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## Article

# Exploring of Knowledge Structure and Research Trend in Soccer Psychology Research: Using LDA Topic Modeling

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**Abstract:** This study aims to identify the knowledge structure and research trends of soccer psychology research during the last 33 years (1990–2022). Data were obtained from 1,863 papers from the Web of Science database. The data were collected through keyword text mining and data preprocessing to determine the keywords needed for analysis. Based on the keywords, latent Dirichlet allocation-based topic modeling analysis was performed to analyze the topic distribution of papers and explore research trends by topic area. The topic modeling process included four topic area and fifty topics. The “Coaching Essentials in Football” topic area had the highest frequency, but it was not statistically identified as a trend. However, coaching, including training, is expected to continue to be an important research topic, as it is a key requirement for success in the highly competitive elite football world. Interest in the research field of “Psychological Skills for Performance Development” has waned in recent years. This may be due to the predominance of other subject areas rather than a lack of interest. Various high-tech interventions and problem-solving attempts are being made in this field, providing opportunities for qualitative and quantitative expansion. “Motivation, cognition, and emotion” is a largely underrated subject area in soccer psychology. This could be because survey-based psychological evaluation attempts have decreased as the importance of rapid field application has been emphasized in recent soccer-related studies. However, measuring psychological factors contributes to the study of football psychology through a new methodology and theoretical background. Recognizing the important role of psychological factors in player performance and mental management, as well as presenting new research directions and approaches that can be directly applied to the field, will advance soccer psychology research.

**Keywords:** soccer; psychology; research trends; data science; topic modeling; bibliometric

## 1. Introduction

It is common knowledge that soccer is the most popular participation and spectator sport in the world today (Kotrba, 2019). This means that there are many players, teams, and fierce competition. As with any sport, soccer teams strive to win in the face of fierce competition, and soccer is widely studied by researchers owing to its popularity. Many professional soccer clubs have emphasized the importance of sports psychology in improving their performance (Negra et al., 2022; Hammami et al., 2018).

In recent years, the role of psychology in various subfields related to soccer has become very important (Villalonga et al., 2015). Many efforts have been made to apply psychology to soccer, including administrative efforts such as the creation of the “Psychology for Soccer” strategy introduced by the English Football Association in 2011 (Dean et al., 2022). These attempts have served as valuable milestones in understanding how psychological exploration can impact players’ performance and lives (Hirose and Meijen, 2022). Research has also repeatedly shown that a healthy body and mind can influence players’ lives after their playing careers (Lavallee, 2005). These findings are relevant not only to professional soccer clubs but also to a wide range of soccer workers, including youth players and referees (Holt et al., 2012; Duncan et al., 2022). As such, much of the research has

been integrated into educational programs for coaches, players, and support staff to teach them psychological concepts and, most importantly, connect them with practicing football and sports science psychologists.

The above-mentioned reviews have all made valuable contributions to the current understanding of the research conducted in the field of sport and exercise psychology; therefore, there must be a large quantitative and qualitative accumulation of psychological research that has been continuously explored for the development of soccer over the years. (Klarin, 2019) reported that a macro view must be taken from a position of reflection and introspection for a discipline's long-standing tradition to become more rooted and more forward-looking.

There are ways to explore the intellectual structure of research through, for example, literature review, content analysis, and meta-analysis, but a framework that integrates large disciplines such as psychology constitutes natural language processing (Scaccia, 2021). The development of computing power, represented by the effective collection, storage, processing, and real-time sharing of data due to the advent of the information age, has made such a framework possible (Hirschberg and Manning, 2015).

In particular, the emergence of the concepts of artificial intelligence and big data has made it possible to derive new insights from vast and unstructured data through high-level analysis (Robaldo et al., 2019). Natural language processing is one of the methods that can realize these expectations, and it is being used in various academic fields. In this study, we used the natural language processing techniques of text mining and topic modeling. Topic modeling is a technique that analyzes a dataset of documents and discovers latent topics through the derived unstructured text to explore key issues and controversies in a particular field (Ma et al., 2022; Vayansky and Kumar, 2020).

