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The Rise of Women's Football within the Athletic Performance Literature: A Team Sports-Based Bibliometric Analysis (2010-2026)

Atletik Performans Literatüründe Kadın Futbolunun Yükselişi: Takım Sporlarına Dayalı Bibliyometrik Bir Analiz (2010-2026)

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ABSTRACT

Purpose: This study examines the historical position and thematic weight of women's football performance research within the broader scientific literature on athletic performance assessment in team sports.
Methods: A corpus of 2,500 documents, retrieved from the SCI-E, SSCI, and ESCI indices of the Web of Science Core Collection on 10 July 2026, was analysed using the Bibliometrix R package and its biblioshiny interface within an integrated performance analysis and science mapping framework. The analysis covers annual production and citation trends, source and author distributions based on Bradford's and Lotka's laws, the country collaboration network, a co-word thematic map, a conceptual structure map based on multiple correspondence analysis (MCA), and a five-period (2010-2012, 2013-2015, 2016-2019, 2020-2022, 2023-2026) thematic evolution analysis. Period boundaries were set to yield approximately balanced document counts per period while aligning with major institutional milestones for women's football (the 2019 and 2023 FIFA Women's World Cups).
Results: The literature expanded at an average annual growth rate of 4.65% between 2010 and 2026 (N = 2500; mean citations per article = 28.3), with the Journal of Strength and Conditioning Research (474 articles; h = 74) forming its core. The thematic evolution analysis showed that a cluster combining football, women, and injury prevention first became distinguishable in 2016-2019 and grew into the largest and most central cluster in the literature by 2023-2026 (n = 733, or 29.3% of the corpus).
Conclusion: These findings indicate that women's football performance research should not be read as a self-contained field but as a subdomain that emerged from, and has come to dominate, the broader athletic performance assessment literature. This perspective departs methodologically from prior bibliometric studies that treated women's football as a fixed search scope, and it documents the field's maturation at a temporal resolution that earlier studies could not reach.

Keywords: *Women's football, Athletic performance, Bibliometric analysis, Science mapping.*

ÖZET

Amaç: Bu çalışma, kadın futbolunda performans araştırmalarının takım sporlarında atletik performans değerlendirmesine ilişkin daha geniş bilimsel literatür içerisindeki tarihsel konumunu ve tematik ağırlığını incelemeyi amaçlamaktadır.
Yöntem: 10 Temmuz 2026 tarihinde Web of Science Core Collection'ın SCI-E, SSCI ve ESCI indekslerinden elde edilen 2500 yayından oluşan veri kümesi, Bibliometrix R paketi ve onun web tabanlı arayüzü olan Biblioshiny kullanılarak bütünleşik performans analizi ve bilim haritalama yaklaşımı çerçevesinde analiz edilmiştir. Analiz kapsamında yıllık yayın ve atıf eğilimleri, Bradford ve Lotka yasalarına dayalı kaynak ve yazar dağılımları, ülkeler arası iş birliği ağı, anahtar kelime eş oluşumuna dayalı tematik harita, Çoklu Uyum Analizi (Multiple Correspondence Analysis, MCA) temelli kavramsal yapı haritası ile beş dönemli (2010-2012, 2013-2015, 2016-2019, 2020-2022, 2023-2026) tematik evrim analizi gerçekleştirilmiştir. Dönem sınırları hem dönemler arası doküman sayısının dengeli dağılımını hem de kadın futbolundaki kurumsal dönüm noktalarını (2019 ve 2023 FIFA Kadınlar Dünya Kupaları) yansıtacak şekilde belirlenmiştir.
Bulgular: Literatür, 2010-2026 yılları arasında yıllık ortalama %4,65 büyüme oranı göstermiştir (N = 2500; makale başına ortalama atıf = 28,3). Journal of Strength and Conditioning Research (474 makale; h-indeksi = 74) alanın çekirdek dergisi olarak belirlenmiştir. Tematik evrim analizi, futbol, kadın ve yaralanma önleme kavramlarını bir araya getiren kümenin ilk kez 2016-2019 döneminde belirginleştiğini ve 2023-2026 döneminde literatürdeki en büyük ve en merkezi tema hâline geldiğini göstermiştir (n = 733; tüm veri kümesinin %29,3'ü). Sonuç: Bulgular, kadın futbolunda performans araştırmalarının bağımsız bir araştırma alanı olarak değil daha geniş atletik performans değerlendirme literatüründen doğmuş ve zamanla bu literatür içinde baskın bir alt alan hâline gelmiş bir araştırma alanı olarak

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değerlendirilmesi gerektiğini göstermektedir. Bu yaklaşım, kadın futbolunu başlangıçtan itibaren sabit bir araştırma kapsamı olarak ele alan önceki bibliyometrik çalışmalardan metodolojik açıdan ayrılmakta ve alanın olgunlaşma sürecini önceki araştırmaların ulaşamadığı zamansal ayrıntı düzeyinde ortaya koymaktadır.

Anahtar Kelimeler: *Kadın futbolu, Atletik performans, Bibliyometrik analiz, Bilim haritalama.*

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1. INTRODUCTION

Women's football has undergone a rapid transformation over the past fifteen years in terms of participation, media visibility, and institutional investment. The year 2010 is taken as the starting point of the analysed period because it marks the onset of the institutional investment cycle in women's football, including the early expansion of FIFA and UEFA development programmes, against which the corresponding growth of the scientific literature can be meaningfully traced. This shift is not confined to on-field performance indicators; it also reflects a broader process of institutional professionalisation supported by large-scale investment programmes led by FIFA and UEFA. FIFA's Women's Football Division runs the FIFA Female Health Project, an institutional initiative aimed at closing the scientific knowledge gap around the biopsychosocial needs of female athletes, and UEFA's 2024 "Unstoppable" strategy commits €1 billion over six years to the growth of the women's game (Scott et al., 2026). Alongside this institutional shift, the demand for scientifically grounded performance assessment has grown, yet the research base has not kept pace. A recent study reported that fewer than 15% of professional football studies include female players, pointing to a marked imbalance in the scientific literature (Karakoc et al., 2026). Bibliometric analysis is particularly well-suited to investigating this imbalance because, unlike a narrative or systematic review of a pre-selected set of studies, it can quantify the relative weight and evolving centrality of a given theme within a much larger surrounding literature, which is precisely the comparison this study's research questions require.

