

Scoliosis Research Trends and the Role of Artificial Intelligence: A Latent Dirichlet Allocation Analysis of Publications (2000–2024)

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ABSTRACT

This study aimed to evaluate global research trends in scoliosis between 2000 and 2024 using latent Dirichlet allocation (LDA) topic modeling. English-language, peer-reviewed journal articles indexed in Scopus were analyzed using their titles, abstracts and keywords to identify dominant and relatively underrepresented research themes. The findings showed that surgery-related topics accounted for the largest thematic proportion of the scoliosis literature, whereas etiopathogenesis and genetic factors had limited structural representation. Artificial intelligence-related studies increased in recent years but remained primarily focused on radiological assessment, Cobb angle measurement and diagnostic applications. These results demonstrate an imbalance in the thematic distribution of scoliosis research; however, bibliometric frequency and topic proportion should not be interpreted as direct indicators of scientific quality or clinical importance. The findings may help researchers recognize areas that warrant further investigation, particularly etiological and genetic mechanisms. The application of artificial intelligence in genetics, precision medicine and treatment planning should be regarded as a potential direction for future research rather than an outcome directly demonstrated by the present analysis.

Keywords: Latent dirichlet allocation, Scoliosis, Topic modeling, Artificial intelligence

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INTRODUCTION

Scoliosis is defined as a three-dimensional spinal deformity of the vertebrae, typically diagnosed through standing spinal radiography. A spinal curvature exceeding 10 degrees is classified as scoliosis [1]. Four main types of scoliosis have been identified: congenital scoliosis, neuromuscular scoliosis, syndromic scoliosis and idiopathic scoliosis [2, 3]. Approximately 80% of cases are categorized as idiopathic scoliosis, the etiology of which remains unknown. The etiopathogenesis of the other types has also not been fully elucidated, but multifactorial influences are believed to play a role [2, 4].

The treatment of scoliosis has evolved significantly over time. In 1879, Sayre Louis first described scoliosis as the lateral curvature of the spine and proposed that all cases could be treated using elastic garments and plaster bandages [5]. Today, bracing and other conservative treatments are employed to halt the progression of scoliosis [6]. Emphasis is placed on the importance of early diagnosis to improve treatment outcomes, with school screening programs being a key component in achieving this goal [3]. The first major advancement in surgical treatment occurred in 1947 with the use of grafts, followed by the development of spinal instrumentation techniques by Harrington, which enhanced the effectiveness of surgical approaches [7, 8]. The combination of instruments and grafts, along with advancements in spinal surgical materials, has significantly improved surgical outcomes over time [9, 10].

Artificial intelligence (AI) was first defined by John McCarthy in 1955 as “intelligent machines.” Since then, it has enabled significant advancements across various domains, including healthcare [11, 12]. The use of AI provides opportunities to improve patient outcomes, reduce costs and enhance public health by assisting clinicians with greater accuracy [13]. Initial applications of AI became widespread in areas such as cancer, neurological disorders and cardiovascular diseases, with its influence in the healthcare sector continuing to grow [14–17].

Artificial intelligence applications are divided into two main categories: machine learning (ML) and natural language processing (NLP). Machine learning provides methods for analyzing genetic and imaging data to predict disease outcomes or cluster patient characteristics. Natural language processing, on the other hand, focuses on extracting information from unstructured texts [14]. In orthopedic surgery, NLP has accelerated access to information by facilitating the analysis of literature. Studies that utilize methods such as latent Dirichlet allocation (LDA), which

categorizes and organizes texts, have drawn significant attention [18]. Latent Dirichlet allocation is a topic modeling method used to identify word clusters in large text collections, offering a high generalization capability compared to other modeling algorithms [19, 20].

Today, most studies are conducted electronically, making it a time-consuming process for researchers to review thousands of documents [21]. Thus, extracting critical information from comprehensive sources and presenting it in a concise manner is of great importance. Summarizing information, whether through keywords or latent topics, plays a critical role in understanding the research framework, determining the overall structure of knowledge, and analyzing trends [22].

Unlike previous bibliometric studies that primarily focused on publication output, citation patterns or specific scoliosis subfields, the present study combines descriptive bibliometric indicators with LDA-based topic modeling of a large scoliosis corpus. It also separately examines the thematic position of AI-related research. This combined approach aims to provide a broader assessment of dominant research themes and areas with relatively limited representation.

