

# Publication Trends in the Pelvic Parameter Related Literature between 1992 and 2022 : A Bibliometric Review

Serdar Yüksel,<sup>1</sup> Emre Özmen,<sup>1</sup> Alican Barış,<sup>1</sup> Esra Cırcı,<sup>1</sup> Ozan Beytemür<sup>2</sup>

*Istanbul Physical Treatment and Rehabilitation Training and Research Hospital,<sup>1</sup> Istanbul, Turkey  
SBU Bağcılar Training and Research Hospital,<sup>2</sup> Istanbul, Turkey*

**Objective :** This study aimed to conduct a bibliometric analysis on pelvic parameter related research over the last 30 years, analyzing trends, hotspots, and influential works within this field.

**Methods :** A comprehensive Web of Science database search was performed. The search yielded 3249 results, focusing on articles and reviews published from 1992 to 2022 in English. Data was analyzed using CiteSpace and VOSviewer for keyword, authorship, and citation burst analysis, co-citation analysis, and clustering.

**Results :** The number of publications and citations related to pelvic parameters has increased exponentially over the last 30 years. The USA leads in publication count with 1003 articles. Top publishing journals include the European Spine Journal, Spine, and Journal of Neurosurgery: Spine, with significant contributions by Schwab, Lafage V, and Protopaltis. The most influential articles were identified using centrality and sigma values, indicating their role as key articles within the field. Research hotspots included spinal deformity, total hip arthroplasty, and sagittal alignment.

**Conclusion :** Interest in pelvic parameter related research has grown significantly over the last three decades, indicating its relevance in modern orthopedics. The most influential works within this field have contributed to our understanding of spinal deformity, pelvic incidence, and their relation to total hip arthroplasty. This study provides a comprehensive overview of the trends and influential research in the field of pelvic parameters.

**Key Words :** Bibliometrics · Scientometric indicators · Spine · Posture.

## INTRODUCTION

The pelvis constitutes the load transferring unit between the trunk and the lower extremities. Its shape and position in the space is a result of the upright position of the humans<sup>1</sup>. The load from the trunk passes on to the pelvis at the sacral plateau, and the load from pelvis to the lower extremities

passes on the lower extremities through the femoral heads. Deformities or malalignment in either sagittal or coronal plane are associated with disability and pain<sup>4,7</sup>. There has been considerable literature on the optimal way to assess spinopelvic alignment in the recent decades. Pelvic tilt, pelvic incidence, sacral slope, sagittal vertical axis (SVA) are some of the more commonly used parameters<sup>5</sup>. There is no consensus

• Received : March 1, 2023 • Revised : May 20, 2023 • Accepted : June 27, 2023

• Address for correspondence : **Emre Özmen**

Istanbul Physical Treatment and Rehabilitation Training and Research Hospital, Bahçelievler Merkez, Adnan Kahveci Blv. No : 145, Bahçelievler/İstanbul 34186, Turkey  
Tel : +90 539 876 63 03, Fax : +90 212 441 70 83, E-mail : emreozmen@istanbul.edu.tr, ORCID : <https://orcid.org/0000-0002-8384-5468>

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

on the best parameters for evaluation or pre-op planning adult spinal deformity, and the evolution of the literature reflects this<sup>9,19</sup>.

Bibliometric analysis is a method of evaluating the network of countries, institutions, journals, and researchers, identifying popular topics (“hot spots”) and predicting the research trends. To our knowledge, there are no currently no bibliometric studies on pelvic parameter related research. This study aims to visualize the landscape in the literature and both qualitatively and quantitatively assess trends and hot spots in the last 30 years.

## MATERIALS AND METHODS

The Institutional Review Board of Istanbul Physical Treatment and Rehabilitation Training and Research Hospital approval was obtained (02/2023:001). Informed consent was not obtained for this study as only publicly available information was used. The search utilizing every form of the term related to various pelvic parameters was conducted in the Web of Science (WoS) database as follows : (TS = (“pelvic parameter”) OR (“spinopelvic parameter”) OR (“pelvic tilt”) OR (“sacral slope”) OR (“pelvic incidence”))), and document type was set as “Articles”, and indexes were set as “SCI-EXPANDED”. Document type was narrowed to include only include articles and reviews. Results were narrowed down to include publications from 1992 to 2022 in English language. Three thousand two hundred forty-nine results were obtained. Titles, authors,

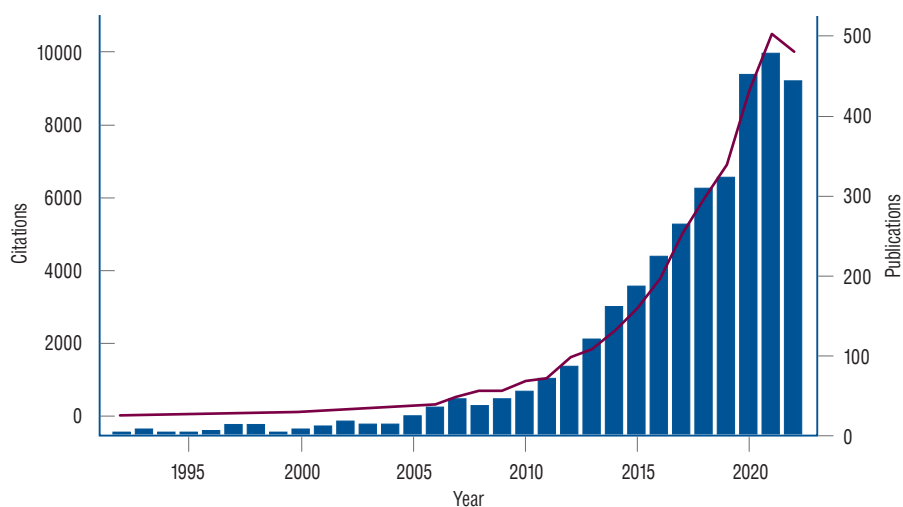
abstracts, institutions, countries, journals, references, and the citation information were recorded.