Bibliometric analysis offers a systematic, quantitative means of describing the structure, growth patterns, and intellectual foundations of a large body of scientific literature (Donthu et al., 2021; Zupic & Čater, 2015). Following the framework proposed by Donthu et al. (2021) and Zupic and Čater (2015), bibliometric studies are typically organised into two complementary categories: performance analysis, which captures productivity and impact, and science mapping, which visualises conceptual, intellectual, and social structure. Combining these two categories makes it possible to describe not only how much a field has grown, but around which conceptual axes it has developed.

Three recent bibliometric studies have addressed women's football specifically, and each carries a particular methodological limitation, summarised below:

- Cherappurath et al. (2024) examined the women's football literature indexed in Scopus from 1984 to February 2024 and identified the field's leading contributors. However, the study treated women's football as a fixed search scope from the outset and did not examine how the relative weight of this theme within the broader performance literature changed over time.
- Ventaja-Cruz et al. (2024) mapped the growth pattern of the women's football literature using a 128-document corpus drawn from Web of Science covering 1992-2024, identifying injury prevention and physical performance as leading themes. Because this corpus was built with a narrow, women's-football-specific query, however, its structural link to the broader athletic performance assessment tradition from which it draws (agility testing, strength and power training, sensor-based measurement) remains invisible.
- Kesler (2026) examined the general, sex-agnostic structure of physical performance research in football through a PRISMA-screened corpus of 1434 documents spanning a six-year window (2020-

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March 2026). Notably, terms such as “women”, “female”, or “women’s football” do not appear as visible nodes in that study’s keyword network or thematic map, suggesting that a six-year cross-sectional window may be structurally ill-suited to capturing a subtheme that has been rising over a longer period.

What these three studies share is that each either treats women’s football as a fixed, self-contained search scope or methodologically isolates it from the wider performance literature in which it is embedded. None of the three explicitly articulates or quantifies the historical process by which women’s football moved from a peripheral to a central position within the broader team-sport performance literature; this is the specific gap the present study addresses. Although the time windows of these studies overlap partially with the present one, the present study is distinguished not by its temporal coverage alone but by treating women’s football as a theme whose position within a larger literature is measured and tracked over time, rather than as a fixed search scope defined from the outset. Yet performance research on women’s football, particularly work on agility, change-of-direction speed, and physical/technical testing, is methodologically a direct extension of the broader team-sport performance assessment literature. To bridge this gap, the present study maps the athletic performance assessment literature in team sports as a whole across 2010-2026, and it traces the historical position and changing weight of the women’s football theme within that literature using a multi-period thematic evolution analysis.

In line with this overall aim, the study addresses the following research questions:

RQ1. How did the annual production and citation trends of the team-sport athletic performance assessment literature evolve between 2010 and 2026?

RQ2. Which sources (journals), authors, institutions, and countries have shaped the intellectual structure of this literature?

RQ3. What are the main conceptual/thematic clusters that structure this literature, and how is women’s football positioned within that structure?

RQ4. How has the relative centrality and weight of women’s football-related themes changed across the five sub-periods spanning 2010-2026? RQ1 and RQ2 provide the descriptive, performance-analytic foundation (productivity and impact) on which the study is built, while RQ3 and RQ4, which address the thematic structure and its evolution, carry the study’s primary original contribution. The original contribution of this study is to reposition women’s football, for the first time in this literature, as a theme whose relative weight within a much broader athletic performance assessment literature is explicitly measured and tracked across five sub-periods, rather than treated as a fixed, self-contained search scope from the outset. In line with this framing, the analysis is expected to show that women’s football-related themes occupied a peripheral position in the earliest periods and moved toward the centre of the literature in the most recent period.

2. METHOD

2.1. Selection of the Data Source

Bibliographic data were drawn from the Web of Science (WoS) Core Collection. This choice is grounded in one key consideration: WoS journal indexing criteria (editorial review, consistency of citation tracking) are generally considered more selective than those of Scopus, which improves the comparability of bibliometric indicators such as the h-index and citation counts (Mongeon & Paul-Hus, 2016; Baas et al., 2020). The possibility that this choice excluded some Scopus-specific sources is addressed separately in the Limitations section. To verify the conceptual validity of the broad search strategy, a manual screening of a randomly selected subset of retrieved records was conducted. This verification confirmed that the vast majority of documents were directly related to athletic performance assessment in team sports, supporting the suitability

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of the search strategy for identifying the broader scientific context within which women's football research has evolved.

2.2. Search Strategy and Field Selection

The query used was:

TS=("female soccer" OR "women's soccer" OR "physical performance") OR TI=("technical performance" OR "female football" OR "women's football" OR "agility")

The topic field (TS, which spans title, abstract, author keywords, and Keywords Plus) and the title field (TI) were combined to capture both studies that refer directly to women's football (TS terms) and studies that carry a core performance-assessment concept in their title without necessarily mentioning football or sex (TI terms, particularly "agility"). Including "agility" in the TI field has a specific rationale: the agility and change-of-direction tests that form the methodological backbone of performance assessment in women's football are frequently published as general test-development studies whose titles make no reference to "women" or "football". Omitting this term would have excluded the methodological roots on which women's football performance research is built.