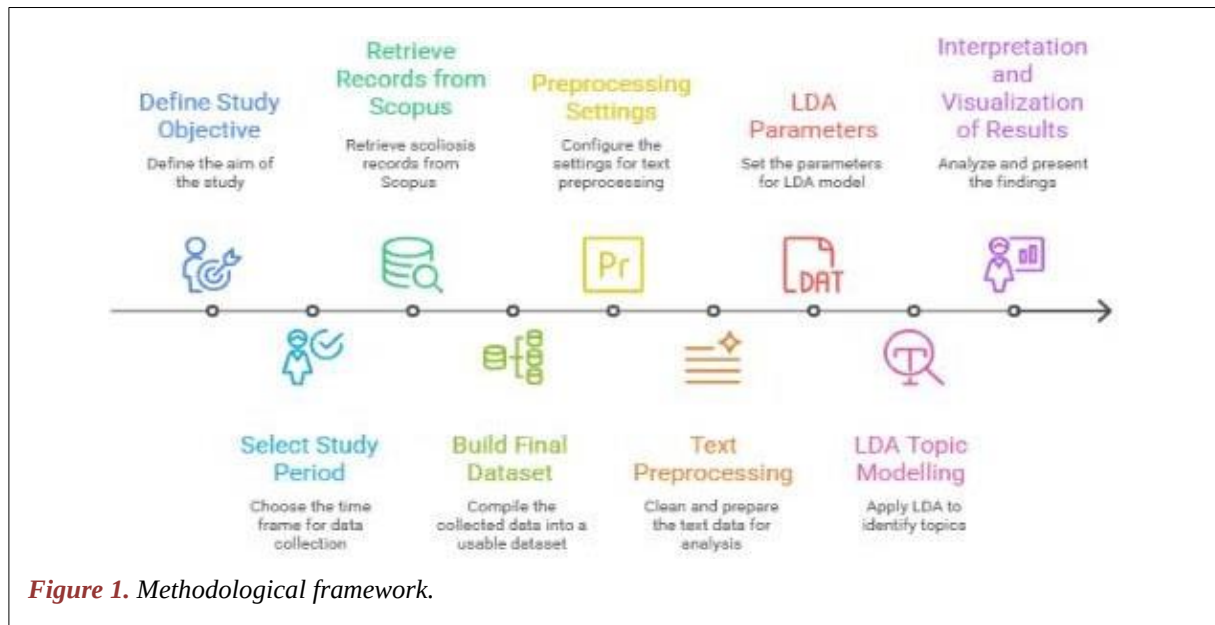
Methodology

This section provides information about LDA, one of the AI algorithms used in this study. The methodological framework of the study is presented in **Figure 1**.

Latent Dirichlet Allocation Algorithm

Latent Dirichlet allocation is a probabilistic framework that models each document as a mixture of topics drawn from a Dirichlet distribution and each topic as a mixture of words governed by a Dirichlet frequency distribution [23]. This methodology provides a powerful mechanism for uncovering latent structures in large text corpora: the distribution of words over topics reveals the main themes embedded in the documents, while the distribution of topics over documents characterizes the statistical properties of the corpus as a whole [24].

As an unsupervised machine learning and text-mining technique, topic modeling with LDA can be used to identify subjects or themes within large document collections [23]. Latent Dirichlet allocation is one of the most widely used topic modeling methods and is formulated as a three-level hierarchical Bayesian, generative probabilistic model of a corpus. In this framework, documents are represented as stochastic combinations of latent topics, and each topic is



defined by a probability distribution over vocabulary items [25].

Data Sources

All data were obtained from the Scopus database, and only peer-reviewed journal articles were considered, as Scopus indexes over 5,000 publishers worldwide [26]. Papers related to “scoliosis” published between 2000 and 2024 were reviewed. The search strategy was as follows: TI = (scoliosis) AND Language = English [27, 28]. Letters, corrections, meeting abstracts, editorial materials, proceeding papers, and book chapters were excluded. Duplicate publications were identified and removed [29].

The Scopus database was searched for English-language, peer-reviewed journal articles published between 2000 and 2024 with the term “scoliosis” in the title. Letters, editorials, corrections, conference abstracts, proceedings and book chapters were excluded, and duplicate records were removed.