The obtained data from WoS was imported to CiteSpace 6.1.R6, 64-Bit (Drexel University, Philadelphia, PA, USA)<sup>2</sup> and VOSviewer 1.6.15<sup>20</sup>. Keyword, authorship and citation burst analysis was performed. Network of keywords and organizations were analyzed with VOSviewer. Co-citation analysis and clustering was performed with CiteSpace.

In the context of our study, we utilize centrality and sigma values, Silhouette, and different labeling methods (latent semantic indexing [LSI], log-likelihood ratio [LLR], mutual information [MI]) as tools in our bibliometric analysis. They help us identify key articles, evaluate the quality of clustering, and understand the content and characteristics of each cluster, respectively.

## RESULTS

The study established a network of 33498 references cited by 3249 nodes. The number of publications increased from three in 1992 to 443 in 2022, and the number of citations rose from one in 1992 to 9989 in 2022. Both of these metrics are highly correlated and are increasing exponentially (Fig. 1). Over the 30-year period analyzed, 88% of studies were published in the last decade, and 57% of the studies were published within the last 5 years. The citations generated in 2022 alone exceeded the total number of citations from 1992 to 2013 (9989 vs. 8660).



**Fig. 1.** Number of publications and citations generated per year. Red line represents the number of citations.

### Country analysis

Table 1 summarizes the top ten countries with the highest number of publications. The USA leads with 1003 articles and a centrality of 0.64. Burst analysis (Fig. 2) reveals that South Korea, Italy, and Turkey experienced a surge in publications at the beginning of the last decade.

### Journal analysis

The top 10 journals publishing the majority of articles are also summarized in Table 2. Sixty percent of these journals are based in the USA, accounting for 75% of the publications in the top 10 list. The most co-cited journal, “Spine”, holds the top position with a frequency of 2666 citations and a centrality value of 0.06, indicating its significant influence within the field since 1992 (Table 3).

### Co-citation and co-cited reference cluster analysis

Co-citation analysis was performed, with lighter colors in Fig. 3 indicating more recent publications. Each node repre-

**Table 1.** Top 10 most publishing countries between 1992–2022

Rank	Country	No. of articles	Centrality
1	USA	1003	0.64
2	Japan	478	0.03
3	China	460	0.09
4	South Korea	325	<0.01
5	France	324	0.05
6	Canada	122	0.01
7	Germany	119	0.01
8	England	112	0.03
9	Turkey	96	0.01
10	Italy	84	<0.01

**Table 2.** Top 10 most publishing journals with impact factors (data from WoS/Journal Homepage)

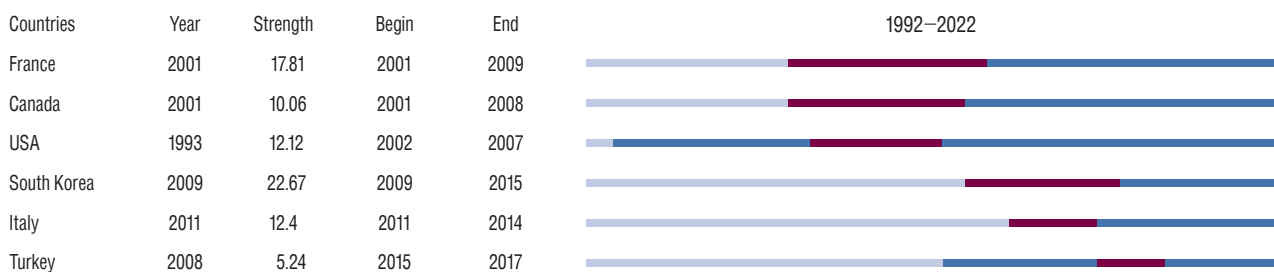
Rank	Journal	No. of articles	Impact factor
1	European Spine Journal	295	3.134
2	Spine	278	3.468
3	Journal of Neurosurgery Spine	126	3.602
4	The Spine Journal	108	4.166
5	BMC Musculoskeletal Disorders	98	2.246
6	Gait Posture	88	2.84
7	World Neurosurgery	75	2.104
8	Journal of Arthroplasty	70	4.757
9	Asian Spine Journal	68	2.022
10	Global Spine Journal	59	2.915

WoS : Web of Science

**Table 3.** Top 10 most co-cited journals according to frequency

Rank	Journal	Centrality	Frequency
1	Spine	0.06	2666
2	European Spine Journal	0.05	2427
3	Journal of Bone and Joint Surgery-American Volume	0.03	1908
4	The Spine Journal	0.03	1331
5	Clinical Orthopaedics and Related Research	0.04	1259
6	Journal of Neurosurgery: Spine	0.01	1151
7	Journal of Spinal Disorders & Techniques	0.01	913
8	Neurosurgery	0.01	873
9	Journal of Bone and Joint Surgery-British Volume	0.03	785
10	Clinical Biomechanics	0.02	591