Combining the two term groups with OR logic gives the query broad-net sensitivity: a document is included if it satisfies at least one of the four term groups. This choice carries a known methodological cost, discussed here openly. As is well established in information retrieval research, sensitivity (the proportion of relevant documents captured) and specificity (the proportion of retrieved documents that are relevant) trade off against one another: broad OR-based queries raise sensitivity at the expense of specificity, while narrow AND-based queries do the reverse. The OR strategy was adopted deliberately here because the research questions, RQ3 and RQ4 in particular, require visibility into the full performance-assessment literature within which women's football is embedded. A narrow, women's-football-specific corpus would have structurally excluded that broader context and obscured the study's central finding, namely the shift of this theme from periphery to centre. The implications of this trade-off for interpreting the results are discussed further in the Limitations section.

The reproducibility of the search strategy is supported by four elements: (i) the query syntax is reported in full above, (ii) the database and indices (WoS Core Collection; SCI-E, SSCI, ESCI) are explicitly stated, (iii) the search date (10 July 2026) is recorded, and (iv) no additional language or document-type filter was applied. Together, these elements allow other researchers to rerun the same query under the same conditions and verify the results.

2.3. Data Selection Process

The search covered 2010-2026 with no additional language or document-type restriction. The query returned 2500 records directly. No systematic post-retrieval filtering or manual exclusion stage was applied to this corpus; this is a deliberate consequence of the broad, OR-based query strategy described in the Search Strategy and Field Selection section, and its implications are addressed in the Limitations section. Because all of these records (2,439 articles, 56 early-access articles, 5 proceedings papers) already fell within academic, peer-reviewed document types by virtue of WoS's own indexing structure, no records were excluded at a separate screening stage. This process is summarised transparently in Figure 1 using a PRISMA-style flow diagram. It should be noted that the data selection process used here differs structurally from the multi-stage filtering applied by Kesler (2026), who narrowed 5,262 records to 1,434. This structural difference reflects a deliberate trade-off between sensitivity and specificity: the broader, OR-based query used here accepts a lower topical precision in exchange for visibility into the full performance-assessment literature within which women's football is embedded, whereas Kesler's (2026) narrower, AND-based, PRISMA-screened design accepts some loss of contextual breadth in exchange for higher topical precision. The present study instead used a broad query to arrive directly at its final corpus, without applying further exclusion criteria. The rationale for this

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choice is discussed in the Search Strategy and Field Selection section, and its implications are evaluated in the Limitations section.

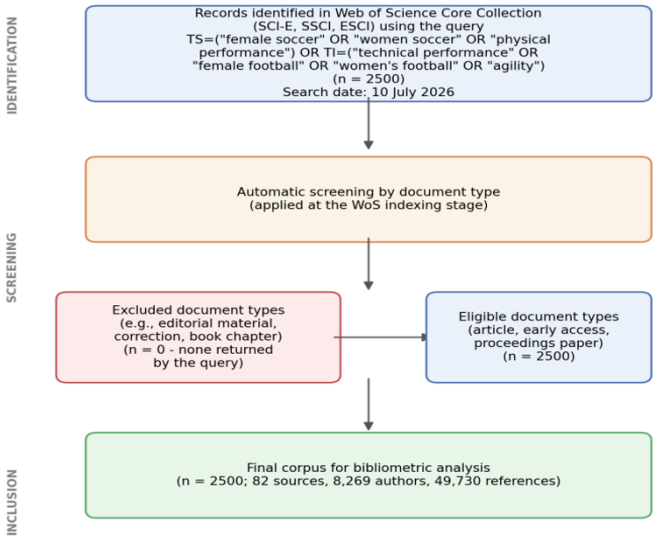


Figure 1. *PRISMA-style flow diagram of the data selection process.*

2.4. Bibliometric Analysis Procedure

Analyses were carried out using R (version 4.6.1) and the Bibliometrix R package with its web-based interface, biblioshiny (version 5.0; Aria & Cuccurullo, 2017), developed at the University of Naples Federico II, Italy. This toolset was chosen because it combines performance analysis and science mapping techniques within a single, reproducible workflow and can process WoS export data directly. The term "bibliometrics" was first defined by Pritchard (1969) as the application of mathematical and statistical methods to books and other media of communication. Science mapping analyses were conducted using Author Keywords (DE field). For the thematic map, the maximum number of terms was set to 250, with a minimum keyword frequency of 12. Keyword clustering was performed using the Louvain community detection algorithm without stemming (stemming = FALSE), considering single-word terms (n-grams = 1). The thematic map was generated based on Callon's centrality and density measures, displaying the 30 most representative labels. The conceptual structure analysis was performed using Multiple Correspondence Analysis (MCA), with four clusters (k = 4) and a minimum degree threshold of 27. For thematic evolution, the maximum number of terms was set to 250 and the minimum keyword frequency to 5, using identical keyword processing settings to ensure methodological consistency across analyses. The two-category framework proposed by Donthu et al. (2021) and Zupic and Čater (2015) was followed, with each technique selected to answer a specific research question, as summarised below:

For RQ1: annual scientific production and citation trend analysis (performance analysis).

For RQ2: source distribution based on Bradford's law (Bradford, 1934), author productivity distribution based on Lotka's law (Lotka, 1926), institution- and country-level contribution analysis, and the country collaboration network (performance analysis and social structure mapping).

For RQ3: a co-word analysis of author keywords (DE field) with Louvain clustering, producing a thematic map, complemented by a conceptual structure map based on multiple correspondence analysis (MCA) (conceptual structure mapping).

For RQ4: a thematic evolution analysis across five sub-periods (2010-2012, 2013-2015, 2016-2019, 2020-2022, 2023-2026), visualised as a Sankey flow diagram (dynamic science mapping).

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These four categories complement one another: performance analysis shows how much of the literature was produced and by whom, static science mapping (the thematic map and the conceptual structure map) shows the conceptual structure at a given point, and dynamic science mapping (thematic evolution) shows how that structure changed over time. The periodisation was chosen deliberately, using two explicit criteria: (i) achieving a roughly balanced number of documents across the five periods, and (ii) aligning period boundaries with major institutional milestones for women's football, namely the 2019 and 2023 FIFA Women's World Cups, so that each tournament falls at or near a period boundary rather than in the middle of a period.

