publications, 2017.
22. Halperin I. Case studies in exercise and sport sciences: a powerful tool to bridge the science–practice gap. *Int J Sports Physiol Perform* 2018; 13: 824–825.
23. Harper LD and McCunn R. "Hand in glove": using qualitative methods to connect research and practice. *Int J Sports Physiol Perform* 2017; 12: 990–993.
24. McKay AKA, Stellingwerff T, Smith ES, et al. Defining training and performance caliber: a participant classification framework. *Int J Sports Physiol Perform* 2022; 17: 317–331.
25. Patton MQ. *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. 4th ed. Thousand Oaks: Sage Publications, 2014.
26. Malone JJ, Lovell R, Varley MC, et al. Unpacking the black box: applications and considerations for using GPS devices in sport. *Int J Sports Physiol Perform* 2017; 12: S2–18-S2–26.
27. Beato M, Coratella G, Stiff A, et al. The validity and between-unit variability of GNSS units (STATSports Apex 10 and 18Hz) for measuring distance and peak speed in team sports. *Front Physiol* 2018; 9: 1288.
28. Beato M and de Keijzer K. The inter-unit and inter-model reliability of GNSS STATSports apex and viper units in measuring peak speed over 5, 10, 15, 20 and 30 meters. *Biol Sport* 2019; 36: 317–321.
29. Anderson L, Orme P, Michele RD, et al. Quantification of seasonal-long physical load in soccer players with different starting Status from the English premier league: implications for maintaining squad physical fitness. *Int J Sports Physiol Perform* 2016; 11: 1038–1046.
30. Mannix P, Roberts SJ, Enright K, et al. Surveying the youth-to-senior transition landscape in Major League Soccer: a new frontier. *Sci Med Footb* 2024; 8: 365–373.
31. Edwards R and Holland J. *What is Qualitative Interviewing?* London: Bloomsbury Academic, 2013.
32. Crilly N, Blackwell AF and Clarkson PJ. Graphic elicitation: using research diagrams as interview stimuli. *Qual Res* 2006; 6: 341–366.
33. McBurnie AJ, Dos'Santos T, Johnson D, et al. Training management of the elite adolescent soccer player throughout maturation. *Sports (Basel)* 2021; 9: 170.
34. Elo S and Kyngäs H. The qualitative content analysis process. *J Adv Nurs* 2008; 62: 107–115.
35. Graneheim UH, Lindgren B-M and Lundman B. Methodological challenges in qualitative content analysis: a discussion paper. *Nurse Educ Today* 2017; 56: 29–34.
36. Sparkes AC and Smith B. *Qualitative Research Methods in Sport, Exercise and Health: From Process to Product*. London: Routledge, 2014.
37. Polit DF and Beck C. *Nursing Research: Principles and Methods*. Philadelphia: Lippincott Williams & Wilkins, 2004.
38. Jeong T-S, Reilly T, Morton J, et al. Quantification of the physiological loading of one week of "pre-season" and one week of "in-season" training in professional soccer players. *J Sports Sci* 2011; 29: 1161–1166.
39. Martin-Garetxana I, Ciaurri J, Gil SM, et al. What are the load and wellness of young second-team football players when transitioning to the first team? A comparison of 2 consecutive preseasons. *Int J Sports Physiol Perform* 2023; 18: 726–733.

40. Murray A. Managing the training load in adolescent athletes. *Int J Sports Physiol Perform* 2017; 12: S2–42-S2–9.
41. Buchheit M and Dupont G. Elite clubs and national teams: sharing the same party? *Sci Med Footb* 2018; 2: 83–85.
42. Edwards D and Brannagan PM. Navigating the club-to-international transition process: an exploration of English Premier League youth footballers' experiences. *Int J Sports Sci Coach* 2023; 18: 1487–1500.
43. Goodrich KA, Sjostrom KD, Vaughan C, et al. Who are boundary spanners and how can we support them in making knowledge more actionable in sustainability fields? *Curr Opin Environ Sustain* 2020; 42: 45–51.
44. Oliva-Lozano JM, Norman D, Sherlock N, et al. Tips for transitioning to and from international soccer camps. *Sports Health* 2025; 17: 11–14.
45. Gamble P. Periodization of training for team sports athletes. *Strength Cond J* 2006; 28: 56–66.
46. Connolly DR, Stolp S, Gualtieri A, et al. How do young soccer players train? A 5-year analysis of weekly training load and its variability between age groups in an elite youth academy. *J Strength Cond Res* 2024; 38: e423–e429.
47. Kristiansen E, Murphy D and Roberts GC. Organizational stress and coping in U.S. Professional soccer. *J Appl Sport Psychol* 2012; 24: 207–223.
48. Gilbert E, Dixon J and Loughead T. An examination of travel effects on performance outcomes in Major league soccer. *J Appl Sport Manag* 2020; 12: 46–59.
49. Janse van Rensburg DC, Jansen van Rensburg A, Fowler PM, et al. Managing travel fatigue and jet lag in athletes. A review and consensus statement. *Sports Med* 2021; 51: 2029–2050.
50. Draper G, Chesterton P and Wright MD. Is travel associated with match performance in elite north American professional soccer? An exploratory study. *Int J Sports Physiol Perform* 2024; 19: 1021–1029.
51. Balk YA and Englert C. Recovery self-regulation in sport: theory, research, and practice. *Int J Sports Sci Coach* 2020; 15: 273–281.
52. Williams AM, Ford PR and Drust B. Talent identification and development in soccer since the millennium. *J Sports Sci* 2020; 38: 1199–1210.
53. Saether SA and Aspvik NP. Norwegian Junior football players – playeŕs perception of stress according to playing time. *Sport Sci Rev* 2016; 15: 85–96.
54. Swainston SC, Wilson MR and Jones MI. Player experience during the junior to senior transition in professional football: a longitudinal case study. *Front Psychol* 2020; 11: 1672.
55. McGuigan M, Dello Iacono A, McRobert A, et al. Facilitators and barriers associated with youth player transition to professional first-team football: a key stakeholder perspective. *Int J Sports Sci Coach* 2024; 19: 988–998.
56. Martín-García A, Gómez Díaz A, Bradley PS, et al. Quantification of a professional football team's external load using a microcycle structure. *J Strength Cond Res* 2018; 32: 3511–3518.
57. Dowling C, Reeves MJ, Littlewood MA, et al. Developing individuals whilst managing teams: perspectives of under 21 coaches within English Premier League football. *Soccer Soc* 2018; 19: 1135–1150.
58. Gamble P, Chia L and Allen S. The illogic of being data-driven: reasserting control and restoring balance in our relationship with data and technology in football. *Sci Med Footb* 2020; 4: 338–341.