

# Prominent themes in shoulder dystocia research

## A bibliometric and document-based analysis

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### Abstract

**Background:** This study aims to comprehensively examine the academic development of shoulder dystocia (SD) through bibliometric and document analysis and to identify topics that can guide future research.

**Methods:** In this study, performance, co-citation, co-word, and document analyses were used as bibliometric analysis techniques.

**Results:** The study identified 3 main themes in terms of the intellectual structure of Shoulder Dystocia (SD): "Management of SD, Risk Factors and Associated Complications," "Clinical Practices, Birth Abnormalities and Effects of Complications," and "Impact of Education, Clinical Maneuvers and Fetal Health Outcomes." Co-occurrence analysis identified 4 significant themes: "Management and Clinical Practice of SD," "Fetal Macrosomia and Risk Factors," "Obstetric Maneuvers and Brachial Plexus Injury," and "Clinical Trends and Risks in SD." Additionally, ten consolidated themes were identified as a result of thematic coding analysis.

**Conclusion:** Shoulder dystocia remains a critical component of obstetric practice. Themes such as training and simulation, risk factors, and technical and management approaches are consistently emphasized. Technological advances and studies on how machine learning techniques can be used effectively in this field reflect innovative approaches in the scientific literature. This analysis confirms that shoulder dystocia is a complex topic requiring a multidisciplinary approach and that research in this field is constantly evolving.

**Abbreviations:** C/Y = citations per year, C = citations, SD = shoulder dystocia, WoS = Web of Science

**Keywords:** co-citation analysis, consolidated themes, co-occurrence analysis, shoulder dystocia

### 1. Introduction

Shoulder dystocia (SD) is a critical obstetric complication characterized by the impaction of the fetal shoulders within the maternal pelvis during labor, impeding the delivery process.<sup>[1,2]</sup> This condition carries severe risks to both the mother and the baby. For the baby, there is a potential risk of fetal injuries, lack of oxygen, and, in some cases, fetal death.<sup>[3,4]</sup> For the mother, complications such as bleeding and tearing can occur.<sup>[5]</sup> The unpredictable nature of shoulder dystocia emphasizes the importance of understanding its management, risk factors, and associated complications.<sup>[6,7]</sup> The management, risk factors, and associated complications of shoulder dystocia constitute a central aspect of the obstetric practice.<sup>[8,9]</sup> In particular, establishing an objective definition of SD is critical for standardizing clinical practice.<sup>[10,11]</sup>

Reported rates of SD vary considerably, from as low as 0.1% to as high as 16.0%. Several factors contribute to this wide range. One major factor is the diverse populations studied; variations in genetic, ethnic, and demographic characteristics can significantly influence the incidence of SD.

Additionally, different definitions of SD applied in various studies create inconsistencies in reported rates. Some definitions might be more stringent or comprehensive than others, leading to higher or lower reported incidences. Furthermore, situations where documentation may not be comprehensive can also affect reported rates. Incomplete or inaccurate medical records, underreporting, or variations in clinical practice and reporting standards across different regions and healthcare settings can all contribute to the observed variability. These factors highlight the complexity of accurately assessing the prevalence of SD and underscore the importance of standardized definitions and rigorous documentation practices in research and clinical settings.<sup>[12]</sup>

Clinical practice and studies on the effects of birth abnormalities and complications provide in-depth information on the causes, risk factors, and potential consequences of SD. In particular, fetal macrosomia and prolonged second stage of labor have been reported to cause SD.<sup>[13,14]</sup> Furthermore, research on the impact of education highlights how young doctors and medical students can increase their competence in the management of

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The datasets generated during and/or analyzed during the current study are publicly available.

Ethical approval was not required for this study as it is an open access work.

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shoulder dystocia.<sup>[15,16]</sup> This suggests that better outcomes can be achieved by combining education and practice.

SD is a critical part of obstetric practice, and scientific research on this topic is vital to protect the health of mothers and babies. By informing and guiding clinical practice, these studies help to tackle this challenging complication during labor.

### 1.1. Motivation for the study

The motivation for this study stems from the need to provide a comprehensive and systematic understanding of the current state of research on SD. Despite its critical importance in obstetric practice, the variability in reported rates and the diverse definitions and documentation practices make it challenging to form a cohesive understanding of SD. By conducting a bibliometric analysis, this study aims to synthesize existing knowledge, identify prominent clusters and themes, and highlight the intellectual structure of SD research. This approach will help clinicians and researchers gain a holistic view of the field, understand its effectiveness and limitations, and pinpoint research gaps. Ultimately, this study seeks to guide future research directions and improve clinical practices related to the management and prevention of SD.