3. RESULTS

Annual Scientific Production and Citation Trends (RQ1)

Annual output rose steadily from 73 articles in 2010 to 252 in 2025 (Table 1, Figure 2), corresponding to a compound annual growth rate of 4.65%. The 2026 figure (n = 151) covers only the first half of the year as of the search date (10 July 2026) and should be read as partial.

Table 1. Annual scientific production by year (N = 2500). *2026 figures are partial as of 10 July 2026.

Year	Number of Articles
2010	73
2011	86
2012	80
2013	119
2014	116
2015	139
2016	150
2017	168
2018	160
2019	161
2020	166
2021	166
2022	183
2023	154
2024	176
2025	252
2026*	151

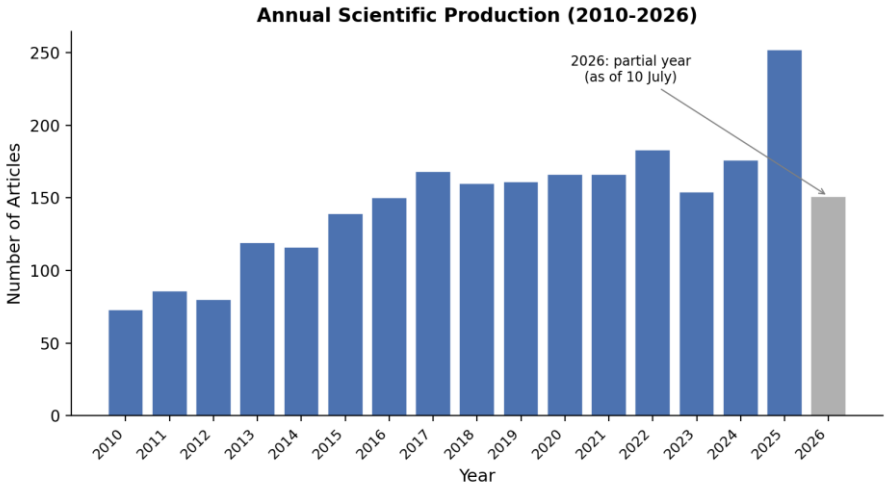


Figure 2. *Annual scientific production.*

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Rather than a single linear growth curve, this pattern shows a relative plateau between 2020 and 2024 followed by a marked jump in 2025. The timing of that jump coincides with the typical 12-18 month lag before studies published after the 2023 FIFA Women's World Cup appear in the WoS index, suggesting that the acceleration reflects a delayed scientific response to the visibility gained by major women's football events. The apparent decline in mean citations per article toward recent years (7.02 for 2024) reflects an expected citation-window effect rather than a loss of interest.

Source Analysis and Bradford's Law (RQ2)

Under Bradford's law (Bradford, 1934), four journals (Journal of Strength and Conditioning Research, Journal of Sports Sciences, Journal of Sports Medicine and Physical Fitness, and International Journal of Sports Physiology and Performance) form the core zone (Zone 1) of the corpus, accounting for 36.5% of all publications (913/2500).

Table 2. Ten most productive journals and their h-indices.

Journal	Articles	h-index
Journal of Strength and Conditioning Research	474	74
Journal of Sports Sciences	159	50
Journal of Sports Medicine and Physical Fitness	145	24
Int. Journal of Sports Physiology and Performance	135	38
Journal of Human Kinetics	117	28
Scandinavian J. of Medicine & Science in Sports	92	36
BMC Sports Science Medicine and Rehabilitation	89	—
Biology of Sport	75	24
Journal of Sports Science and Medicine	70	29
Journal of Science and Medicine in Sport	67	29

More than a third of all output is concentrated in just four journals, which suggests that the field's disciplinary identity has largely consolidated around sport science and strength-and-conditioning outlets. At the same time, this concentration means that the dissemination of women's-football-specific findings remains dependent on the editorial priorities of a small set of core journals, pointing to potential for the field to expand toward adjacent disciplines such as sports medicine and sports sociology.

Author Productivity and Lotka's Law (RQ2)

The most productive authors are Lockie R.G. and Nakamura F.Y. (34 articles each), followed by Loturco I. (33) and Hägglund M. (32). Lockie's output stems largely from validity and reliability work on multidirectional speed and change-of-direction tests (e.g., Lockie et al., 2014). In terms of impact, Loturco I. and Nakamura F.Y. lead with an h-index of 20, followed by Krustrup P. and Lockie R.G. at 19. Under Lotka's law (Lotka, 1926), 77.1% of authors (6,377/8,269) contributed only a single article to the corpus.

The estimated Lotka exponent for this corpus ($\beta = 2.64$, $C = 0.5912$) was higher than the classical value of 2, and a Kolmogorov-Smirnov goodness-of-fit test indicated a statistically significant deviation from the classical Lotka distribution ($p = 0.046$). The fitted distribution, however, provided a good match to the observed data

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(R^2 = 0.93; K-S test on the fitted model, p = 0.57), indicating that author productivity in this corpus is even more concentrated among low-output authors than the classical Lotka pattern would predict, and that the field is broadly participatory but has not yet consolidated disciplinarily. This pattern is notable in suggesting that advanced specialisation specific to women's football remains concentrated in a limited number of research groups.

Institutional and Country-Level Contribution (RQ2)

At the country level, the United States (419 articles, 16.8%; 12,300 citations), Spain (274; 11.0%), the United Kingdom (247; 9.9%), and Australia (199; 8.0%) are the four most productive countries. Norway (51.9 citations/article) and Australia (36.8) show the highest mean citation impact. International co-authorship (MCP%) is highest for Brazil (50.8%), Italy (51.3%), and Portugal (52.4%), whereas only 14.6% of United States output involves international co-authorship. At the institutional level, the University of Granada (81 articles), Linköping University (71), and the University of Copenhagen (70) are the most productive.