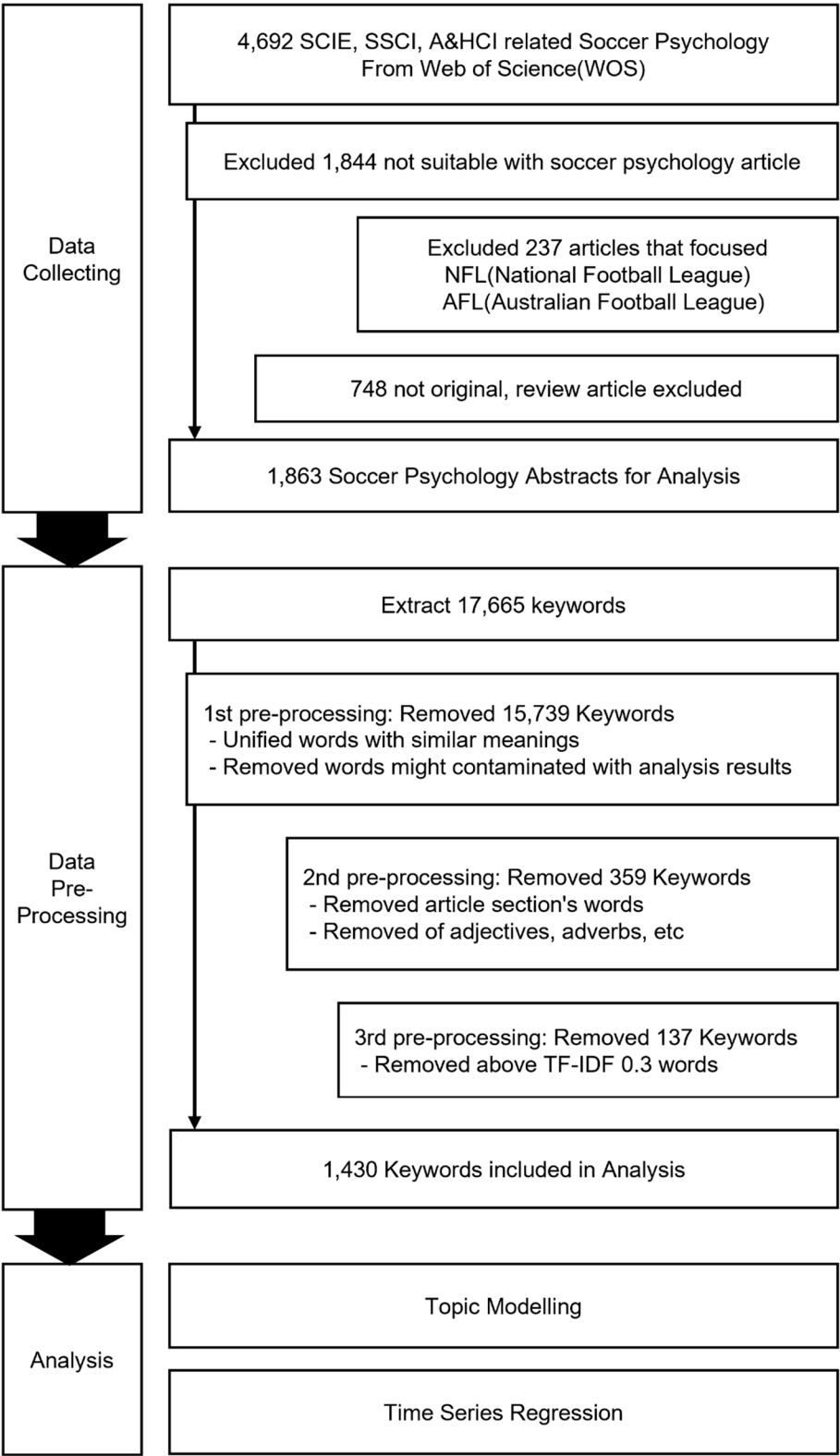
Compared to other literature review methodologies, topic modeling is advantageous owing to its ability to explore the published literature in a field in depth. (Bruner et al., 2010) reported that the keyword-driven segmentation of topic areas can reveal the major theories, methodologies, and themes that shape the sport and exercise psychology literature and how these various aspects relate to each other. By building on this body of work, we could further solidify the findings of the literature and uncover meaningful insights into new areas of research.

In this study, we aimed to extend topic modeling to soccer psychology to uncover meaningful insights for new fields by investigating two aspects of the field of soccer psychology. First, we examined sports psychology research topics addressed in papers published between 1990 and 2022 to identify research trends, focusing on research topics and the keywords that comprise them. Second, we examined macro-level trends in soccer psychology research by aligning the identified micro-topics with soccer psychology theories. We also determined directions for future soccer psychology research by overviewing how published macro-topics have been activated and deactivated over time.

## **2. Materials and Methods**

### *2.1. Data Collection*

We collected soccer psychology studies by searching the Web of Science (WOS) database. Relevant soccer psychology articles were collected from the Science Citation Index, Science Citation Index Expanded, and Social Sciences Citation Index. The keywords used in the searches included "soccer" and "football." Next, from the list of all retrieved soccer-related articles, only articles in the field of psychology were extracted through the WOS's filtering function. From the collected data, we excluded articles that were irrelevant to our research topic. In addition, we excluded "football" articles that focused on the National Football League and the Australian Football League. Next, we excluded studies that focused on rugby, American national football and Australian football. Furthermore, non-peer-reviewed articles (e.g., news articles, letters to the editor, research reports, conference proceedings, and books) were excluded from collected data. The research flow and procedures for this study are shown in Figure 1.



**Figure 1.** Research flow.

2.2. Data Preprocessing

Natural language processing involves synthesizing a set of processes that intuitively derive meaning from unstructured words in a textual document consisting of sentences (Corcoran et al., 2020). The first process is to extract most of the words from the papers as nouns. From the 1,863

articles collected in this study, 17,665 words were extracted that were initially determined by the natural language processing process to represent the research concepts of soccer psychology.

Most natural language processing analysis methods, including topic modeling, are preceded by data preprocessing techniques to identify only the words that will be used in the analysis. Data preprocessing involves a series of refinement processes, such as deleting words from a large set of documents that may contaminate the analysis results and unifying words with similar meanings (Zhao et al., 2016). The data analyzed in this study were obtained from a knowledge document of soccer psychology, and words (except for keywords that imply the meaning of the subject area of each paper) were analyzed. For example, from the words that were initially identified, we deleted words that describe the methodological unit of the paper, such as “purpose,” “research,” “method,” “result,” “discussion,” and “conclusion,” and adverbs and adjectives that are not keywords related to the actual research topic, such as “tomorrow,” “meanwhile,” “recently,” “always,” and “although”. In addition, words that have the same meaning but are recognized as separate keywords due to slight differences, including differences in expression, were combined, which may have affected the analysis results.