Summarizing and highlighting the state-of-the-art intellectual structural conceptual structure and common themes of publications in SD is vital for clinicians and researchers to have a holistic understanding of the current state of the literature, its effectiveness, and limitations. Therefore, this study aimed to compile the existing knowledge on SD and conduct a bibliometric analysis to assess the prominent clusters and content of themes in this field.

This bibliometric analysis aims to provide a comprehensive assessment of SD-related publications. By providing a scientific perspective on the full scope of SD, this study aims to help identify current research gaps in the field and provide directions for future work. The following questions are the research questions selected to address the above gaps:

- i) What are the most prolific authors, the most cited journals, institutions, and countries, and the most cited articles in the field of “SD?”
- ii) What are the most important classical works in the field of “SD?” What are the dynamics of the development of the intellectual structure of this field?
- iii) Which concepts feed the conceptual structure of the field of “SD?” What are the prominent themes and essential issues emphasized in the theme?
- iv) Can consolidated themes be identified through document review analysis using article titles and abstracts in SD?

The paper is divided into 5 sections. We start the second section with the methodology, outlining the research technique. The results of our performance analysis, bibliometric analysis, and document analysis are presented in Section 3. In Section 4, we discuss the results, the limitations of the research, and recommendations for future research. Finally, we conclude with a conclusion.

## 2. Material and method

In the first stage, we evaluated the publications on “shoulder dystocia” through bibliometric analysis. Bibliometric analysis enables the evaluation of a topic or field using quantitative and statistical analysis.<sup>[17]</sup> This analysis helped us identify the most influential authors, institutions, and countries. We chose the Web of Science (WoS) database, which is frequently used in the social sciences.<sup>[18]</sup> Clarivate Analytics’ WoS is one of the leading scientific citation platforms. It is used for academic research and data analysis, contains millions of records and citations, and thousands of new items are added daily.<sup>[19]</sup>

We created the dataset with a specific search strategy using the word “Shoulder Dystocia.” As a result of this strategy, we reached 498 articles. These articles were analyzed with Bibliometrix software.<sup>[20]</sup> We performed science mapping with techniques such as co-citation, coauthor, and co-word analysis.<sup>[17]</sup> In the second stage, we performed thematic coding using the titles and abstracts of 498 articles. This analysis helped us to identify the most studied topics in SD in a field. The methodological process of the research is shown in Figure 1.

The extensive body of knowledge in the literature can present significant challenges for researchers. Bibliometric analysis offers an effective solution to this issue. By examining the literature at a macro level, bibliometric analysis provides a comprehensive overview of scientific outputs and their developmental processes within a single projection.<sup>[21]</sup> Bibliometrix program was used to analyze the data obtained. The Bibliometrix program is a recent open-source software developed based on R to perform science mapping.<sup>[22]</sup>

In our review, 498 articles were analyzed in 2 sections. In the first part, performance analysis of articles in SD, including basic statistics, publication amounts, authors, articles, journals, institutions, and countries, and in the second part, science mapping, including co-citation network visualization and co-occurrence analysis, was performed. No word combinations were made during the analysis. A consolidated theme analysis was performed for thematic coding in the last stage. The study framework we have determined for the study on SD is shown in Figure 1.

The data search was conducted in the WoS database on August 16, 2023. Sorting and filtering were performed while retrieving the data from Wos. Publications on “Shoulder Dystocia” were searched in the WoS database, and 498 publications were obtained.

### 2.1. Findings

In this section, we first analyzed the number of publications and citation amounts, the most productive journals, authors, and countries in SD through 498 articles. In the second stage, we visualized the field of SD through co-citation and co-word analyses. Finally, document analysis identified the prominent themes and topics in the field.

**2.1.1. Performance analysis.** According to the results of the analysis, 498 academic and research documents from 93 different sources were analyzed between 1982 and 2023. These documents are of moderate influence in their respective fields, with an average of 14.47 citations and contributions from 1168 authors. On average, there are 3.23 authors per document, while about 6.6% involve international collaboration. Most documents are in article format, and the dataset has rich keywords. These documents, covering both old and new research, are of reasonable quality and relevance, and the level of international collaboration is notable. Collaborative rather than individual studies are more common (Fig. 2).