A comprehensive review was conducted based on the titles, keywords, and abstracts of the articles. These articles were subsequently added to the dataset. Each bibliographic entry includes the title, author, keywords, and abstract [29].

To categorize the text, a probabilistic topic modeling approach was used to create and fit a topic model to the scoliosis corpus and analyze this corpus using LDA [26]. In order to determine the appropriate number of labels and keywords using the LDA algorithm, various variations were tried by calculating in different iterations. In the calculations performed, six topics and seven or more keywords under each

topic were arranged in 2,000 iterations. Topic-word weight represents the relative contribution of a term to an LDA topic, whereas topic proportion represents the relative share of that topic within the analyzed corpus.

Analysis and Results

The results of the study are first presented descriptively, considering studies related to scoliosis in terms of country, citations, keywords, title, and abstract. Next, a detailed topic modeling analysis is provided to offer a comprehensive overview of scoliosis research.

Descriptive Analysis

Based on data obtained from 33,704 studies, the following descriptive analysis is presented. Descriptive analyses in Tables 1–3 were generated using VOSviewer, while LDA analyses in Tables 4–9 were conducted in Python. In the VOSviewer analysis, relevance indicates how specifically a term characterizes the mapped literature, and total link strength represents the sum of the strengths of an item’s connections with other items. All preprocessing and topic-modeling steps (including tokenization, stop-word removal, lemmatization and n-gram generation) were implemented with standard text-processing libraries such as NLTK and Gensim. The term “total link” denotes the total number of connections between an object (e.g., author, article or keyword) and other objects, providing an aggregate indicator of academic influence and collaboration patterns [30].

In **Table 1**, the United States had the highest number of publications, followed by China, Canada, Japan and the United Kingdom. In terms of total citations, the United States ranked first, followed by the United Kingdom, Canada, France and

publication count and total link strength, whereas Canada had the highest citation count.

Table 2 presents an analysis of the terms found in the titles and abstracts of scoliosis-related studies. When considering

Table 1. Scoliosis and scoliosis-AI: Document citation and total link strength by country.

Scoliosis				Scoliosis and AI			
Country	Documents	Citations	Total link strength	Country	Documents	Citations	Total link strength
United States	10737	296798	4882	United States	26	423	11
United Kingdom	1973	58710	2390	France	6	200	8
France	1869	44640	2156	United Kingdom	8	61	8
Canada	2112	56509	2111	Switzerland	5	127	7
Germany	1587	37780	1908	Italy	6	45	7
Italy	1679	38864	1785	Poland	5	31	4
Spain	969	18098	1443	Canada	18	530	3
Netherlands	811	26080	1388	China	14	45	2
Australia	727	21518	1107				
Switzerland	564	12590	1107				
China	4132	38421	1067				
Japan	2023	33883	1028				
Turkey	1370	17878	1022				
Belgium	380	14235	881				
Hong Kong	738	16940	759				
Poland	813	10494	587				
Denmark	268	6908	581				
Sweden	346	12886	572				
Brazil	668	9906	476				
India	1021	7948	459				

Italy. For total link strength, the leading countries were the United States, the United Kingdom, France, Canada and Germany. These indicators should be interpreted separately because publication output, citation impact and collaboration strength represent different dimensions of research activity. In the AI-related subset, the United States had the highest

scoliosis, terms such as “syndrome,” “screw,” and “disorder” rank highest, while, when incorporating AI, terms related to “algorithms” and “measurement” are especially emphasized. The table contrasts raw term frequency with contextual significance, highlighting high-frequency, high-importance terms such as “screw” (4,751 occurrences, 0.82 significance) and “pedicle” (1,195 occurrences, 0.85 significance), which are

central in medical and technical discussions. Conversely, terms with low frequency but high contextual weight, such as “ChatGPT” (33 occurrences, 5.78 significance) and “performance” (50 occurrences, 0.81 significance), indicate emerging or specialized topics. Genetic terms, including “mutation” and “phenotype,” appear frequently but show moderate significance, while concepts such as “reliability” are crucial for evaluating methodological and clinical performance. Overall, the analysis underscores the strategic value of underused yet contextually important terms in medical, genetic and technological research on scoliosis.

are the most frequently used and strongly connected terms, indicating their central role in the field. Terms such as “surgery” and “quality of life” highlight the clinical and patient-centered focus of many studies, while terms indicating deformities such as “kyphosis” and “idiopathic scoliosis” are important subcategories.