Table 3. Ten most productive countries, article share, and total citations.

Country	Articles	Article %	Total Citations
USA	419	16.76	12,300
Spain	274	10.96	7,880
United Kingdom	247	9.88	8,223
Australia	199	7.96	7,323
Brazil	118	4.72	2,345
China	106	4.24	—
Germany	89	3.56	2,272
Italy	78	3.12	2,779
Türkiye	71	2.84	—
Portugal	63	2.52	1,725

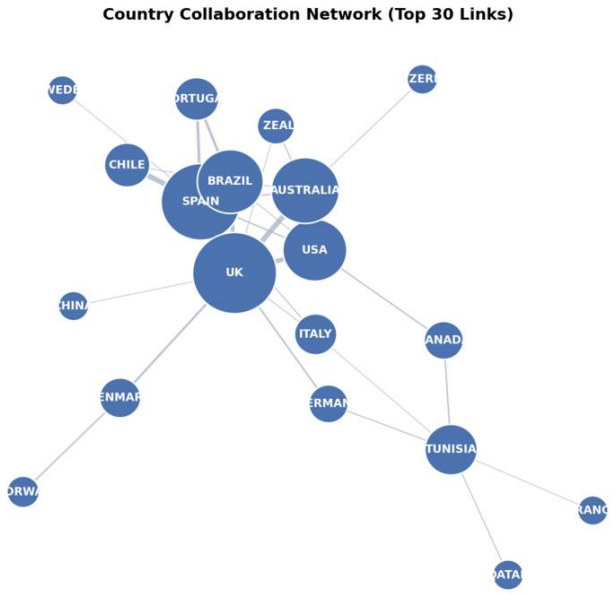


Figure 3. *Country collaboration network. Node size reflects weighted degree; edge thickness reflects co-authorship frequency between two countries (top 30 links).*

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The network structure shows that the United States, despite leading in output volume, sits toward the periphery of the collaboration network, whereas Spain, the United Kingdom, Portugal, and Brazil form its dense core. This split suggests that high national output and international integration do not necessarily coincide within the same country, and that European and Latin American collaborations play a more decisive role in the international diffusion of women's football research.

Most Cited Documents (RQ2)

The most cited documents include Koga et al. (2010, 700 citations) on anterior cruciate ligament (ACL) injury mechanisms in women's handball and basketball, the return-to-sport consensus statement by Ardern et al. (2016, 687 citations), normative fitness data for young people by Tomkinson et al. (2018, 387 citations), and an injury-prevention adherence study by Steffen et al. (2013, 306 citations).

Table 4. Ten most globally cited documents.

Author, Year, Journal	Total Citations	Citations/Year
Koga H., 2010, Am J Sport Med	700	41.2
Ardern C.L., 2016, Brit J Sport Med	687	62.5
Galna B., 2014, Gait Posture	410	31.5
Tomkinson G.R., 2018, Brit J Sport Med	387	43.0
Ortega F.B., 2011, Brit J Sport Med	323	20.2
Steffen K., 2013, Brit J Sport Med	306	21.9
Spiteri T., 2014, J Strength Cond Res	273	21.0
Ben Abdelkrim N., 2010, J Strength Cond Res	271	15.9
Okada T., 2011, J Strength Cond Res	266	16.6
Nimphius S., 2016, J Strength Cond Res	264	24.0

That most of these documents are not specific to women's football, belonging instead to the general athletic performance and injury epidemiology literature,f ollows directly from the broad search strategy described in the Search Strategy and Field Selection section. These documents represent the methodological and clinical foundation on which women's football performance research has been built.

Science Mapping: Thematic and Conceptual Structure (RQ3)

The co-word analysis of author keywords identified four main thematic clusters: (1) an "agility" cluster (agility, speed, strength, plyometrics, change of direction), (2) a "soccer" cluster (soccer [304], football [208], women [99], female [72], women's football [43], injury prevention, fatigue), (3) an "athletic performance" cluster (general exercise, muscle strength, resistance training), and (4) a "performance" cluster (team sport, youth, training, sex). Under Callon density-centrality analysis, the "performance" cluster shows the highest internal coherence (density = 6.39), while the "soccer" cluster combines high density (6.29) with relatively high centrality (0.358), positioning it as a well-developed, core theme of the literature (Figure 4).

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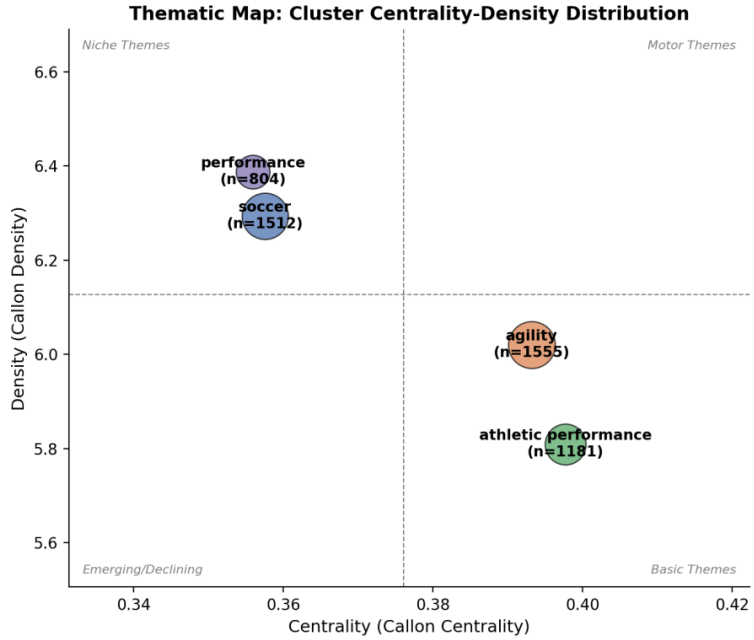


Figure 4. *Thematic map: position of the four main clusters on the Callon centrality-density plane (bubble size reflects cluster frequency).*

As a complement to the thematic map, multiple correspondence analysis (MCA) was applied to the author keywords to construct a conceptual structure map (Figure 5). This map shows how closely terms co-occur in a two-dimensional space, and it places "agility", "speed", "strength", and "power" together in one region while "soccer", "football", "women", and "athletes" cluster in a separate region. This separation independently confirms the four-cluster structure of the thematic map using a different technique (MCA rather than co-word analysis); the convergence of the two methods strengthens confidence that the thematic structure reflects the literature's actual conceptual organisation rather than an artefact of a single method.