For publications on “Shoulder Dystocia,” the years 1985, 1998, 2006, and 2016 stand out with their prominent citation numbers. However, in 2022, 19 articles received only 10 citations, indicating that these articles are new and may receive more citations over time. Citation counts are a critical factor in determining the impact of an article. The low number of citations in recent years reflects the potential of new articles. Studies on “Shoulder dystocia” have increased impact and acceptance over time (Fig. 3).

Total number of publications and citations is given in Figure 4. The total number of articles is 498 and the total number of citations is 7031.

Clear trends emerge when we analyze the evolution of publications on “Shoulder Dystocia” over the years. In the period

1982 to 1990, the number of publications could be much higher, indicating that the topic may have been a new and little-known field at that time. In the period 1991 to 2000, especially towards the end of the 90s, there is a marked increase in the number of publications. This suggests a growing scientific interest in “Shoulder Dystocia” during this period. Between 2001 and 2010, the number of publications increased steadily. However, a notable increase in the number of publications was observed in 2011 to 2022, especially in 2016 and 2018. Overall, publications on the topic “Shoulder Dystocia” have shown a steady increase over time. From a relatively low level of interest in the early 1980s, there was a significant acceleration in the late 1990s and early 2000s. In the last decade, this topic has been a sustained interest and research activity. This shows that “Shoulder Dystocia” is becoming increasingly important for medical research.

Table 1 shows the most prolific authors on “Shoulder Dystocia” and the number of citations they have received. Most Prolific Author, Gherman, RB, stands out as the author with the most publications in this field. He has a total of 23 publications, and these publications have been cited 299 times. The average number of citations per year is 18.7. The Highest Cited Author, Gonik B, has 11 publications with 332 citations. This means

an average of 42.73 citations per year. This statistic shows that Gonik B’s work is highly influential and recognized. In terms of High Annual Average Citation, Croft J has received 279 citations with a total of 9 publications. This means an average of 40.22 citations per year. This shows that Croft J’s work has been highly influential in a short period of time. In terms of University Distribution, 2 authors from Johns Hopkins University (Allen RH and Gurewitsch, E) made the list. Likewise, 2 authors from the University of Southern California (Ouzounian, JG and Goodwin, TM) were included in the list. This shows that these universities can be an essential research center on “Shoulder Dystocia.” Another distinction is the Country Distribution. The majority of the authors on the list come from the USA. Only Croft J is represented from the UK.

\* Only the first author’s name is written. PY: Publication year; TC: Total Citation; C/Y = Citations per Year

Table 2 shows the most prolific authors working on “Shoulder Dystocia.” Citation counts are an important indicator of the influence and recognition of an author or work. These authors have made a significant contribution to the body of knowledge on “Shoulder Dystocia.”

Some of the research on “Shoulder Dystocia” has played an important role in deepening knowledge and understanding in this