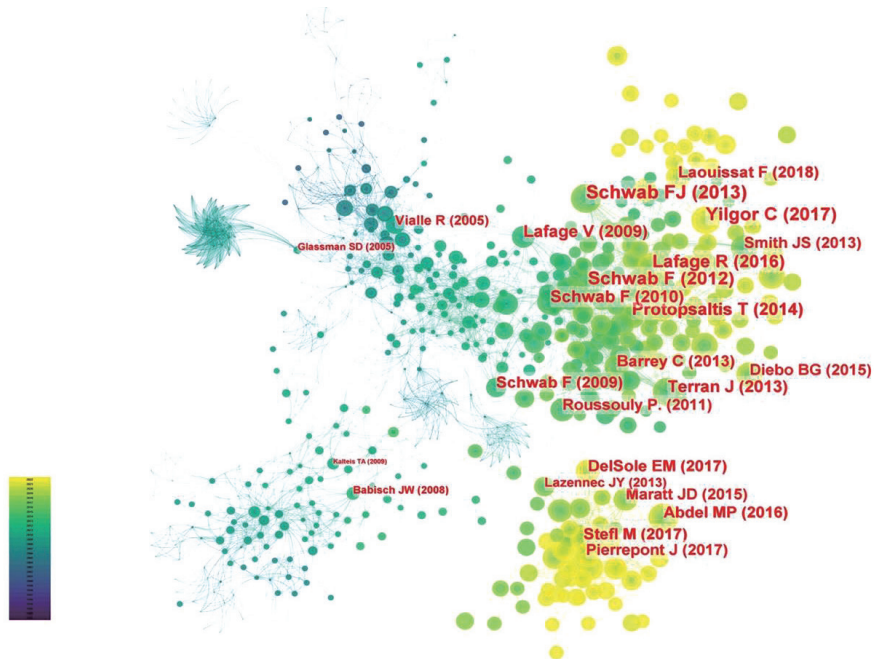
Top 6 countries with the strongest citation bursts



**Fig. 2.** Burst analysis of publishing countries.

sents a cited article, with the node's diameter proportional to its co-citation count. The top 10 co-cited articles on pelvic parameter-related research are shown in Table 4. Fig. 4 shows the

clustering of co-citations according to title, abstract, and keywords, with only connected clusters visualized. Top 10 clusters ranked according to size are shown in Table 5. Supplementary



**Fig. 3.** Co-citation map of references.

**Table 4.** Top 10 co-cited articles on pelvic parameter research since 1992

Rank	Author	Year	Centrality	Frequency	Title
1	Schwab, F	2013	0.03	136	Radiographical spinopelvic parameters and disability in the setting of adult spinal deformity: a prospective multicenter analysis
2	Yilgor C	2017	0.01	118	Global alignment and proportion (GAP) score: development and validation of a new method of analyzing spinopelvic alignment to predict mechanical complications after adult spinal deformity surgery
3	Schwab F	2012	0.02	113	Scoliosis research society—schwab adult spinal deformity classification
4	Lafage R	2016	0.02	98	Defining spino-pelvic alignment thresholds: should operative goals in adult spinal deformity surgery account for age?
5	Protopsaltis T	2014	0.05	83	The T1 pelvic angle, a novel radiographic measure of global sagittal deformity, accounts for both spinal inclination and pelvic tilt and correlates with health-related quality of life
6	Lafage V	2009	0.03	74	Pelvic tilt and truncal inclination: two key radiographic parameters in the setting of adults with spinal deformity
7	Schwab F	2010	0.00	73	Adult spinal deformity—postoperative standing imbalance: how much can you tolerate? An overview of key parameters in assessing alignment and planning corrective surgery
8	Laouissat F	2018	0.01	68	Classification of normal sagittal spine alignment: refounding the Roussouly classification
9	Pierrepoint J	2017	0.00	67	Variation in functional pelvic tilt in patients undergoing total hip arthroplasty
10	Terran J	2013	0.01	67	The SRS-schwab adult spinal deformity classification: assessment and clinical correlations based on a prospective operative and nonoperative cohort

Table 1 provides a ranking of the top 10 publications based on their Sigma value, indicating their significance in the research area of spinal alignment and related conditions.

Supplementary Table 2 lists the top 10 publications ranked by centrality, highlighting their importance in the network of spinal research based on the frequency of their citation and