Meanwhile, among the representative keywords that describe the research topic area, a potential problem is that the representativeness of the area is excessively high and only the keyword influences the overall result. In this study, keywords such as “soccer” and “football” appeared as keywords in all papers at the time of the initial search. Thus, even if they do not appear in individual clusters of the topic model to be analyzed, they are sufficiently recognizable as basic topic areas. As an indicator to determine the presence of such words, TF-IDF (Term Frequency-Inverse Document Frequency) is a formula that calculates the number of words that appear universally in all documents and words that appear frequently in specific documents (i.e., keywords that are representative of the topic area) (Tighe et al., 2020). TF-IDF indexes above 0.3 are generally deleted (Kamyab et al., 2021). After conducting these preprocessing steps, we refined the final 1430 words and utilized them for the analysis.

### 2.3. Topic Modeling

Various types of algorithms can be used for topic modeling, depending on the calculation method used, including individual analysis techniques. In this study, we used the latent Dirichlet allocation (LDA) technique. LDA is generally adopted when the topic areas across documents have a strong tendency to be reduced to a single contact point; it is also used to derive topic modeling results for knowledge technology documents that contain specific domain knowledge such as papers, news, and patents (Jelodar et al., 2019; Tian et al., 2022). The parameter values of alpha, beta index, and the number of topics must be arbitrarily specified in the topic modeling analysis settings to derive analysis results through topic modeling. However, both alpha and beta range from 0.01 to 0.99, and in some cases, they can be divided into thousands of digits (Vorontsov et al., 2015). Furthermore, determining the number of cases, calculating the number of topics, and finding the optimal topic organization can be very difficult. These difficulties can be overcome by utilizing the coherence coefficient to find the optimal number of topics and keywords within topics (O'Callaghan et al., 2015).

The coherence coefficient is a virtual proxy for the number of cases with the alpha, beta, and number of topics settings described above, and it adopts the number of cases with coherence values close to 1. In this study, the number of cases for alpha and beta values was set to 0.01~0.99 to consider the optimal number of topics and parameters for topic modeling results. The number of topics varied from seven to twenty, considering the total number of papers, and the consistency index was calculated for the number of all cases. As a result, the consistency index was very high (0.921) when the number of topics was fifty (alpha: 0.01, beta: 0.1). Therefore, by comparing the topic composition according to the number of topics, we derived core topics that show a high density of keyword composition in any setting and variable topics that indicate changes depending on the setting and suggested the meaning and implications of the subject area implied by each topic. Figure 2 shows a probabilistic graphical model of LDA.



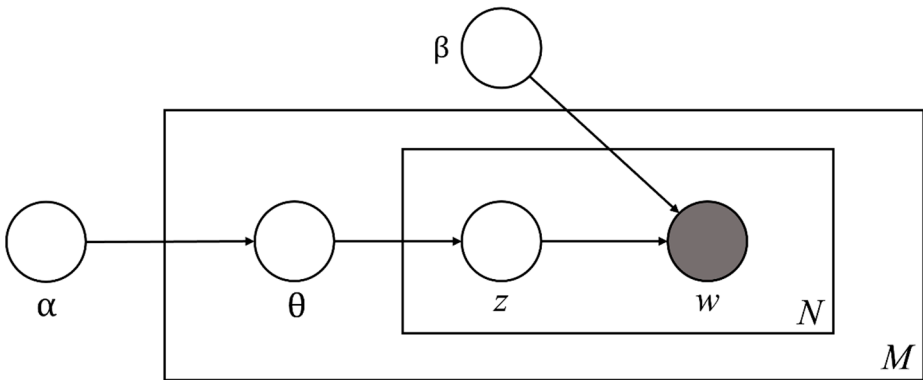


Figure 2. Topic modeling design.

2.4. Change in Topics by Period

The temporal evolution of soccer psychology research topics was investigated through a comprehensive analysis of article frequency conducted across 32 years (1990–2022) marking the genesis of soccer psychology research. Topics were segregated based on discernible patterns of growth or decline over the specified time. A linear regression model was applied utilizing SPSS 23.0 (IBM Corp, Armonk, New York), with the timeline serving as the independent variable and the frequency and proportion of each topic acting as the dependent variables.

The results were subsequently interpreted using a systematic, two-step approach. First, after linear regression analysis, if the Durbin-Watson statistic was within the range of 1.5 to 2.5, it was considered a suitable regression model, and the regression coefficient and significance were checked (Seo et al., 2021; Durbin and Watson, 1971). Topics were categorized as hot if the coefficient was positive (+) and statistically significant, warm if the coefficient was positive (+) but lacked statistical significance, cold if the standardized regression coefficient was negative (-) with statistical significance, or cool if the coefficient was negative (-) but not statistically significant.