The results indicate that, in conjunction with AI, algorithms are increasingly used for Cobb angle measurement, whereas in the broader scoliosis literature, it continues to focus on emphasising the impact of surgery. In the AI context, “artificial intelligence” is the most frequently used general

Table 2. Analysis of Terms Found in Titles and Abstracts

Scoliosis			Scoliosis and AI		
Term	Occurrences	Relevance	Term	Occurrences	Relevance
Syndrome	5,046	0.24	Radiograph	83	0.28
Screw	4,751	0.82	Measurement	82	0.34
Disorder	4,107	0.13	Algorithm	58	0.43
Gene	4,082	0.31	Performance	50	0.81
Mutation	3,889	0.33	Surgeon	50	0.61
Family	2,132	0.29	Parameter	47	0.33
Phenotype	2,009	0.32	Surgery	45	0.45
Feature	1,967	0.14	Level	45	0.36
Variant	1,948	0.33	Case	36	0.32
Malformation	1,568	0.35	ChatGPT	33	5.78
Anomaly	1,537	0.31	Artificial intelligence	33	0.22
Lenke	1,424	0.92	Dataset	32	0.28
Reliability	1,403	0.90	Group	29	0.50
Defect	1,396	0.22	Reliability	28	0.48
Protein	1,227	0.27	Prediction	26	0.34
Pedicle	1,195	0.85	Sensitivity	25	0.49
Expression	1,163	0.48	Cobb angle measurement	25	0.28
Cell	1,123	0.35	Radiologist	18	0.30

Table 3 presents a comparative analysis of the occurrence and total link strength of keywords in the studies included. An examination of keywords in scoliosis research indicates that the broader scoliosis literature primarily focuses on demonstrating the impact of surgery. Among scoliosis-related keywords, “scoliosis” and “adolescent idiopathic scoliosis”

term, followed by specific methods such as “deep learning” and “machine learning”. The presence of “ChatGPT,” although less common, demonstrates the emergence of newer AI tools. Overall, scoliosis-related keywords are more prevalent and strongly linked compared to AI-related terms, but the data

highlight the growing role of AI technologies, especially deep learning, in scoliosis analysis and treatment.

“imaging,” indicating a focus on structural changes in the adult spine and their impact on health. Topic 1, titled “Severe lumbar disease in children: treatment, complications and risks to growth,” centers on lumbar problems in children, highlighting

Table 3. Analysis of the Keywords

Scoliosis Keyword	Occurrences	Total Link Strength	AI Keywords	Occurrences	Total Link Strength
Scoliosis	6,410	14,657	Artificial intelligence	30	47
Adolescent idiopathic scoliosis	2,805	5,658	Deep learning	18	34
Spine	1,171	3,479	Scoliosis	29	31
Surgery	624	2,048	Cobb angle	7	17
Kyphosis	581	2,027	Adolescent idiopathic scoliosis	12	16
Complications	607	2,007	Spine	6	15
Adult spinal deformity	634	1,888	Adult spinal deformity	6	10
Idiopathic scoliosis	1,014	1,878	Machine learning	9	10
Spinal deformity	615	1,828	ChatGPT	5	8
Spinal fusion	631	1,820			
Deformity	404	1,399			
Adolescent	403	1,221			
Posterior spinal fusion	415	1,171			
Outcomes	285	1,068			
Cobb angle	410	1,036			
Quality of life	356	1,027			
Cerebral palsy	385	995			
Children	429	982			
Congenital scoliosis	463	975			
Early-onset scoliosis	368	942			

Topic Modeling Analysis from 2000 to 2024

Table 4 presents the topics generated by LDA for the period 2000–2024. Overall, the themes revolve around spinal health, deformities and treatment processes, covering both surgical and non-surgical approaches in children and adults. Across topics, key issues include radiographic measurements, complication rates, structural preservation of the spine and postoperative recovery.