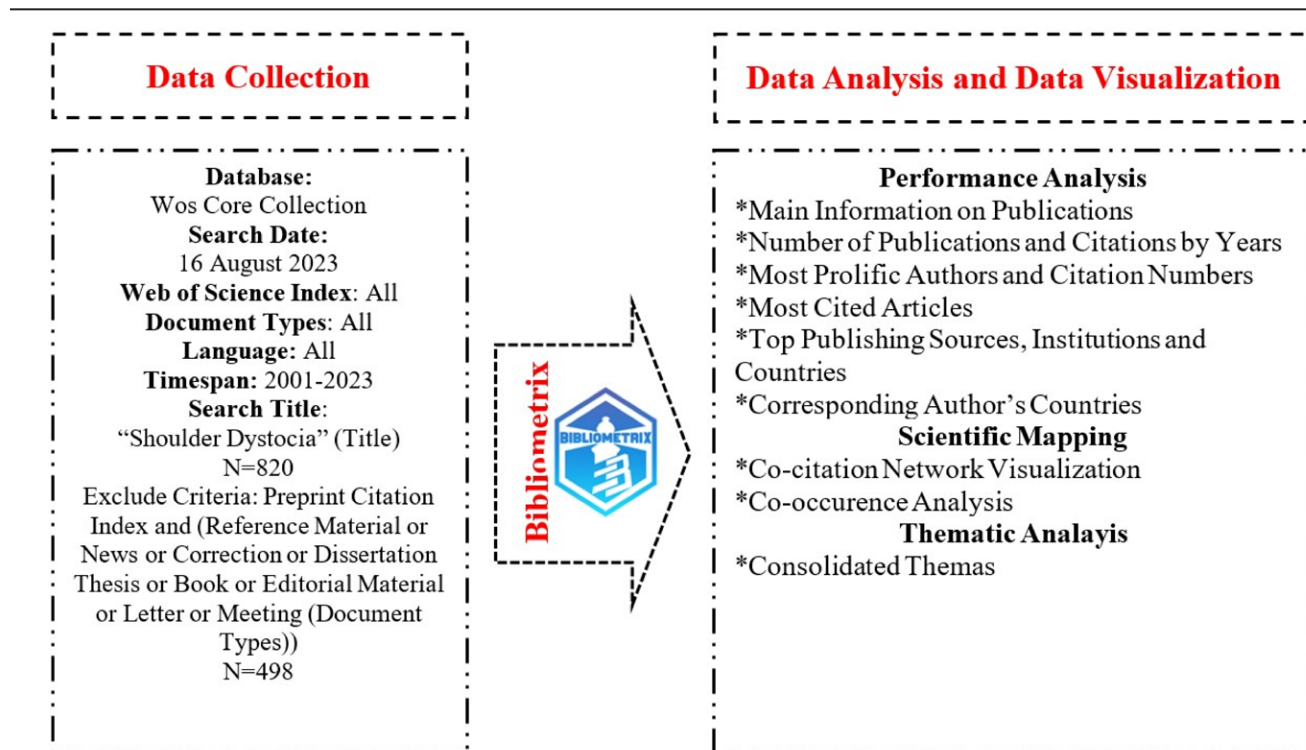


Figure 1. Flowchart of data collection, data analysis, and data visualization.



Figure 2. Main information on publications.

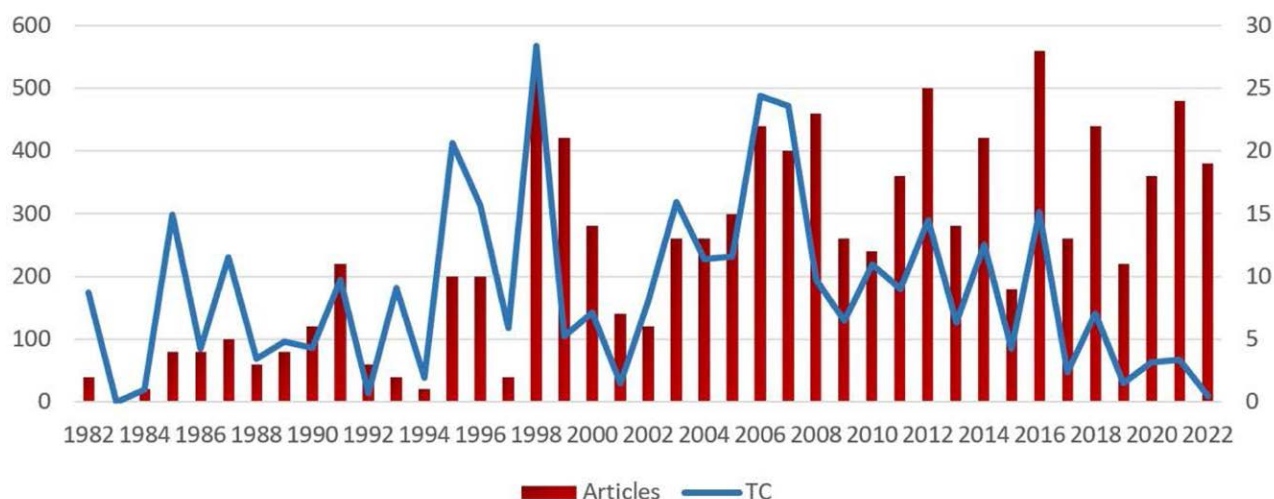


Figure 3. Number of publications and citations by year.