3. Results

3.1. Topic Modeling

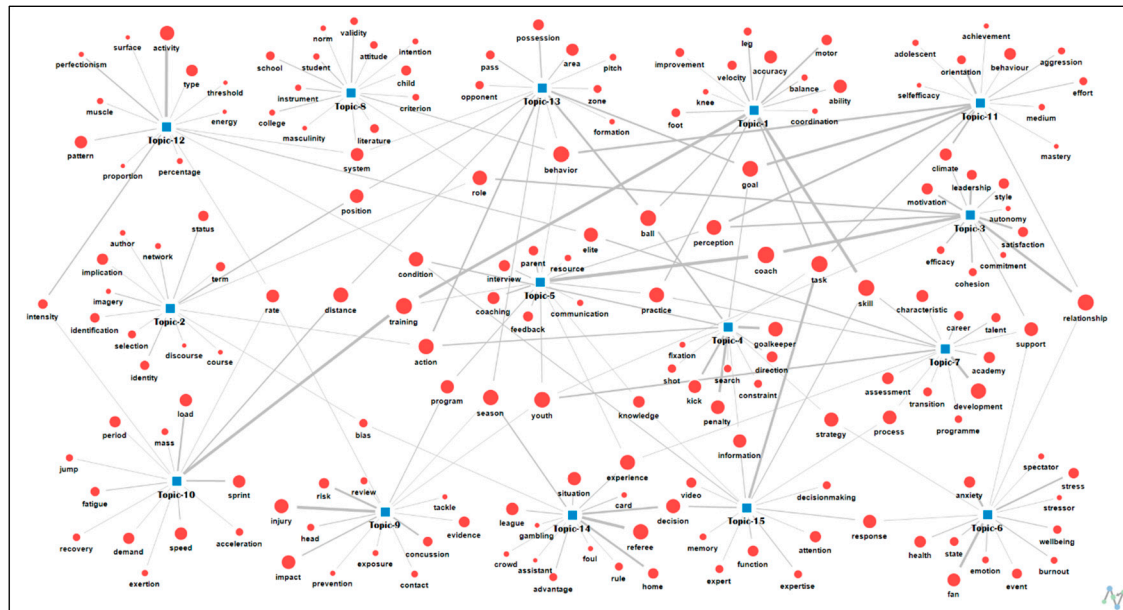
The topic modeling results are shown in Table 1. The clustered interest of Topic 1 appears to be related to soccer motor skill training, specifically focusing on leg work; accuracy and speed with the ball; and motor tasks related to foot ability, balance, knee improvement, and coordination. Topic 2 was clustered and was related to soccer training and performance, particularly regarding physical characteristics and requirements. Topic 3 was clustered and demonstrated the importance of coaching and leadership by measuring and analyzing the strong relationships that effective coaching and leadership create, the establishment of clear roles and responsibilities, the creation of a supportive atmosphere, satisfaction, motivation, efficacy, cohesion, support, style, atmosphere, commitment, youth, and autonomy.

Table 1. Results of topic modeling in soccer psychology.

Topic 1	Topic-2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7
skill	position	coach	goalkeeper	coach	anxiety	development
training	identity	relationship	penalty	coaching	stress	youth
motor	status	leadership	kick	parent	health	elite
task	network	satisfaction	ball	feedback	state	skill
leg	imagery	motivation	condition	perception	burnout	academy
practice	term	perception	action	practice	wellbeing	talent
ball	selection	role	goal	youth	emotion	career
accuracy	identification	efficacy	direction	program	support	practice
velocity	role	cohesion	shot	interview	response	transition

foot	bias	support	task	training	relationship	assessment
ability	action	style	search	experience	stressor	process
balance	author	relation	information	behavior	mood	program
knee	course	commitment	strategy	communication	strategy	experience
improvement	implication	coaching	constraint	knowledge	depression	support
coordination	discourse	autonomy	fixation	resource	behavior	characteristic
Topic 8	Topic 9	Topic 10	Topic 11	Topic 12	Topic 13	Topic 14
validity	injury	training	goal	activity	ball	task
student	risk	load	behavior	intensity	goal	decision
behavior	concussion	sprint	orientation	perfectionism	action	expertise
instrument	impact	distance	perception	elite	possession	information
college	head	fatigue	climate	pattern	season	skill
school	program	speed	task	surface	position	function
child	youth	rate	relationship	type	distance	condition
criterion	prevention	acceleration	aggression	energy	pass	response
role	exposure	jump	effort	muscle	area	process
norm	review	period	mastery	percentage	zone	Decision making
masculinity	season	mass	Self-efficacy	threshold	pitch	expert
attitude	tackle	demand	behavior	condition	behavior	memory
intention	rate	exertion	medium	proportion	system	attention
system	evidence	intensity	adolescent	rate	opponent	video
literature	contact	recovery	achievement	system	formation	knowledge

Topic 4 focused on the role of goalkeepers in soccer, including their behavior and strategies when faced with penalty kicks and shots on goal. Topic 5 was clustered around the coaching process (encompassing feedback, practice, training, and communication, among other aspects) and considered the crucial role of coaches in developing youth programs and their support towards parents. Topic 6 was clustered with keywords related to psychological aspects of sports, such as anxiety, stress, burnout, and emotions, as well as strategies and support for coping with stressors and events. Topic 7 was clustered into keywords related to youth athlete development in elite sports academies, including talent and career assessment processes, transition, and support. Topic 8 was clustered with keywords related to the validity and reliability of measures and instruments used to assess soccer student-athlete behavior, including standards, norms, and attitudes. Topic 9 was clustered with keywords related to injuries in soccer—specifically regarding the risk of concussions and head impacts—and brain injury prevention and exposure review for adult, youth, and elite soccer players during the season. Topic 10 was clustered into keywords related to training load and physical demands, including fatigue, speed, acceleration, intensity, and recovery, which affect soccer players’ physical performance, including their sprinting, long-distance running, and jumping performance. Topic 11 was clustered with keywords related to soccer players’ goal orientations and behaviors, including perception and mastery, aggression, self-efficacy, and achievement in youth development. Topic 12 was clustered with keywords related to the pattern and intensity of physical activity, including perfectionism, energy, muscle, and threshold states in the soccer elite sport system. Topic 13 was considered to explore the different tactical formations used by soccer teams and how they affect gameplay. Topic 14 was clustered with keywords related to decision-making processes involving expert knowledge, information, and video analysis of technical functions, conditions, and reactions in soccer matches. A visualization of the keyword network for each topic is shown in Figure 3.



### 3.2. Trend Analysis by Topic Area

First, the “Motivation, Cognition, and Emotion” section focuses on soccer players’ motivation and psychological factors such as mood, grit, and mental strength. The topic modeling resulted in the inclusion of Topics 6 and 11, which are related to this topic area.