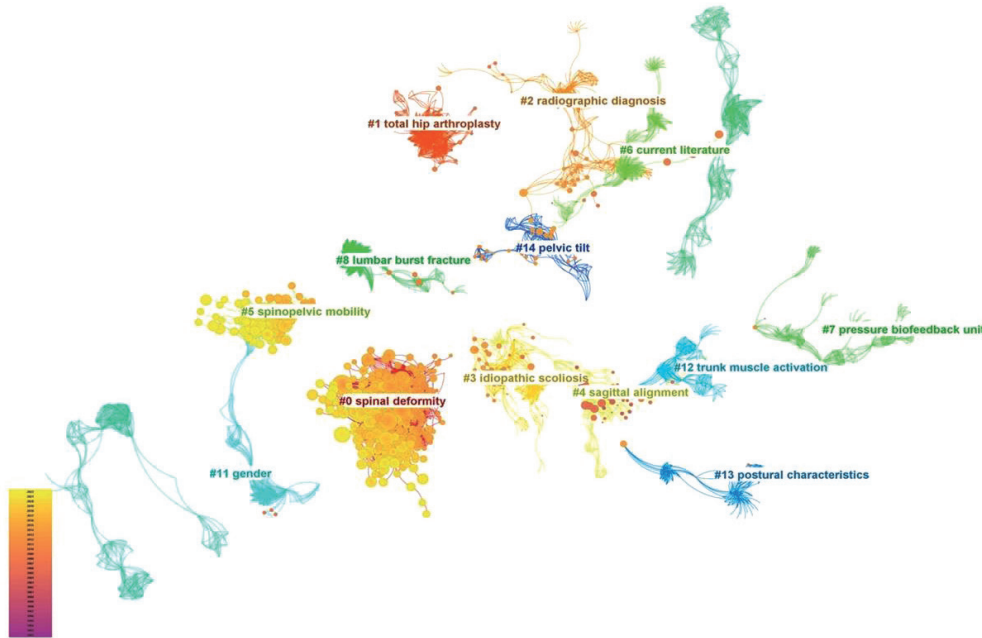


Fig. 4. Visual representation of the clustering of co-citations according to title, abstract, and keywords.

Table 5. Top 10 cluster groups with relevant characteristics

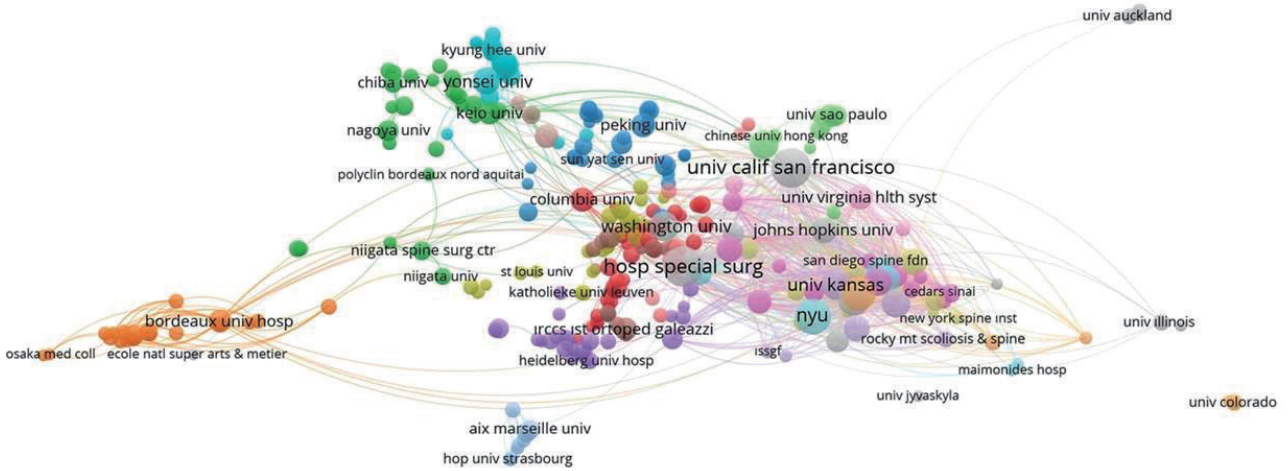
Cluster No.	Size	Silhouette	Label (LSI)	Label (LLR)	Label (MI)	Average year
0	235	0.814	Spinal deformity	Total hip arthroplasty (2977.63, 1.0e-4)	Surgical outcomes review (7.09)	2013
1	150	0.926	Pelvic incidence	Spinopelvic alignment (1121.73, 1.0e-4)	Surgical outcomes review (0.46)	2006
2	113	0.987	Total hip arthroplasty	Total hip arthroplasty (426.96, 1.0e-4)	Weight bearing anteroposterior pelvic radiograph (0.03)	2006
3	86	0.99	Total hip arthroplasty	Total hip arthroplasty (5400.54, 1.0e-4)	Dual mobility device (0.73)	2016
4	63	0.97	Pelvic incidence	Postoperative mechanical complication (1111.07, 1.0e-4)	Surgical outcomes review (1.05)	2017
5	59	0.964	Lenke type	Anterior spinal fusion (101.43, 1.0e-4)	Spinal deformity (0.03)	1999
6	58	0.933	Spinal deformity	Anterior column realignment (744.36, 1.0e-4)	Additional sacropelvic fixation (0.3)	2013
7	50	0.946	Spinal deformity	Thoraco-lumbar fusion (738.38, 1.0e-4)	Surgical outcomes review (0.32)	2014
8	47	1	Locomotive syndrome	Locomotive syndrome (308.33, 1.0e-4)	Spinal deformity (0.03)	2009
9	46	0.998	Anatomic predictor	Anatomic predictor (358.12, 1.0e-4)	Spinal deformity (0.03)	2013

LSI : latent semantic indexing, LLR : log-likelihood ratio, MI : mutual information