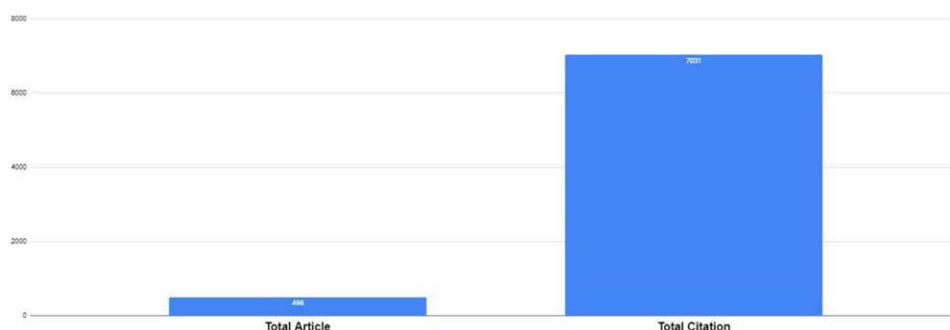


Figure 4. Total number of publications and citations.

Table 1

Most prolific authors and citation numbers.

| Authors      | University                                        | Country | TP | C   | C/Y   |
|--------------|---------------------------------------------------|---------|----|-----|-------|
| Gherman RB   | Luminis Hlth Syst                                 | USA     | 23 | 299 | 18.7  |
| Chauhan SP   | University of Texas Health Science Center Houston | USA     | 19 | 150 | 11.16 |
| Ouzounian JG | University of Southern California                 | USA     | 13 | 290 | 29.62 |
| Allen RH     | Johns Hopkins University                          | USA     | 13 | 214 | 26.67 |
| Gonik B      | Wayne State University                            | USA     | 11 | 332 | 42.73 |
| Gurewitsch E | Johns Hopkins University                          | USA     | 10 | 77  | 8.8   |
| Gherman R    | US Navy Reserve                                   | USA     | 10 | 180 | 18.9  |
| Croft J      | North Bristol NHS Trust                           | England | 9  | 279 | 40.22 |
| Goodwin TM   | University of Southern California                 | USA     | 9  | 263 | 35.78 |
| Sandmire HF  | Ob Gyn Assoc Green Bay Ltd                        | USA     | 8  | 82  | 10.38 |

C = citations; C/Y = citations per year, TP = total publication.

field. A study conducted in California looked in detail at the risk of shoulder dystocia at birth in macrosomic infants and the factors associated with this risk. This study provided critical information for counseling obstetric care providers in cases of suspected macrosomia.<sup>[24]</sup> At the same time, highlighting that our current knowledge of shoulder dystocia is limited and sometimes inconsistent, another study found that this condition is an unpredictable event and infants at risk of permanent injury are difficult to predict.<sup>[6]</sup>

Other critical studies of shoulder dystocia have focused on the management and training of this condition. For example, one study evaluated the retention of acquired skills following shoulder dystocia training and found that training led to a sustained improvement

in performance.<sup>[28]</sup> Another study examining the impact of simulation training in shoulder dystocia management demonstrated how such training can improve performance.<sup>[15]</sup> Among diabetic women, a study on whether elective delivery of infants diagnosed with macrosomia by ultrasound reduces the risk of shoulder dystocia showed that such an approach can positively affect outcomes for high-risk women and infants.<sup>[30]</sup> These studies increase our knowledge on SD and emphasize the importance of research in this field in the medical literature.

In publications on SD, the most active institution is “The University of Texas System” with 23 publications. This institution is followed by “Johns Hopkins University” with 19