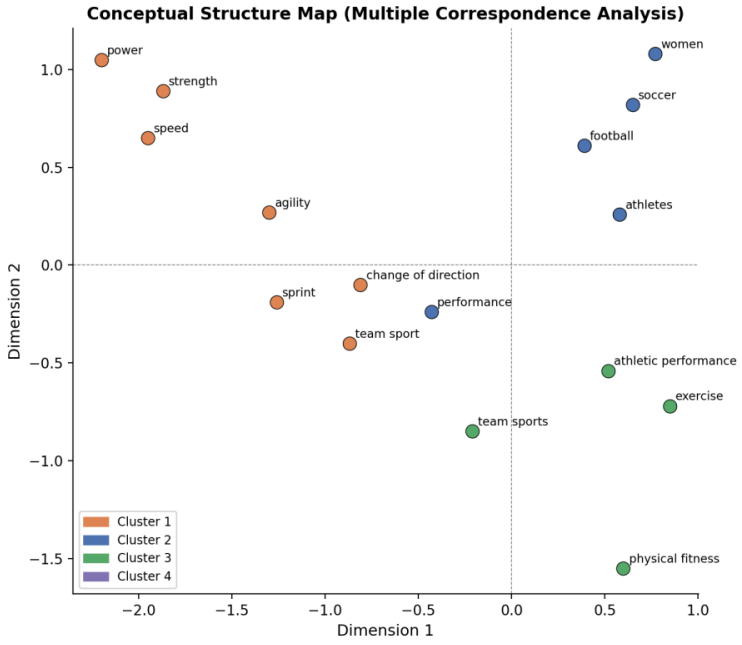


Figure 5. *Conceptual structure map (multiple correspondence analysis).*

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Thematic Evolution Analysis (RQ4)

The five-period thematic evolution analysis shows how the position of the women's football theme within the literature changed over time (Table 5, Figure 6). In 2010-2012 (n = 239), "women's football" had not yet emerged as a distinct cluster label. By 2016-2019 (n = 639), the terms "women's football" and "female football" became visible for the first time, embedded within the "fatigue" and "anthropometry" clusters. By 2023-2026 (n = 733, or 29.3% of the corpus, the largest sub-period), the single largest and most central cluster is now directly labelled by the terms football, female, women, injury prevention, women's football, and injury.

Table 5. Summary of the five-period thematic evolution analysis (2010-2026).

Period	Documents	Dominant Clusters (Keywords)
2010-2012	239	agility, soccer/football/ACL/adolescent, performance
2013-2015	374	agility, soccer, football (female, children, epidemiology)
2016-2019	639	agility, soccer, football, injury prevention, fatigue (women's football emerges), anthropometry (female football)
2020-2022	515	agility, soccer (women, female, rehabilitation), athletic performance, physical performance
2023-2026	733	football-female-women-injury prevention-women's football (largest cluster), agility/performance, athletic performance, female athletes

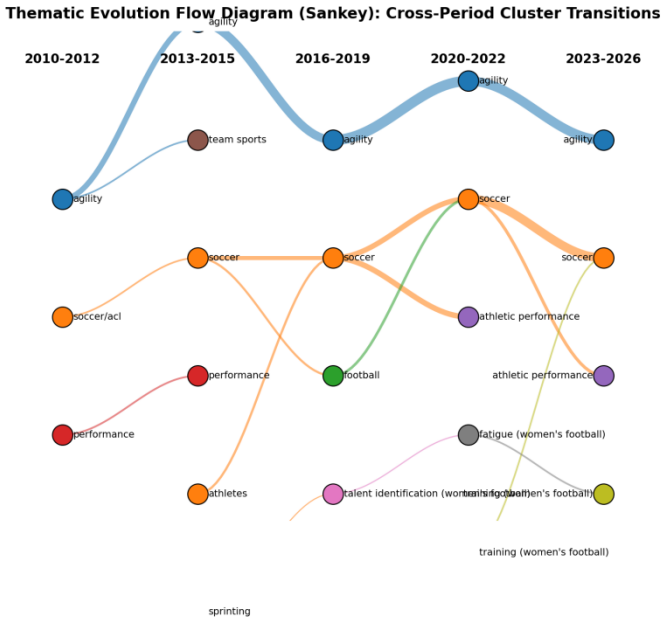


Figure 6. *Thematic evolution flow diagram (Sankey): cross-period cluster transitions and flow intensities (line thickness reflects transition weight, Occ).*

The Sankey diagram shows that the "agility" and "soccer" clusters form the thickest flows between periods, that is, the highest-weight transitions, functioning as the core themes that give the literature its continuity. Women's-football-specific subthemes, by contrast, appear at first as thin, irregular, peripheral flows; after 2020, these flows both thicken and connect directly to the central clusters (soccer, athletic performance). This pattern indicates that the women's football theme did not grow incidentally within the literature but underwent

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a systematic consolidation from periphery to centre, a temporal dynamic that a single cross-sectional window, such as that used by Kesler (2026), could not reveal.