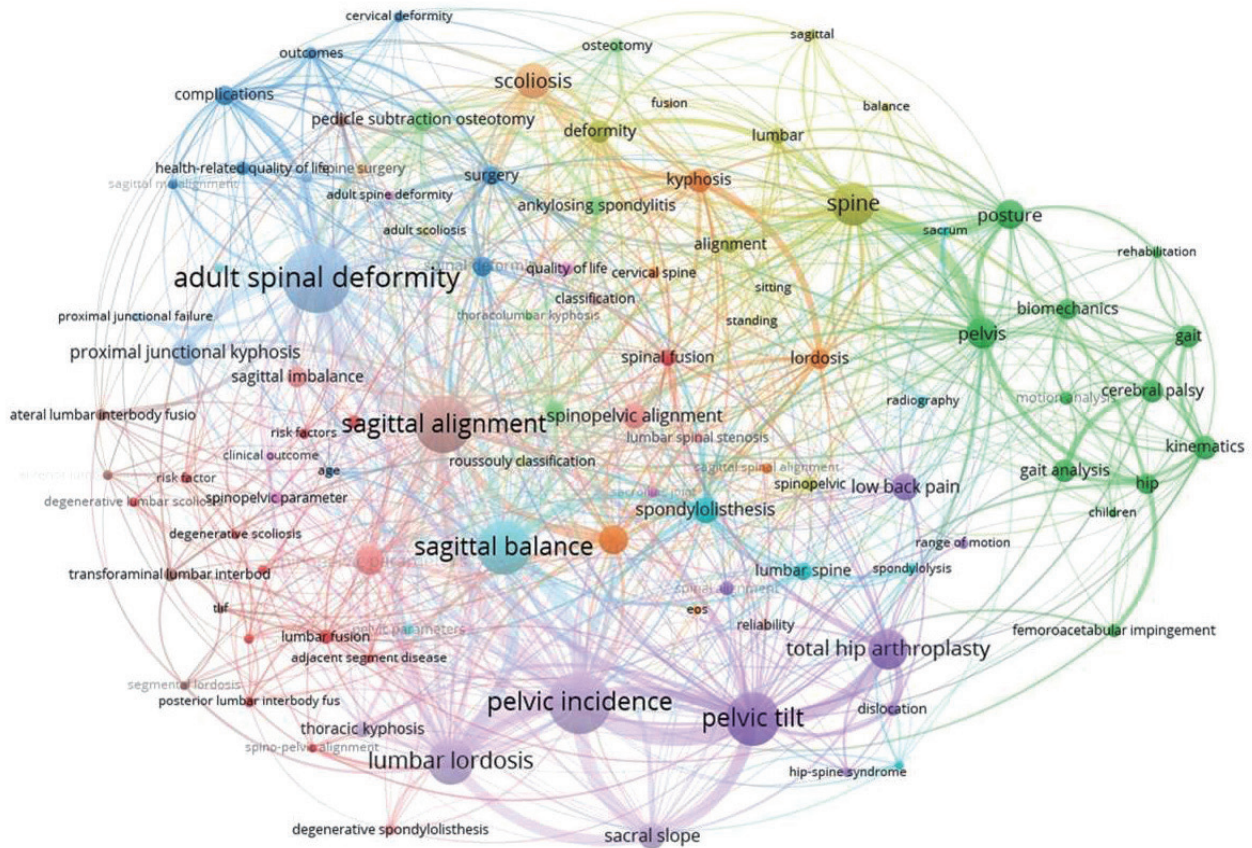
reference. Supplementary Table 3 identifies the major citing articles for each cluster, showing the most influential papers that have significantly cited the research in each specific cluster of spinal study.

**Organization and keyword analysis**

Network visualization of the organizations was performed with VOSviewer. Of 3206, 342 met the minimum threshold of five publications (Fig. 5). Larger text indicates a more signifi-