We assessed the change in trends over time for each clustered topic area. The change in frequency of each topic area from 1990, when soccer psychology research was first identified, to 2022 is shown in Figure 4. All four topic areas experienced similar increases and decreases from the 1990s to the early 2000s. However, since the mid-2000s, the topic areas of “Coaching Essentials in Football” and “Developing the young player in Football” have experienced a steep increase in frequency. The frequencies of the topic areas of “Psychological Skills for Performance Development” and “Motivation, Cognition, and Emotion” have also increased but with a more modest linear trend.

The trend changes based on the frequency of each topic area shown in Figure 4 were evaluated by linear regression (Table 2). The Durbin-Watson values were 0.263(Developing the young player in Football), 0.272(Coaching Essentials in Football), 0.784(Psychological Skills for Performance Development), and 0.759(Motivation, Cognition, and Emotion), respectively, and were not classified. The trend change was not statistically validated, even though both the frequency and the change in



the chart showed an upward linear trend. Therefore, the change in the share of each year of the topic area was explored, and the trend change was statistically validated (Table 3).

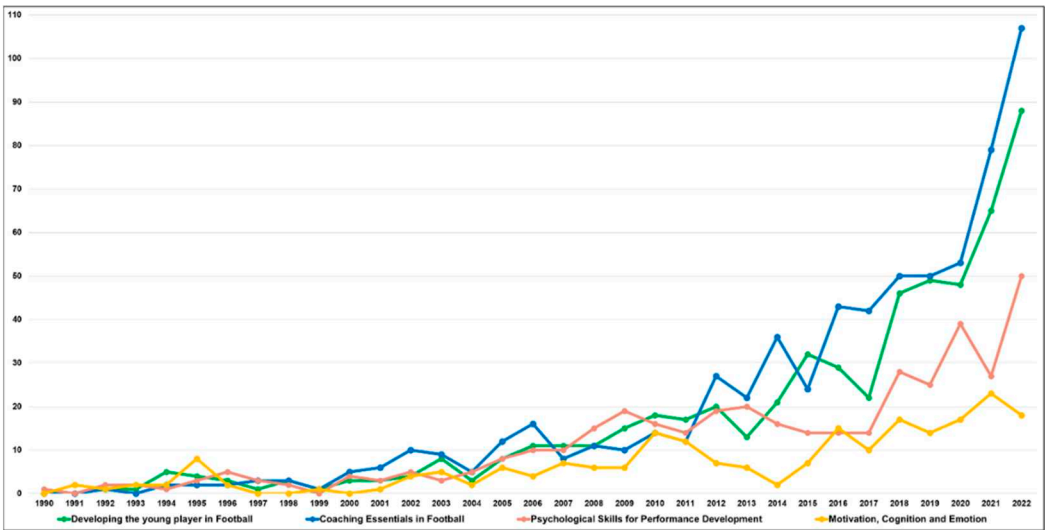


Figure 4. Frequency change for each subject area in football psychology.

Table 2. Trend classification using regression analysis of frequency change by topic area.

Topic Area	Topic No.	Durbin-Watson	Coefficient	t-Value	p-Value	Hot/Cold
Developing the young player in Football	Topic 5	0.263	0.834	8.431	0.001	-
	Topic 7					
	Topic 8					
	Topic 9					
Coaching Essentials in Football	Topic 1	0.272	0.836	8.498	0.001	-
	Topic 2					
	Topic 3					
	Topic 10					
Psychological Skills for Performance Development	Topic 13	0.784	0.865	9.616	0.001	-
	Topic 4					
	Topic 12					
Motivation, Cognition, and Emotion	Topic 14	0.759	0.816	7.850	0.001	-
	Topic 6					
	Topic 11					

Figure 5 shows the change in the share of each topic area by year. The topic area “Developing the young player in Football” had a share of 20–30% except in 1997 (14.2%) and 2015 (41.5%). The topic area of “Coaching Essentials in Football” was characterized by a minimal representation of 0–20% prior to 1996 and experienced a substantial surge after 1996. Notably, in 10 years, this topic area had a share of 40% or more, and its contribution peaked between 2010 and 2020. However, we observed a large variation in its share over time.

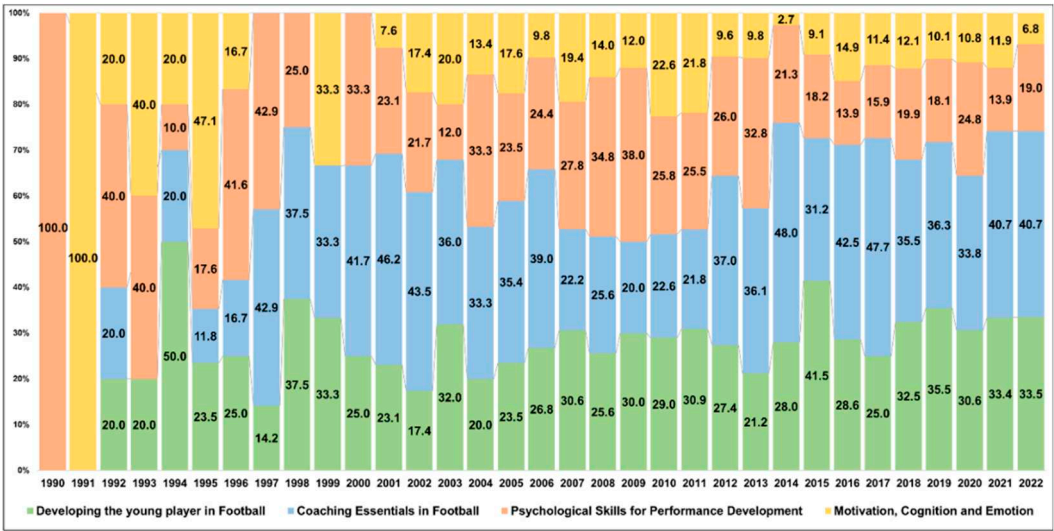


Figure 5. Changes in occupancy rate (%) of football psychology by subject area.