Collaboration Network and Overall Assessment

The mean number of co-authors per document is 5.23, and 38.6% of articles involve international co-authorship. The rate of single-authored articles is low (n = 56; 2.2%), consistent with a field driven by large, multi-centre research teams. Taken together, the four analytical techniques used here (thematic map, conceptual structure map, thematic evolution, Sankey flow diagram) converge on a single pattern: women's football began as a peripheral subset of the team-sport performance literature and has, in the most recent period, become its most central and fastest-growing theme.

4. DISCUSSION

This study set out to map the team-sport athletic performance assessment literature as a whole across 2010-2026 and to trace the changing position of the women's football theme within it. The findings show steady growth in the team-sport athletic performance assessment literature between 2010 and 2026, with the women's football/female athlete theme moving to the centre of that literature in the most recent period. This pattern can be read as a reflection, in scientific output, of the visibility and professionalisation that women's football has gained through the 2019 and 2023 FIFA World Cups. Scott et al. (2026) report that the 2023 World Cup was the first women's tournament to break even financially, with 32 teams and $570 million in revenue, and that FIFA's digital platforms recorded more than three billion content views around the event; a shift of this scale in institutional and commercial terms would be expected to reshape the scientific research agenda as well. That the women's football theme became the literature's most central cluster precisely in the period following this tournament (2023-2026) supports this reading.

That the dominant cluster of the most recent period (2023-2026) pairs the terms "injury prevention" and "injury" with "women's football" suggests that the field's focus has broadened from performance measurement alone toward understanding the sex-specific determinants of injury risk in female athletes. This broadening is consistent with FIFA's institutional Female Health Project; Scott et al. (2026) describe this project as a collaboration between FIFA's Women's Football Division and its Medical Department aimed at addressing the distinct biopsychosocial needs of female footballers, raising awareness, and supporting research. This finding is also consistent with Ventaja-Cruz et al. (2024), who identified injury prevention and physical performance as leading themes in their women's-football-specific corpus; the present study complements that consistency by situating it within the broader performance assessment literature from which women's football research draws.

The field's technological shift also deserves attention here. The integration of GPS and wearable sensor technology into performance monitoring in women's football has accelerated in recent years. Karakoc et al. (2026), for instance, used wearable GPS sensors to track players of the Turkish Women's National Team across UEFA Nations League matches, examining how score status and playing position affected the most demanding passages of play, and explicitly noted that female players remain represented in less than 15% of professional football research. The growing number of such high-resolution, sensor-based monitoring studies indicates that the "agility", "physical performance", and "fatigue" clusters at the centre of the thematic map are increasingly being populated by data specific to women's football. Indeed, the thematic evolution analysis shows the "training" and "fatigue" clusters co-occurring with "women's football" and "GPS" in the two most recent periods, a bibliometric trace of this technological shift.

That the most productive and most cited authors (Loturco, Nakamura, Lockie, Hägglund, Krustrup) work primarily on strength and power training, sprint and agility testing, and football injury epidemiology points to a strong methodological backbone underlying the field. The change-of-direction and agility test-development literature at the core of the corpus traces a continuous methodological lineage, from the earliest football-

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specific validity and reliability studies (Sporis et al., 2010; Veale et al., 2010; Young et al., 2011) to the contemporary change-of-direction deficit approach (Nimphius et al., 2016). This lineage is increasingly being tested in female athletes and in women's football specifically: fluid balance and passing skill in female soccer players (Ali et al., 2011), eccentric training in young female handball players (Chaabene et al., 2020), lower-body power in female basketball players (Banda et al., 2019), and change-of-direction performance in elite female athletes across different team sports (Freitas et al., 2022; Loturco et al., 2022) are concrete examples of this expansion. From an applied standpoint, this methodological backbone provides a strong scientific basis and validation ground for developing sensor-based test systems that measure agility, reactive agility, and change-of-direction speed.

The findings also stand in methodological contrast to Cherappurath et al. (2024) and Ventaja-Cruz et al. (2024), both of which treated women's football as a fixed search scope from the outset and reported the absolute size of the literature over time. This study instead shows how the relative centrality of the women2s football theme, its share within the broader literature, changed over time, demonstrating not merely that the topic grew but that it became the dominant agenda of the wider performance assessment literature surrounding it.

Comparing these findings with Kesler (2026) is informative both where the two studies converge and where they diverge. On author productivity, there is notable overlap: eight of Kesler's (2026) ten most productive authors, Loturco I., Ramirez-Campillo R., Granacher U., Nakamura F.Y., Bishop C., Chaabene H., Krustrup P., and Pereira L.A., also appear among the most productive and influential authors identified here. This convergence, arrived at through two independent search strategies and different time windows, suggests that both corpora reliably capture the field's core research group. The country collaboration pattern, by contrast, diverges: in Kesler's (2026) 2020-2026 corpus focused directly on football performance, Spain, the United Kingdom, and Portugal sit at the centre of the collaboration network while Turkey occupies a peripheral position; in the broader 2010-2026 corpus used here, the United States leads in volume but shows a comparatively low rate of international co-authorship (14.6%), while Portugal retains a strong collaborative position in both studies. This comparison suggests that the two studies are complementary rather than competing: Kesler's (2026) AND-based query, narrowed through PRISMA-style screening by document type and language, describes the current, post-2020 core of football performance research with high precision, whereas the OR-based, broader query and sixteen-year temporal depth used here are better suited to tracing a subtheme, such as women's football, as it rises over time.

Scientific Contribution

The most original aspect of this study is that it positions women's football not as an independent, self-contained object of study but as a subtheme that emerged historically from, and has become the centre of gravity of, the team-sport athletic performance assessment literature. This approach departs from prior bibliometric work in three respects. First, in scope: whereas Cherappurath et al. (2024) and Ventaja-Cruz et al. (2024) take women's football as their starting point, this study treats it as a destination, a thematic concentration reached by a broader literature. Second, in temporal resolution: unlike Kesler's (2026) six-year cross-sectional window, the sixteen-year, five-period design used here makes it possible to observe directly how the women's football theme moved from periphery to centre. Third, in methodological range: the joint use of the thematic map, the MCA-based conceptual structure map, and the Sankey flow diagram shows that the findings are not an artefact of a single technique but a pattern confirmed by several independent methods.