**Fig. 5.** Network visualization of organization co-authorship.

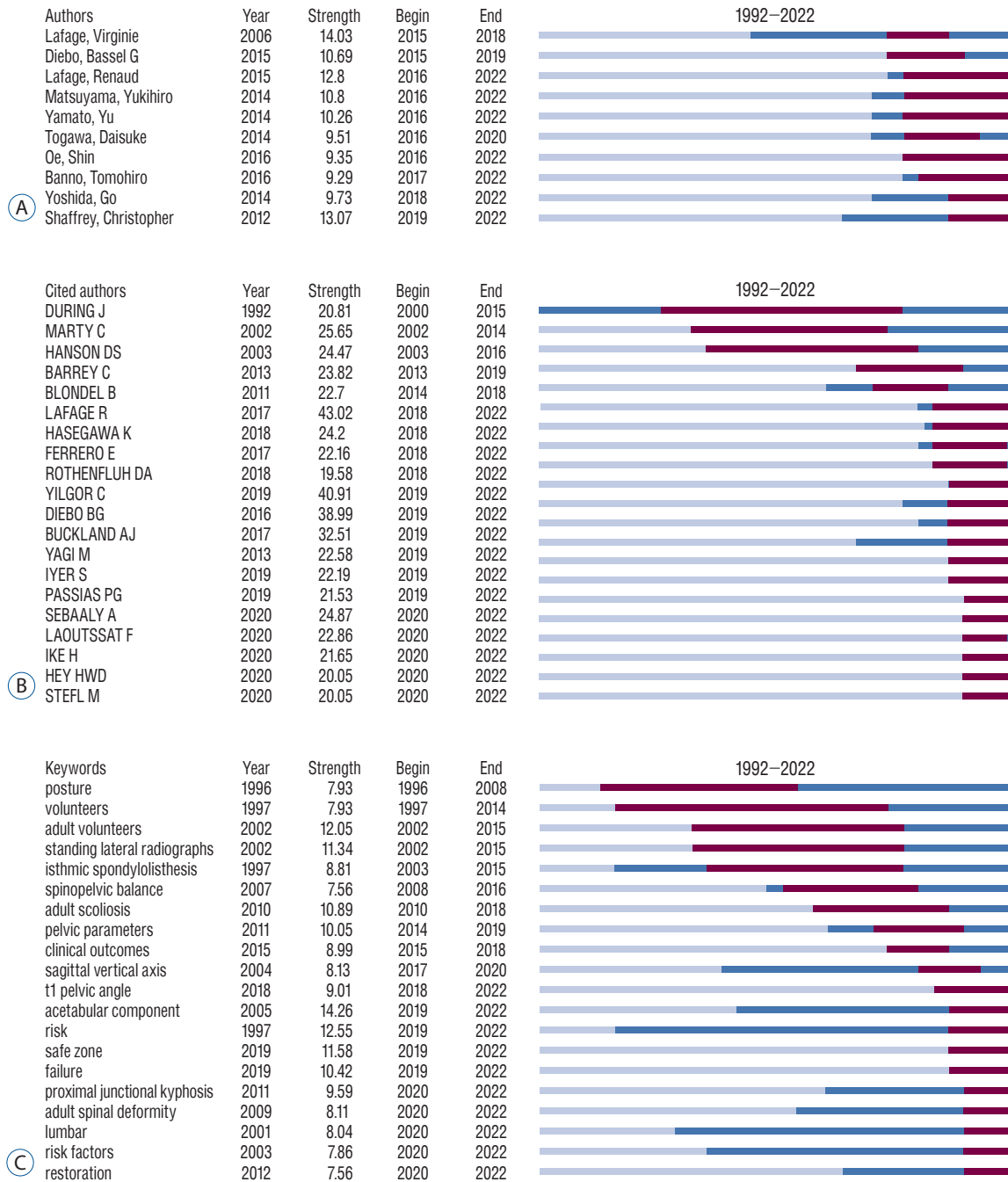


**Fig. 6.** Network of 100 most commonly used keywords.

cant contribution and color indicates the cluster of more strongly connected organizations. Network visualization was also performed for the 100 most commonly used keywords (Fig. 6), with larger link widths indicating stronger connections.

### Burst analysis

Burst analysis was performed for authorship, times cited, and keywords. Fig. 7 shows the top 10 authors with spikes in authored publications, the top 20 authors with spikes in times cited, and the change in popular keywords over the last 30 years, respectively. Some of the popular keywords are non-



**Fig. 7.** A : Top 10 author with the strongest authorship burst. B : Top 20 cited authors with the strongest citation burst. C : Top 20 keywords with the strongest citation burst.

specific, such as ‘risk factors’ or ‘restoration’, but specific keywords related to measurements (e.g., T1 pelvic angle and SVA) and proximal junctional kyphosis have gained popularity in recent years.

## DISCUSSION

Centrality is a key metric in network analysis, reflecting the importance of an article within its cluster. In this context, it refers to how well an article connects to other articles in the same cluster. An article with a higher centrality is considered to be more influential than others. Sigma values, on the other hand, indicate an article’s significance based on its citation patterns. A higher sigma value suggests that an article is more frequently cited than expected, implying its substantial influence in the field. Together, centrality and sigma values assist in identifying key articles within clusters. They highlight articles that not only connect numerous other pieces but also receive more citations than anticipated, signifying their prominence. Silhouette values represent the quality of clustering. Labels using different techniques (LSI, LLR, MI) were used for assigning descriptive names to clusters.

Pelvic morphology and its position relative to the trunk and lower extremities are popular topics in orthopedics as it affects gait mechanics. The normal coronal alignment of pelvis is symmetric and horizontal. The sagittal alignment is more complex<sup>8)</sup>. The ideal sagittal balance is present when body weight is positioned along a line slightly behind the axis of rotation of the femoral heads<sup>15,17)</sup>. Several angles and lines are classically used to assess the sagittal alignment. Pelvic incidence, pelvic tilt and sacral slope are the sagittal parameters of the pelvis. Pelvic incidence is a radiographic measurement that refers to the angle between the line perpendicular to the sacral plate and the line connecting the midpoint of the sacral plate to the center of the femoral heads. Sacral slope refers to the angle formed between the horizontal plane and the superior surface of the sacrum. It is an important parameter used to evaluate the alignment of the pelvis and spine in radiographic images. Lower pelvic incidence is associated with a smaller sacral slope and vice versa<sup>7)</sup>. Pelvic incidence is also related with the lumbar lordosis as required degree of lumbar lordosis is roughly 10 degrees more than the pelvic incidence in the surgical setting<sup>10,18)</sup>. Pelvic tilt is also an important pa-

rameter indicative of pelvic compensation and increased pelvic tilt is associated with increased disability<sup>6)</sup>.

Not only sagittal balance deviates in patients with adult spinal deformity compared to normal population, various spinal pathologies affect the sagittal balance in different ways<sup>12)</sup>. Recent studies suggest that sagittal spinal alignment is more important than coronal deformity when correlated with significant disability<sup>3,13)</sup>. Using bibliometric analysis, our data also revealed research related to sagittal balance and pelvic parameters achieved significant growth over the last decade.