Table 3. Trend classification using regression analysis of occupancy rate change by topic area.

Topic Area	Topic No.	Durbin-Watson	Coefficient	t-Value	p-Value	Hot/Cold
Developing the young player in Football	Topic 5	1.554	0.470	2.961	0.006	Hot
	Topic 7					
	Topic 8					
	Topic 9					
	Topic 1					
Coaching Essentials in Football	Topic 2	0.908	0.585	4.019	0.001	
	Topic 3					
	Topic 10					
	Topic 13					
Psychological Skills for Performance Development	Topic 4	1.981	-0.325	-1.912	0.065	Cool
	Topic 12					
	Topic 14					
Motivation, Cognition, and Emotion	Topic 6	2.443	-0.384	-2.31	0.027	Cold
	Topic 11					

Table 3 shows the results of the trend analysis of the occupancy rate of each topic area using linear regression. The topic area “Developing the young player in Football” had a Durbin-Watson value of 1.554, which is close to 2, meaning the trend could be validated through the regression coefficient. The regression coefficient was .470 (p=.006), which is a significant positive coefficient, indicating that this was a hot topic. The topic area “Essentials of Soccer Coaching” had a Durbin-Watson value of 0.908, which is not in the range of 1.5 to 2.5. Therefore, the trend was not statistically significant. The topic area “Psychological Skills for Performance Development” had a Durbin-Watson value of 1.981, which is close to 2, meaning the trend could be validated through the regression coefficient. The regression coefficient was -0.384, which is not statistically significant; thus, this topic area was categorized as cool. Finally, the topic area “Motivation, Cognition, and Emotion” had a Durbin-Watson value of 2.443, which is close to 2, meaning that the trend could be validated through the regression coefficient. The regression coefficient was -.384 (p>.027), which indicates a significant positive coefficient; therefore, this topic was classified as cold.

#### 4. Discussion

“Developing the young player in Football” is an area of research focusing on the importance of understanding the player development process in identifying and nurturing soccer talent. This topic area was organized into Topics 5, 7, 8, and 9.

Feedback in soccer, covered in Topic 5, has been a particularly important aspect of coaching. Research in this area has explored how feedback from parents and coaches can influence youth development (Kwon et al., 2020; Kim and Connaughton, 2021). In addition, the most effective ways to provide feedback to young players have been investigated (Hoigaard et al., 2017; Yiannaki et al., 2018). In some ways, these findings have contributed to the development of new technologies that facilitate feedback and communication between coaches and parents at all levels of the game from elite youth.

Approaches related to Topic 7 include how youth athletes could develop the skills and traits needed to succeed at the elite level, an exploration of effective strategies for identifying and nurturing talent in young athletes (Yiannaki et al., 2018), and how coaches and programs can balance individual skill development with team success and cohesion (Agusti et al., 2020; Hendry et al., 2018). The role of talent identification and selection has been investigated, and various training and support structures have been proposed, which have helped build a more advanced player development system.

Topic 8 was considered to gain an in-depth understanding of the role masculinity norms play within a soccer setting. It also explores the constructs of masculinity, attitudes, intentions, and behaviors within soccer-educational settings, presumably at the college or school level (Adams, 2011; Kennedy et al., 2021). Furthermore, this topic aims to unravel how these norms might be manipulated by the prevalent school system and the post pandemic sports culture (Vanraalte et al., 1992; Jin, 2022). This topic was investigated through a critical lens to understand the socio-cultural aspects of soccer and its effects on individual players' behaviors.

Topic 9 deeply investigates the pressing issue of injury risk, specifically focusing on concussions within the context of youth soccer. This topic offers a detailed literature review regarding the prevalence of head injuries associated with soccer and interventions for their prevention, including descriptions of the effectiveness of such strategies. Research approaches related to this topic include the common types of brain-related injuries in soccer, including concussions, and how they can be prevented or managed (Colantonio, 2020; Abbas et al., 2015); methods that coaches and organizations can employ to mitigate the risk of concussion and head injury in youth soccer (Morgan et al., 2018; Terry et al., 2019); and evidence-based strategies that can be used to reduce the incidence of brain and head-related injuries in soccer players (Yao et al., 2020; Rusciano et al., 2017). This topic highlights the urgent requirement for scientifically substantiated approaches for the effective management and minimization of concussion risks in youth soccer (Al Attar et al., 2018). Research related to this topic has contributed to improvements in youth training and conditioning programs that can help prevent various injuries, including concussions.

The first publication in this topic area within the study period of 1990–2022 was published in 1992. Research on this topic has increased in frequency, albeit with variations from year to year, with a steep rise after 2017. The trend classification for the increase in frequency was not statistically significant. However, the regression model against occupancy rate statistically confirmed that this is an active area of research in soccer psychology.

The process of effectively identifying and developing players with the potential for future success is becoming increasingly important (Murr et al., 2018). In other words, it is very difficult to provide the necessary conditions for players to fulfill their potential. Psychological approaches are among the various ways to solve this problem (Vaeyens et al., 2008). The importance of such research focusing on youth and adolescents was also demonstrated in a study on women and all genders that reported higher levels of adolescent and youth soccer players aged 6–18 than adult soccer players (Kirkendall and Krstrup, 2022). The field of soccer player development includes proactive strides across multiple research disciplines, and soccer psychology has actively contributed to this multidisciplinary effort.