**Table 2**  
**Top 10 most cited studies.**

| Year                                    | Sources                                       | Title                                                                                                                          | Journal                                       | Publisher                     | TC  | C/Y  |
|-----------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------------------------|-----|------|
| Acker, DB (1985) <sup>[23]</sup>        | Obstetrics and Gynecology                     | Risk-factors for shoulder dystocia                                                                                             | Obstetrics and Gynecology                     | Lippincott Williams & Wilkins | 227 | 5.82 |
| Nesbitt, TS (1998) <sup>[24]</sup>      | American Journal of Obstetrics and Gynecology | Shoulder dystocia and associated risk factors with macrosomic infants born in California                                       | American Journal of Obstetrics and Gynecology | Elsevier                      | 195 | 7.5  |
| Gherman, Robert B (2006) <sup>[6]</sup> | American Journal of Obstetrics and Gynecology | Shoulder dystocia: The unpreventable obstetric emergency with empiric management guidelines                                    | American Journal of Obstetrics and Gynecology | Elsevier                      | 158 | 8.78 |
| Baskett, TF (1995) <sup>[25]</sup>      | Obstetrics and Gynecology                     | Perinatal implications of shoulder dystocia                                                                                    | Obstetrics and Gynecology                     | Lippincott Williams & Wilkins | 155 | 5.34 |
| Nocon, JJ (1993) <sup>[26]</sup>        | American Journal of Obstetrics and Gynecology | Shoulder dystocia – An analysis of risks and obstetric maneuvers                                                               | American Journal of Obstetrics and Gynecology | Elsevier                      | 143 | 4.61 |
| Gross, TL (1987) <sup>[27]</sup>        | American Journal of Obstetrics and Gynecology | Shoulder dystocia – A fetal-physician risk                                                                                     | American Journal of Obstetrics and Gynecology | Elsevier                      | 128 | 3.46 |
| Crofts, Joanna F (2007) <sup>[28]</sup> | Obstetrics and Gynecology                     | Management of shoulder dystocia – Skill retention 6 and 12 months after training                                               | Obstetrics and Gynecology                     | Lippincott Williams & Wilkins | 124 | 7.29 |
| Deering, S (2004) <sup>[15]</sup>       | Obstetrics and Gynecology                     | Improving resident competency in the management of shoulder dystocia with simulation training                                  | Obstetrics and Gynecology                     | Lippincott Williams & Wilkins | 123 | 6.15 |
| Modanlou, HD (1982) <sup>[29]</sup>     | Obstetrics and Gynecology                     | Large-for-gestational-age neonates – Anthropometric reasons for shoulder dystocia                                              | Obstetrics and Gynecology                     | Lippincott Williams & Wilkins | 116 | 2.76 |
| Conway, DL (1998) <sup>[30]</sup>       | American Journal of Obstetrics and Gynecology | Elective delivery of infants with macrosomia in diabetic women: Reduced shoulder dystocia versus increased cesarean deliveries | American Journal of Obstetrics and Gynecology | Elsevier                      | 109 | 4.19 |

publications and “University of California System” with 17 publications. In addition, institutions such as “The University of Southern California,” “Wayne State University,” “Rutgers State University Medical Center,” and “Rutgers State University New Brunswick” contributed with 13 to 14 publications. In terms of journals, the “American Journal of Obstetrics and Gynecology” is the leader with 80 publications, followed by “Obstetrics and Gynecology” with 65 publications and “The European Journal of Obstetrics Gynecology and Reproductive Biology” with 21 publications. On a country basis, the USA is the most productive country with 251 publications, followed by the UK with 43 publications and Canada with 24 publications. Israel, Australia, Italy, and France are among the other countries that attract attention with their publications in this field (Table 3).

### 2.1.2. Scientific mapping.

In this section, co-citation and cooccurrence analyses were performed. Here, by using the prominent color clusters, the name of each color was determined and its relevance to the SD topic was clarified.

#### 2.1.2.1. Co-citation analysis.

Co-citation analysis allowed us to visualize the patterns of co-citation between field studies and determine the intensity and strength of the relationships between studies. The authors named the themes after carefully reading the articles collected in each cluster. The co-citation analysis shows that the intellectual structure of articles studying SD is organized into 3 main themes: “Management of SD, Risk Factors and Associated Complications,” “Clinical Practices, Birth Abnormalities, and Complications,” and “Impact of Education, Clinical Maneuvers and Fetal Health Outcomes.” The network visualization resulting from the co-citation analysis is presented in Figure 5.

**2.1.2.1.1. Red cluster.** Management of SD, Risk Factors, and Associated Complications: This theme encompasses management strategies, risk factors, and potential complications associated with this condition, frequently appearing in article titles.

SD is a condition in which the baby’s head gets stuck in the birth canal of the shoulders after birth. This obstetric complication carries severe risks for both mother and baby and can

lead to fetal injury, oxygen deprivation, and sometimes fetal death.<sup>[11]</sup> It can also cause bleeding, lacerations, and other complications in the mother.<sup>[24]</sup> Gherman et al<sup>[31]</sup> conducted several studies on the management of shoulder dystocia and associated fetal morbidity. The study on the effectiveness of McRoberts’ maneuver and the study on shoulder dystocia as an unpredictable obstetric emergency has made essential contributions in this field.<sup>[6]</sup> Spong et al<sup>[32]</sup> focused on objectively defining shoulder dystocia. This definition is critical for the standardization of clinical practice.