This study also showed the popular authors, keywords and references in the literature both qualitatively and quantitatively. Keyword burst analysis is a feature of CiteSpace that allows searching for popular keywords within titles, abstracts or reference titles in the dataset. Some of the popular keywords are non-specific such as “risk factors” and do not offer any particular insights. Others; however, are more specific and can suggest the popular themes in the literature. In our case, three specific keywords that are popular recently stand out : SVA, T1 pelvic angle, and proximal junctional kyphosis.

SVA is a measurement used in spinal evaluation that determines the vertical alignment of the head, trunk, and pelvis. It is the distance between the vertical line that passes through the center of the hip joint and the plumb line from the spinous process of C7 vertebra<sup>21)</sup>. The T1 pelvic angle is a relatively new radiographic measurement that assesses the relationship between the pelvis and the spine. It is defined as the angle formed between a line drawn from the center of the T1 vertebra to femoral head axis a line from femoral axis to the S1 superior endplate and a line perpendicular to the sacral endplate. Its utility is it combines information from SVA and pelvic tilt. It was found to be highly correlated with both<sup>14)</sup>.

This study revealed the recent interest in SVA and T1 pelvic angle, with the latter appearing only within the last 5 years. The current interest in T1 pelvic angle suggests that the debate is not settled on the best way to assess adult spinal deformity.

In the context of Table 2, centrality is a measure of a country’s influence within the network of scholarly publications. The USA stands out as the leading country in terms of both the number of articles published (985) and centrality (0.74). This indicates that the USA not only has a substantial volume of research output but also holds a strong position in terms of its influence within the scholarly community in relation to pelvic parameters. Although when combined Japan and Chi-



na has almost as much research published, their centrality is much lower than that of the USA.

Co-citation analysis, such as in this study, also provides points of view that traditional review of literature cannot reveal. Co-citation means citing of two sources by the same article. Since related literature is usually cited together, the network of co-cited sources can be a new angle in analyzing the underlying research trends<sup>2)</sup>. Co-cited references that are positioned centrally and have numerous connections to other groups are more significant in the network and exert more influence. The table of co-cited references presented in this paper can be a solid starting point for future researchers who are not familiar with the topic.

Centrality measures the importance of a node (article) within a network based on its connections to other nodes. Articles with higher centrality values indicate that they are more central and influential within their clusters. For example, the article by Le Huec et al.<sup>8)</sup> in Cluster 0 has a centrality of 0.09, suggesting that it plays a significant role in connecting other articles within the cluster. Similarly, the article by Legaye et al.<sup>11)</sup> in Cluster 10 also has a centrality of 0.09, indicating its influential position within its cluster.

The article by Protopsaltis et al.<sup>14)</sup> in Cluster 0 has the highest sigma value of 4.07, indicating that it has received significantly more citations than would be expected. This highlights the influential nature of the article within its cluster.

Furthermore, the most commonly co-cited articles with highest centrality values on pelvic parameter research since 1992 have been authored by Schwab, Lafage V, and Protopsaltis (Table 4), suggesting their crucial role in the field. This emphasizes the significance of their work on adult spinal deformity and spinopelvic alignment.

From a geographical perspective, the USA leads in terms of the number of articles published, followed by Japan and China. This indicates a strong research focus on spinal disorders in these countries.

The cluster analysis reveals a particular emphasis on topics such as spinal deformity, pelvic incidence, and total hip arthroplasty in recent years, with average years around 2006 to 2017. Moreover, specific articles by authors like Protopsaltis, Lafage, and Schwab stand out with high sigma values, indicating their influential role in the field.

In summary these findings provide a comprehensive overview of the current trends and influential works in the field of

spinal research. It emphasizes the significance of spinopelvic parameters and related surgical outcomes, shaping the research agenda for the foreseeable future.

## CONCLUSION

The interest in studies related to pelvic parameter related topics has been outstanding in the recent decade. Virtually non-existent 30 years ago, pelvic parameter related literature demonstrated an exponential growth. The most productive journals in this area of spinal research have been the European Spine Journal, Spine, and Journal of Neurosurgery Spine, with significant contributions by Schwab and Lafage. The USA, Japan, and China dominate in the number of published articles on spinal disorders, with a focus on spinal deformity, pelvic incidence, and total hip arthroplasty. Protopsaltis et al.<sup>14)</sup>, Lafage et al.<sup>6)</sup>, and Schwab et al.<sup>16)</sup>'s articles show particular influence in the field, as indicated by high sigma and centrality values.

## AUTHORS' DECLARATION

### Conflicts of interest

No potential conflict of interest relevant to this article was reported.

### Informed consent

This type of study does not require informed consent.

### Author contributions

Conceptualization : EÖ, SY; Data curation : EÖ, EC; Formal analysis : EC, OB; Methodology : EÖ, AB; Project administration : AB; Visualization : EÖ; Writing - original draft : EÖ, AB, OB; Writing - review & editing : EÖ, AB, OB

### Data sharing

Data is available on request.