“Coaching Essentials in Football” refers to research on coaching, which is an essential component of elite sports, including soccer. Research in this area explores the relationship between coaches and players and the effectiveness of different coaching styles and support structures. This topic area was organized into Topics 1, 2, 3, 10 and 13.

Topic 1 addresses the importance of skill training for the motor tasks that soccer players need to perform. Relevant research has identified the most effective training methods and strategies for improving accuracy, speed, footwork, balance, and coordination (Zhongfan et al., 2002; Egan et al., 2007; Ren et al., 2022). Advances in soccer performance have been made possible by research investigating the impact of individualized training programs on player performance and the development of new technologies and tools to assess and improve training outcomes.

The Topic 2 keyword clusters show that studies have explored star player's status or role affects their identity and perception of their place in society (Zuccheromaglio, 2005; Adams et al., 2010) and how language and discourse can influence the formation and reinforcement of identity and bias (Adams et al., 2010; Cocking and Drury, 2014). Understanding how the individual and organizational conditions of a team, such as position, identity, and network dynamics, affect team performance was important for coaches and team managers (Fielding-Lloyd and Meân, 2008; Foroughi et al., 2018). Number of related studies have contributed to the impact of social dynamics on team performance and how they can be applied to strengthen team cohesion.

Topic 3 research on this topic has examined how coaches can build effective relationships with athletes and how this can affect their motivation and performance (Myers et al., 2006; Li et al., 2020). Furthermore, studies on this topic have explored the common leadership styles in coaching and how they can affect team cohesion and success (Høigaard et al., 2008; Keattholetswe and Maletse, 2019). Reasonable coaching created a positive and intellectual atmosphere that fosters commitment and autonomy in soccer players (Marholz et al., 2016; Pulido et al., 2018). Research in this area could also investigate the relationship between coaches and players and the effectiveness of different coaching styles and supported structures. Thus, research on the potential of technology-based coaching tools and interventions has contributed to the understanding and practice of effective soccer coaching.

Topic 10 includes research examining how soccer coaches and players can effectively manage training load to optimize performance and reduce the risk of injury or burnout, the physiological and psychological factors that contribute to fatigue during training or competition and how this fatigue can be mitigated (Haddad et al., 2013; Coutinho et al., 2018), and how players and coaches can balance training and competition demands with the need for rest and recovery (Redkva et al., 2017; Swallow et al., 2021). Research in this area has explored the physiological and psychological factors that influence performance and strategies for managing workload and recovery. In addition, the impact of individualized training programs on athlete performance and fatigue management and the development of new technologies to aid in performance monitoring and recovery have been explored. This research provides a strategy for efficient performance training and recovery for soccer players from intense schedules.

Topic 13 includes studies exploring how ball possession and distance affect the likelihood of scoring (Shafizadeh et al., 2014; Nunes et al., 2021); how different formations and positioning affect player behavior, team chemistry, and performance during a match; and the key factors that determine successful passes in soccer and how they vary across different areas and zones of the field (Clemente et al., 2013; Fernandes et al., 2021). This topic area represents ball possession, position, passing, actions, opponents, and formation, all of which are important aspects of soccer strategy and tactics. By studying these factors, coaches and players can develop game plans that maximize their chances of winning (Varela-Quintana et al., 2016). Coaches can assist teams understand how to control the ball, create scoring opportunities, and defend against opponents through this research in this topic. This topic contributed how different formations affect the game and has supported teams adjust their strategies and improve their overall performance.

The first publication in this topic area within the study period of 1990–2022 was published in 1992. This topic area has increased in frequency, albeit with variations from year to year, with a steep rise after 2017. No statistical significance was detected in the trend classification for the increase in

frequency, nor was any significant statistical trend classification performed in the regression model for share. Therefore, further exploration and measurement are needed to identify trends in this topic area. However, this topic has the highest frequency and a generally high share, and it is important in many studies.

Coaches' efforts to improve their coaching abilities are fundamental to all sports and should be taken seriously (Gomez et al., 2021). Coaching and performance and coaching and psychology were high on the list of research areas in the bibliometric analysis of soccer research (Cefis, 2022; Kirkendall and Krustrup, 2022). In addition, many studies have emphasized the importance of training systems, motor learning, and physical performance in soccer coaching. In particular, the recent surge in soccer training research has been predicted to have been driven by a relative increase in research in training environments due to the COVID-19 pandemic, which has limited evaluations related to on-field performance (Partington and Cushion, 2013; Jones et al., 2023). Although it is difficult to confirm statistical significance due to the irregularly changing nature of the soccer coaching research field due to these internal and external factors, this study confirms that it is the broadest research field.

The topic area "Psychological Skills for Performance Development" addressed psychological approaches to soccer performance development, including the intervention of coaching but focusing on psychological skills. This topic area was organized into Topics 4, 12 and 14.

Goalkeepers play an important role in soccer, and they were mentioned more often in Topic 4. Research in this topic has explored factors that contribute to success in penalty kicks and other situations, as well as goalkeeper decision-making and strategy. Specifically, this research has translated into topics exploring the strategies goalkeepers use to effectively defend against penalty kicks (McMorris and Colenso, 1996; Comas et al., 2018), how goalkeepers can improve their ability to predict the direction and force of shots (Pereira and Patching, 2021; Lopes et al., 2014) and the physical and mental conditions required for optimal goalkeeping performance and strategy of developing and maintained (Ford et al., 2007; Navia et al., 2019). This topic contributed impact of physical and mental conditioning on goalkeeper performance and the development of new technologies to aid goalkeeper decision-making, which positively impacts the ongoing evolution of goalkeeping performance.