The practical value of this positioning lies less in showing why women's football research has grown than in showing which scientific tradition, agility test development, strength-and-conditioning research, injury epidemiology, it has grown out of. This information can help future researchers identify which methodological base to build on and help sports technology developers identify which measurement approaches are best positioned for adaptation to women's football. Beyond this methodological positioning, the present findings also carry a more direct research-encouragement value: by showing that the "football-female-women-injury

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prevention" cluster is now the literature's largest and most central theme, this study provides a concrete, quantitative rationale for expanding experimental and longitudinal research that directly monitors athletic performance and injury risk in female football players, rather than continuing to extrapolate from methodological work conducted primarily on male athletes.

Practical Implications

The findings carry concrete implications for several stakeholder groups.

For researchers: that the fastest-growing cluster in the most recent period sits at the intersection of "injury prevention" and "women's football" indicates that sex-specific injury risk factors in female footballers (e.g., ACL injury mechanisms, the effects of the menstrual cycle on performance and injury risk) remain a comparatively underexplored area for systematic reviews and primary research.

For performance analysts and coaches: the change-of-direction deficit approach developed by the field's core author group (Loturco, Nakamura, Lockie, and others), and its validated applications in female footballers, can be drawn on directly when designing field-based test batteries.

For sports technology developers: the increasingly frequent co-occurrence of "training", "fatigue", and "GPS" with women's football in the thematic evolution analysis, exemplified by recent work such as Karakoc et al. (2026), points to growing market demand and a growing need for validation of wearable sensors and agility test systems adapted to the anthropometric and physiological characteristics of female athletes.

For federations and clubs: the mismatch between the most productive countries (United States, Spain, United Kingdom) and the most collaborative ones (Portugal, Brazil, Italy) suggests that building research output and building international knowledge exchange call for distinct strategies; national federations would likely benefit from pursuing both local research capacity and deeper participation in international collaboration networks.

Limitations

Several limitations of this study warrant analytical consideration, together with their likely effects on interpretation.

- Database coverage: data were drawn exclusively from the Web of Science Core Collection. The exclusion of Scopus may have left out studies from journals with stronger regional or linguistic diversity that are more heavily represented in Scopus (Mongeon & Paul-Hus, 2016), and this may have modestly skewed the country- and institution-level productivity rankings toward Anglophone and Western European institutions, which tend to be well represented in WoS.
- The broad, OR-based search strategy: this was a deliberate methodological choice (see the Search Strategy and Field Selection section) that increases sensitivity at the cost of specificity. Its direct consequence is that a substantial share of the corpus consists of general performance/agility literature not specific to women's football; the study should accordingly be read as a broad, contextual mapping of the literature within which women's football is embedded, rather than a narrow, women's-football-specific bibliometric description. The AND-based query design and PRISMA-style narrowing used by Kesler (2026) offer a complementary alternative for studies seeking higher topical precision.
- Partial 2026 data: the 2026 figures (n = 151) cover only the first half of the year as of the search date (10 July 2026) and do not reflect full-year output; this has been flagged separately wherever it affects growth-rate calculations and figures.
- The time sensitivity of citation-based indicators: citation counts are inherently sensitive to publication age, so the lower citation counts of recent publications should be read as an unmatured citation window rather than as evidence of lower impact.

Building on the broad mapping presented here, future research would benefit from a multi-database systematic

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bibliometric study that combines Web of Science and Scopus with an AND-based query restricted specifically to women's football, which would further sharpen the field's intellectual structure.

5. CONCLUSION AND RECOMMENDATIONS

Conclusion

This study has mapped the team-sport athletic performance assessment literature as a whole across 2010-2026 and documented, through four complementary science mapping techniques, the transformation of the women's football theme within that literature. The findings indicate that women's football performance research can no longer be treated as either an independent or a marginal field. It should instead be read as a maturing research programme that emerged from the general athletic performance testing literature, has developed its own methodological identity, and has, in the most recent period, become the dominant agenda of that broader literature.

The value of this finding lies in reframing the growth of women's football research, not simply as a quantitative increase, but as a qualitative process of maturation situated within a wider scientific tradition. Whatever pace the on-field professionalisation of women's football takes, understanding the intellectual roots that feed its scientific counterpart will remain decisive both for setting research priorities and for directing limited research resources effectively. In this respect, the present study offers more than a map of the field's past: it provides a concrete reference framework for where a sustainable research agenda in women's football performance science should draw its strength.

Recommendations

Building directly on the findings above, three concrete directions are recommended for future research and practice. First, a multi-database systematic bibliometric study combining Web of Science and Scopus, restricted to a women's-football-specific AND-based query, would complement the present broad mapping with higher topical precision. Second, given the growing centrality of the "injury prevention" and "women's football" cluster identified here, targeted experimental and longitudinal studies on sex-specific injury risk factors (including menstrual-cycle-related effects on performance and injury risk) are recommended. Third, the increasing co-occurrence of "training", "fatigue", and "GPS" with women's football in the most recent periods points to a concrete need for validation studies of wearable sensor and agility-testing systems specifically calibrated to female athletes.

DECLARATIONS

Ethics Committee Approval: This study is exempt from ethics committee approval because it is a bibliometric analysis.

Conflict of Interest: There is no personal and/or financial conflict of interest related to this study.

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* The number(s) corresponding to the relevant explanation in the contribution section have been written.			
1. Designing the study 2. Collecting the data 3. Analysis and interpretation of the data 4. Writing the article 5. Critical revision			

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