### Preprint

None

## ORCID

Serdar Yüksel	<a href="https://orcid.org/0000-0001-9796-5033">https://orcid.org/0000-0001-9796-5033</a>
Emre Özmen	<a href="https://orcid.org/0000-0002-8384-5468">https://orcid.org/0000-0002-8384-5468</a>
Alican Barış	<a href="https://orcid.org/0000-0001-6031-6777">https://orcid.org/0000-0001-6031-6777</a>
Esra Cerci	<a href="https://orcid.org/0000-0001-6515-4324">https://orcid.org/0000-0001-6515-4324</a>
Ozan Beytemür	<a href="https://orcid.org/0000-0002-9608-7280">https://orcid.org/0000-0002-9608-7280</a>

### • Supplementary materials

The online-only data supplement is available with this article at <https://doi.org/10.3340/jkns.2023.0047>.

## References

- Berge C : Heterochronic processes in human evolution: an ontogenetic analysis of the hominid pelvis. **Am J Phys Anthropol** **105** : 441-459, 1998
- Chen C : CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature. **JASIST** **57** : 359-377, 2006
- Glassman SD, Bridwell K, Dimar JR, Horton W, Berven S, Schwab F : The impact of positive sagittal balance in adult spinal deformity. **Spine (Phila Pa 1976)** **30** : 2024-2029, 2005
- Król A, Polak M, Szczygieł E, Wójcik P, Gleb K : Relationship between mechanical factors and pelvic tilt in adults with and without low back pain. **J Back Musculoskelet Rehabil** **30** : 699-705, 2017
- Lafage R, Ferrero E, Henry JK, Challier V, Diebo B, Liabaud B, et al. : Validation of a new computer-assisted tool to measure spino-pelvic parameters. **Spine J** **15** : 2493-2502, 2015
- Lafage V, Schwab F, Patel A, Hawkinson N, Farcy JP : Pelvic tilt and truncal inclination: two key radiographic parameters in the setting of adults with spinal deformity. **Spine (Phila Pa 1976)** **34** : E599-E606, 2009
- Lafage V, Schwab F, Vira S, Patel A, Ungar B, Farcy JP : Spino-pelvic parameters after surgery can be predicted: a preliminary formula and validation of standing alignment. **Spine (Phila Pa 1976)** **36** : 1037-1045, 2011
- Le Huec JC, Aunoble S, Philippe L, Nicolas P : Pelvic parameters: origin and significance. **Eur Spine J** **20(Suppl 5)** : 564-571, 2011
- Le Huec JC, Faundez A, Dominguez D, Hoffmeyer P, Aunoble S : Evidence showing the relationship between sagittal balance and clinical outcomes in surgical treatment of degenerative spinal diseases: a literature review. **Int Orthop** **39** : 87-95, 2015
- Legaye J, Duval-Beaupère G : Sagittal plane alignment of the spine and gravity: a radiological and clinical evaluation. **Acta Orthop Belg** **71** : 213-220, 2005
- Legaye J, Duval-Beaupère G, Hecquet J, Marty C : Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves. **Eur Spine J** **7** : 99-103, 1998
- Lim JK, Kim SM : Difference of sagittal spinopelvic alignments between degenerative spondylolisthesis and isthmic spondylolisthesis. **J Korean Neurosurg Soc** **53** : 96-101, 2013
- Makhni MC, Shillingford JN, Laratta JL, Hyun SJ, Kim YJ : Restoration of sagittal balance in spinal deformity surgery. **J Korean Neurosurg Soc** **61** : 167-179, 2018
- Protopsaltis T, Schwab F, Bronsard N, Smith JS, Klineberg E, Mundis G, et al. : The T1 pelvic angle, a novel radiographic measure of global sagittal deformity, accounts for both spinal inclination and pelvic tilt and correlates with health-related quality of life. **J Bone Joint Surg Am** **96** : 1631-1640, 2014
- Roussouly P, Gollogly S, Nosedà O, Berthonnaud E, Dimnet J : The vertical projection of the sum of the ground reactive forces of a standing patient is not the same as the C7 plumb line: a radiographic study of the sagittal alignment of 153 asymptomatic volunteers. **Spine (Phila Pa 1976)** **31** : E320-E325, 2006
- Schwab FJ, Blondel B, Bess S, Hostin R, Shaffrey CI, Smith JS, et al. : Radiographical spinopelvic parameters and disability in the setting of adult spinal deformity: a prospective multicenter analysis. **Spine (Phila Pa 1976)** **38** : E803-E812, 2013
- Schwab F, Lafage V, Boyce R, Skalli W, Farcy JP : Gravity line analysis in adult volunteers: age-related correlation with spinal parameters, pelvic parameters, and foot position. **Spine (Phila Pa 1976)** **31** : E959-E967, 2006
- Schwab F, Patel A, Ungar B, Farcy JP, Lafage V : Adult spinal deformity-postoperative standing imbalance: how much can you tolerate? An overview of key parameters in assessing alignment and planning corrective surgery. **Spine (Phila Pa 1976)** **35** : 2224-2231, 2010
- Sullivan TB, Marino N, Reighard FG, Newton PO : Relationship between lumbar lordosis and pelvic incidence in the adolescent patient: normal cohort analysis and literature comparison. **Spine deform** **6** : 529-536, 2018
- van Eck NJ, Waltman L : Software survey: VOSviewer, a computer program for bibliometric mapping. **Scientometrics** **84** : 523-538, 2010
- Van Royen BJ, Toussaint HM, Kingma I, Bot SD, Caspers M, Harlaar J, et al. : Accuracy of the sagittal vertical axis in a standing lateral radiograph as a measurement of balance in spinal deformities. **Eur Spine J** **7** : 408-412, 1998