Topic 0, titled “Spinal deformity in adults: imaging, treatment techniques and health implications,” is characterized by terms such as “spinal,” “deformity,” “health” and

treatment outcomes and complications. Topic 2, titled “Radiographic evaluation after curve correction: Cobb angle, screw levels and postoperative results,” addresses correction of spinal curves and postoperative follow-up, with particular emphasis on curve correction techniques and complication rates; this topic represents the highest proportion (0.198), reflecting the dominant role of surgical interventions. Topic 3, titled “Thoracic fusion surgery: clinical cases, pain management and sagittal plane evaluation,” focuses on spinal fusion in clinical practice, emphasizing surgical effects and pain management. Topic 4, titled “Evaluation of kyphosis angle:

pelvic levels, clinical parameters and determining factors,” concentrates on measuring spinal deformities, especially kyphosis angle, and relating these measurements to clinical scores and patient status. Topic 5, “Adolescent idiopathic scoliosis: preoperative evaluation, curves and surgical outcomes,” highlights adolescent idiopathic scoliosis (AIS) in young patients, underlining preoperative assessment of curves, posterior surgical approaches and treatment planning.

When reviewing the evaluations suggested by LDA, it is

insights for the medical community. Knowledge mapping plays a critical role in examining the development and boundaries of a discipline, helping researchers understand research priorities and guide future research directions [21, 22, 29].

Previous bibliometric research has consistently identified the United States as the leading contributor to scoliosis-related studies, followed by China, Canada, Japan and France. A study by Zhao et al. [35], focusing on idiopathic scoliosis, analyzed

Table 4. Identification of Topics and Keywords for 2000–2024 using LDA

Topic 0	0,135	Topic 1	0,162	Topic 2	0,198	Topic 3	0,195	Topic 4	0,159	Topic 5	0,152
Word	Weight	Word	Weight	Word	Weight	Word	Weight	Word	Weight	Word	Weight
Spinal	1065	Children	835	Curve	1245	Fusion	1155	Angle	945	AIS	1280
Deformity	785	Lumbar	810	Correction	1215	Clinical	1100	Based	660	Preoperative	890
Loss	415	Complications	795	Postoperative	1050	Cases	830	Level	630	Spine	570
Health	340	Significant	720	Associated	1045	Surgical	655	Parameters	550	Curves	570
Adult	295	Severe	605	Rate	660	Pain	640	Kyphosis	540	Higher	500
Imaging	270	Treatment	585	Performed	655	Thoracic	620	Scores	490	Improved	425
Individuals	195	Disease	550	Significantly	620	Average	620	Factors	465	Posterior	355
Postoperatively	185	Risk	550	Cobb	580	Sagittal	605	Pelvic	405	Congenital	345
Rib	180	Bone	500	Levels	510	Surgery	595	Lower	400	Adolescent	340
Effects	180	Found	450	Showed	495	Age	465	Observed	375	Incidence	325
Initial	165	Growth	435	Radiographic	490	Case	435	Clinical	360	Major	315
Bracing	160	Pain	435	Months	430	Brace	425	Blood	340	Cohort	295
Procedure	160	Function	425	Range	385	Medical	295	Common	335	Number	290
Technique	155	Progression	395	Screw	380	Diagnosis	375	Instrumentation	305	Idiopathic	270

evident that Topics 2, 3 and 5 are related to surgical treatment. Topics 2, 3 and 5 were predominantly related to surgical assessment and treatment. Together, these topics accounted for an aggregated thematic proportion of 54.5% within the analyzed corpus, indicating the substantial representation of surgery-oriented research during the aggregated thematic proportion of 54.5% within the analyzed corpus, indicating the substantial study period.

DISCUSSION

Scoliosis is considered a significant public health problem. Given its prevalence and the growth of the global population, it is increasingly recognized as a disease that affects society as a whole [31]. Despite being a multifactorial condition, the etiology of scoliosis is still not fully understood [3, 6, 32]. Numerous studies have been conducted on scoliosis [27, 28, 33, 34]. However, the extensive literature needs to be systematically analyzed and interpreted to provide meaningful

2,266 articles published between 1985 and 2020 and reported similar findings. Likewise, Tao et al. [27], who analyzed 8,324 studies published between 2009 and 2018, demonstrated comparable results. A comprehensive bibliometric study conducted by Güler et al. [28], which included 9,706 studies, identified the United States, China, Canada, Japan and the United Kingdom as leading contributors to research. Consistent with these findings, our study, which included over 33,000 articles published between 2000 and 2024, also demonstrated that the United States, China, Canada, Japan and the United Kingdom rank at the top of countries contributing to research. Notably, when analyzing larger datasets, an increase in publications from the United Kingdom becomes evident, while the rapid growth in China’s research output in recent years is also remarkable.