Deering et al<sup>[15]</sup> studied increasing the competence of medical students and junior doctors in SD management through simulation training. This shows that better results can be achieved by combining education and practice. Nesbitt et al<sup>[24]</sup> conducted an in-depth review of SD and associated risk factors in macrosomic infants. These risk factors are critical in prenatal risk assessment and birth planning. Chauhan et al<sup>[33]</sup> shared their extensive experience with brachial plexus injury. This injury is a common complication of SD and can lead to long-term disability. Other authors have also contributed to various aspects of SD, indicating that this topic requires a multidisciplinary approach.<sup>[34,35]</sup>

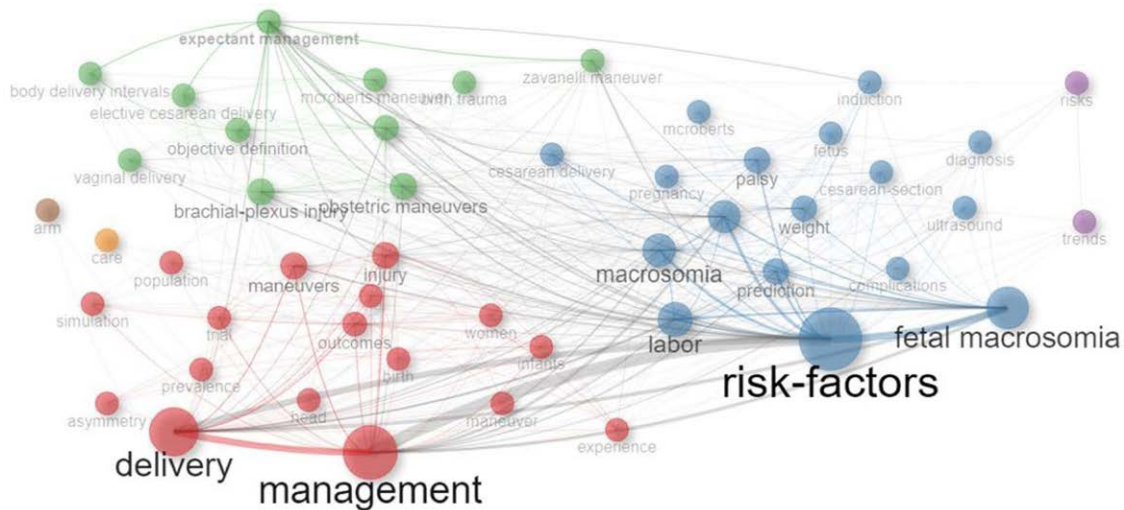
Consequently, the management of SD, its risk factors and associated complications is a critical part of obstetric practice and scientific research in this area is vital to protect the health of both mothers and infants.<sup>[8]</sup>

**2.1.2.1.1. Blue cluster.** Clinical Practice, Effects of Birth Abnormalities and Complications: SD describes a condition in which the baby’s shoulders are compressed in the birth canal during labor and is a serious complication encountered in obstetric practice. This condition carries potential risks for both mother and baby. In particular, fetal injuries, lack of oxygen and sometimes fetal death are associated with this complication.<sup>[23,25]</sup>

Many researchers have studied the causes, risk factors, and potential consequences of SD. For example, Benedetti and Gabbe<sup>[36]</sup> reported that fetal macrosomia and prolonged second stage of labor might cause SD in association with mid pelvic delivery. Nocon et al<sup>[26]</sup> analyzed the risks of SD and obstetric maneuvers. Langer et al<sup>[37]</sup> questioned whether babies over 4000 grams should be delivered by cesarean section.

Some researchers, such as Gross et al<sup>[27]</sup> and Rouse et al,<sup>[38]</sup> have focused on the fetal and physician risks of SD. In particular,





**Figure 6.** Co-occurrence analysis.

This injury is a common complication of SD and can lead to long-term disability.

Some researchers, such as Hoffman et al<sup>[53]</sup> and Grobman et al,<sup>[54]</sup> have focused on comparing obstetric maneuvers and the outcomes of introducing protocols for the acute management of SD. These studies help to overcome this challenging complication during labor by informing and guiding clinical practice.

In the co-citation analysis, several papers emerged as highly influential due to their high co-citation counts and strong link strengths. For instance, Gherman et al<sup>[31]</sup> and Spong et al<sup>[32]</sup> are frequently co-cited, reflecting their pivotal role in defining and managing SD. Nesbitt et al<sup>[24]</sup> and Chauhan et al<sup>[33]</sup> also demonstrate high co-citation link strength, indicating their critical contributions to understanding risk factors and complications associated with SD. Additionally, Leung et al<sup>[49]</sup> and Draycott et al<sup>[50]</sup> are notable for their strong influence on education and clinical maneuvers, emphasizing the importance of combining practical training with clinical practice to improve outcomes in SD management. These high co-citation counts and strong link strengths underscore the foundational role these studies play in shaping the field of SD research.