Topic 12 is a cluster including psychological skills approaches that have been attempted to effectively harness perfectionism, which has advantages and disadvantages. Appropriate perfectionism can help coaches and athletes develop effective training and conditioning programs (Terryshort et al., 1995). However, excessive perfectionism can lead to negative psychological effects and injury (Hill et al., 2018). Several research areas have addressed these issues, including the optimization of perfectionist tendencies through psychological skills training and the development and validation of psychological and physical training programs that consider energy metabolism, thresholds, and muscle loading for effective intensity setting (Donachie and Hill, 2022; Vieira et al., 2013). In other words, understanding the relationship between physical activity and soccer performance with psychological skills has contributed to developing strategies for soccer practitioners to optimize player performance.

Topic 14 explores the key factors that influence player decision-making when carrying out the complex tasks presented in a soccer game; how soccer players' expertise and competence develop over time; the roles of factors such as memory, attention, and knowledge in this process (Zoudji and Thon, 2003; Reigal et al., 2019), and the most effective strategies for improving decision-making in tight game situations (Fontana et al., 2009; Horrocks et al., 2016). Furthermore, research has explored ways to improve soccer players' decision-making and skill development using new technologies such as virtual reality and cognitive training programs (Vu et al., 2022; Musculus et al., 2021). In other words, research on this topic assisted strategies for improving decision-making processes, optimizing skill development, and enhancing overall performance.

The frequency measures and the significance test of the regression model confirm that the number of studies on this topic published each year has not decreased. However, the share of this topic area has decreased somewhat over time due to the increase in the overall research area of soccer psychology. This phenomenon is related to the relative activation of other research areas rather than decreased interest in this topic area.



Nevertheless, techniques for achieving the right psychological state are important to the optimal performance of soccer players (Gilson, 2015). In addition, this research area has shown that the correct decision-making of players and all other units that make up a soccer game improves the quality of the game. In the future, the psychological state of soccer players can be effectively enhanced through high technology, such as virtual reality, which could increase the diversity of this research area.

The topic area "Motivation, Cognition, and Emotion" was organized into topics that examined and evaluated psychological traits that occur in different situations experienced by soccer players. This topic area was organized into Topics 6 and 11.

Topic 6 aims to understand professional soccer players' experiences with burnout, with a focus on potential causes, such as overtraining, personal stressors, or the pressures of professional sports. Moreover, matches were determined and investigations were conducted to observe how stress and anxiety levels might affect players' performance (Vanypere, 1995; Mehrsafari et al., 2021). Research on this topic has also shown how relationships with coaches, teammates, and others influence players' stress levels and mental health (Kroshus and DeFreese, 2017; Moll and Davies, 2021). By promoting a holistic understanding of soccer players' mental health, this topic could improve how players are coached, how clubs are managed, and how the soccer area considers mental health (Hertting et al., 2022; Fessi et al., 2016). This knowledge could guide the development of interventions and strategies to support soccer players' mental health and prevent issues such as burnout, depression, and severe anxiety. Research on this topic contributed strategy of mental and emotional control for soccer players.

Topic 11 was examined to determine how players' goal orientation (e.g., mastery goals versus performance goals) influences their performance on the field. This topic explores perceptions of self-efficacy among soccer players and its impact on performance (Cetinkalp and Turksoy, 2011; Zourbanos et al., 2016). This topic also explores how the team atmosphere affects players' aggression and effort (Zourbanos et al., 2016; Tractlet et al., 2008). For instance, understanding how a player's self-efficacy (i.e., their belief in their own ability) affects their performance could inspire coaching techniques designed to build self-efficacy (Barker et al., 2010; Zourbanos et al., 2016). This topic contributed to providing a reference for effective and actionable strategies for goal orientation.

This topic area contributes to a nuanced understanding of what drives soccer players and how these motivations impact their performance and behaviors. This topic area was introduced in 1990, when the first soccer psychology study was published. Its frequency has increased from year to year but only slightly compared to other topic areas. Furthermore, the statistical significance of the decrease was verified using a regression model. Several studies were found in this topic area in which data were collected and evaluated using questionnaires.

Research in most elite sports, including soccer, is increasingly focused on direct applications on the field. Such field-oriented research inevitably has a high proportion of interdisciplinary approaches such as psycho-physiological, psycho-performance, and psycho-physical approaches. Therefore, relatively few studies explore psychological factors alone. Nevertheless, measuring psychological factors contributes to the idea of new research approaches and their application to the field. In the future, recognizing the important role of psychological factors in player performance and mental management, and suggesting new research directions and approaches that can be directly applied to the field, can advance soccer psychology research.

## 5. Conclusions

This study aimed to identify the knowledge structure of and research trends in soccer research from 1990–2022. Data were collected from 1,863 articles obtained from the WOS database. The articles' topic distribution was analyzed using LDA-based topic modeling analysis, and research trends were explored by topic area. Topic modeling resulted in 14 topics. The topic area "Essential Coaching in Soccer" was the most frequent, but not statistically trending. However, coaching, including training, is expected to continue to be an important research topic as it is a key requirement for success in the highly competitive world of elite soccer. Interest in the research area of "psychological skills for performance development" has waned in recent years, possibly due to the

dominance of other subjects rather than a lack of interest. There are a number of cutting-edge interventions and problem-solving attempts in this area, providing opportunities for qualitative and quantitative expansion. "Motivation, cognition, and emotion" is a vastly underappreciated topic area in soccer psychology. This may be due to the fact that recent soccer research has emphasized the importance of rapid on-field application, resulting in fewer attempts at survey-based psychological assessment. However, measuring psychological factors contributes to the study of soccer psychology through new methodologies and theoretical backgrounds. Recognizing the important role that psychological factors play in players' performance and mental management and providing new research directions and approaches with direct field application will advance soccer psychology research.

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