When considering citation impact, it appears that China ranks lower, while the United Kingdom rises to second place. In a study by Liu Po-Chun et al. [36] that examined the 100 most cited articles on spinal deformities published between

2011 and 2020, the United States, France and Italy were identified as the most frequently cited countries, with China ranking sixth. Another study supports this, showing that China ranks seventh in an evaluation of citations per publication [37]. This study also noted China's relatively lower position. In our analysis, China ranked even lower in terms of total link strength, falling to 11th place. The consistency in rankings of leading countries in both citation counts and total link strength suggests that these metrics are reliable indicators of scientific influence. However, it is important to note that citation frequency is influenced by various factors. For example, rigorous systematic reviews tend to receive, on average, more than twice the number of citations compared to other types of studies [38]. This should be taken into consideration when interpreting citation-based results.

The analysis of AI and scoliosis studies indicates that out of 33,704 studies, only 95 are AI studies, which equates to three per thousand studies. Again, the top three countries in terms of the number of studies are the USA, Canada and China. While Canada leads in the number of citations, it is interesting to note that its total link power ranks seventh. According to our table, the USA leads in total link strength. Although AI is currently indicated as having good application prospects in early screening, diagnosis, treatment decision making, intraoperative operation ("surgical assistance" and "insertion of pedicle screw"), and prognosis prediction of scoliosis [39], in our study, the majority of studies related to AI [40] included mainly keywords supporting screening and diagnosis topics.

The most frequently reported keywords in bibliometric analyses of adolescent idiopathic scoliosis include "surgery," "thoracolumbar instrumentation," "fixation," "pedicle screw," "complications", and "constructs" [41]. Despite ongoing debates and unresolved questions regarding AIS, one of the most significant challenges remains the lack of sufficient knowledge about its etiopathogenesis [35].

In a study by Güler et al. [28], the keyword "etiology" was ranked 77th, indicating a relatively low emphasis. Notably, 16 of the top 20 keywords identified in Güler's study were also present among the top 20 keywords in our analysis. Similarly, in our study, when the keyword "etiology" was evaluated using LDA, a clear scarcity of etiological studies was observed.

In bibliometric analyses focusing on AIS and genetics, including 479 publications, China was ranked first, followed by the United States, Canada and Japan [42]. By contrast, a systematic review examining genetic factors in idiopathic scoliosis included only eight studies [33]. The discrepancy between these findings can be attributed to methodological

differences, as bibliometric studies tend to analyze larger datasets and provide a broader overview of the field [26].

To identify latent thematic structures in large text corpora, text mining techniques such as LDA have been successfully applied across various fields [42]. In our study, which analyzed titles and abstracts, terms such as "gene" and "mutation" were moderately important in relation to etiological factors. However, when evaluated using LDA, it was observed that studies focusing on etiological causes had extremely low weight and were almost negligible within the overall topic structure. In fact, etiological themes were not sufficiently represented to form distinct topic clusters. This indicates that studies on etiopathogenesis are not only limited in number but also lack structural prominence in the literature.

This finding contrasts with studies conducted in other medical fields. For instance, in an analysis using NLP and non-negative matrix factorization (NMF) techniques in developmental dysplasia of the hip (DDH), research topics such as clinical, diagnostic, genetic, anatomical, and surgical domains were found to have nearly equal representation [43].

In another bibliometric study, "AIS" and "idiopathic scoliosis" were ranked first and second, respectively. Excluding disease-specific terms, "surgery" emerged as the most frequent keyword, followed by related terms such as "fusion," "internal fixation", and "posterior spinal fusion" [37]. Consistent with these findings, our study also demonstrates the dominance of surgery-related keywords. One possible explanation is that the majority of scoliosis studies are conducted by orthopedic surgeons, who tend to focus primarily on surgical treatment outcomes [44]. Additionally, the increasing rate of scoliosis surgeries over time may contribute to this trend [31, 34]. Improvements such as reduced hospitalization duration, shorter operative times, increased use of all-screw constructs, decreased blood loss and lower complication rates have further reinforced the importance of surgical approaches [31, 45, 46]. However, it is important to note that, although the prevalence of scoliosis is relatively high, the rate of surgical intervention remains low. For example, in a 2009 study by Rigo et al. [47], only 5.6% of patients underwent surgery. In a more recent study conducted in 2021, this rate was reported to be as low as 0.7% [48].

Despite the high prevalence of scoliosis and the relatively low rate of surgical intervention, as well as the fact that its etiology remains largely unknown [33, 49], our findings indicate that insufficient emphasis is placed on etiopathogenesis. Despite ongoing discussions and research efforts on genetic and etiological factors, the current level of knowledge remains inadequate [32, 33, 50]. Given the

importance of understanding disease mechanisms to improve treatment outcomes, the lack of sufficient research in this area represents a significant gap.

Temporal analyses further suggest that etiological research has not gained substantial prominence over time. Nevertheless, even with this progression, etiological research remains limited. Artificial intelligence has not yet been sufficiently utilized in this area. Although AI applications have increased since 2020, as observed in our study, they are primarily used in scoliosis assessment and Cobb angle measurement, where they have significantly improved imaging accuracy and reliability [51]. In many medical fields, particularly in oncology, AI has already been successfully applied in gene-related research. The use of AI in genetics, precision medicine, screening and treatment planning should therefore be considered a potential direction for future research rather than an outcome directly demonstrated by the present analysis. Artificial intelligence may offer opportunities to integrate genetic variants, epigenetic markers and clinical data, including imaging parameters and anthropometric measurements, in future precision-medicine research [32].

As a multifactorial disease, scoliosis has received limited research attention regarding its etiological basis [52]. Future studies focusing on epigenetic and genetic mechanisms, supported by advances in AI, may provide valuable insights into the development of disease treatment [33, 39].

Although AI-based text-mining methods may eventually become the gold standard for large-scale data analysis, the field is still in its early stages. The continuous expansion of unstructured data and electronic health records suggests that these approaches will play an increasingly important role in evidence-based medicine. However, it is essential to understand both the capabilities and limitations of AI in order to use these tools effectively [18].

Limitations of the Study

This study has some limitations. First, although the dataset is large, it was not possible to collect all relevant articles due to limitations in terms of time and access rights. In addition, while this study identified general trends in research on scoliosis, no analysis was conducted to assess the quality of individual studies. Second, we only used the most popular topic modeling method, which is an effective method for identifying topics, but it may not have fully captured the contextual meaning of the text content, and the results may vary depending on different parametric settings. Finally, although the role of AI applications in scoliosis research has been examined, more

detailed research is needed on the clinical uses and effectiveness of these technologies.

Conclusion and Suggestions for Future Research

This study analyzed academic research on scoliosis published between 2000 and 2024 using LDA to identify trends in the literature. The findings show that scoliosis studies largely focused on surgical approaches, especially surgical techniques, outcomes and advances. However, it was noted that studies on the etiopathogenesis of scoliosis were limited and genetic factors were not sufficiently addressed. In recent years, it has been observed that AI applications have been increasingly used in scoliosis research, especially in areas such as Cobb angle measurement and scoliosis assessment. However, it appears that AI has not yet been fully utilized in less studied areas such as genetic and etiologic studies.

Accordingly, some strategic recommendations are offered for scoliosis research to be more effective. First of all, a more in-depth investigation of etiologic causes and genetic factors is of great importance. Elucidating the mechanisms of the disease may increase the effectiveness of treatment approaches. Furthermore, greater use of AI applications in genetic analysis, personalized treatment planning and long-term patient follow-up should be encouraged.

In addition, a multidisciplinary approach should be adopted to increase collaboration between physiotherapists, geneticists, orthopedists and data scientists. International collaboration and knowledge sharing can enhance contributions to etiopathology, particularly through the integration of artificial intelligence and genetic research. Expanding school screening programs for early detection of scoliosis and using AI-enabled tools in these processes have the potential to improve treatment outcomes. Finally, research into innovative conservative treatment methods for cases where surgery is not required should also be encouraged.

These recommendations aim to enhance understanding of scoliosis, improve treatment and provide a framework to guide future research. Focusing on both etiologic and technological innovation in the field of scoliosis will be a critical step towards reducing the public health impact of the disease.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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