In conclusion, SD is a critical part of obstetric practice and scientific research on this topic is vital to protect the health of mothers and babies. By informing and guiding clinical practice, these studies help to overcome this challenging complication during labor.

#### 2.1.2.2. Co-occurrence analysis.

These themes are a reflection of the keywords you have provided and the overall context of the topic you are studying. These themes represent different aspects of shoulder dystocia and the focus of research on this topic. We would like to point out that the first 4 clusters are seen as patterns in the co-occurrence analyses as there are no other phrases in the orange and brown clusters.

The network map resulting from the common word analysis on SD is presented in Figure 6. This co-occurrence analysis reveals several distinct clusters, each representing different aspects of research on shoulder dystocia (SD).

2.1.2.2.1. Red cluster: “Management and clinical practice of SD”. This cluster encompasses the clinical management strategies and practices related to SD. Key terms such as “management,” “delivery,” “maneuvers,” and “injury” indicate that this cluster is primarily concerned with how SD is handled during labor. It includes discussions on various

maneuvers employed to resolve shoulder dystocia, such as the McRoberts maneuver, and the clinical outcomes associated with these practices. This cluster also covers the risk factors and complications associated with SD, emphasizing the importance of effective management strategies to minimize maternal and fetal injuries during delivery.

2.1.2.2.2. Blue cluster: “Fetal macrosomia and SD risk factors”. This cluster focuses on the etiological factors and risk determinants of SD, particularly the role of fetal macrosomia. Keywords like “risk-factors,” “fetal macrosomia,” “macrosomia,” and “labor” suggest that this cluster is dedicated to understanding how the size of the fetus, especially larger-than-average fetuses, contributes to the occurrence of SD. The discussion in this cluster likely covers prenatal assessments and interventions aimed at identifying and managing pregnancies at high risk for SD due to macrosomia, thereby improving labor outcomes.

2.1.2.2.3. Green cluster: “Obstetric maneuvers and brachial plexus injury”. This cluster highlights the obstetric maneuvers used during the management of SD and the potential complications, with a particular focus on brachial plexus injuries. Keywords such as “brachial-plexus injury,” “obstetric maneuvers,” and “microberts maneuver” indicate an emphasis on the clinical techniques used to address SD and the associated risks. Discussions in this cluster may include the effectiveness and safety of various maneuvers, as well as strategies to prevent or mitigate injuries to the brachial plexus during shoulder dystocia events.

2.1.2.2.4. Purple cluster: “Clinical trends and risks in SD”. The keywords “trends” and “risks” in this cluster suggest a focus on the evolving clinical practices and emerging risks associated with SD. This cluster likely explores the latest research trends, technological advancements, and shifts in clinical guidelines related to the management of SD. It may also cover the identification of new risk factors and the implications of these findings for clinical practice and patient safety.

2.1.2.2.5. Orange cluster: “Comprehensive care in SD”. The keyword “care” in this cluster indicates a focus on the holistic management and overall care of patients experiencing SD. This cluster is likely concerned with the multidisciplinary approach to managing SD, encompassing prenatal care, intrapartum strategies, and postpartum follow-up. It emphasizes the importance of coordinated care to improve outcomes for

both mothers and infants, addressing all aspects of patient management from risk assessment to recovery.

**2.1.2.2.6. Brown cluster:** “SD and upper limb complications”. The keyword “Arm” suggests that this cluster is dedicated to the study of upper limb complications resulting from SD. This includes the examination of injuries such as brachial plexus palsy and other arm-related injuries that can occur during delivery. Research in this cluster likely focuses on the mechanisms of injury, prevention strategies, and the long-term outcomes for infants affected by these complications.

These themes, derived from the keywords provided and the overall context of the topic, represent the multifaceted nature of shoulder dystocia research. Each cluster highlights a different aspect of SD, from management practices and risk factors to clinical trends and comprehensive care. The first 4 clusters, in particular, are seen as prominent patterns in the co-occurrence analyses, providing valuable insights into the primary areas of focus within the field. The themes identified through this analysis offer a holistic understanding of the current state of research on SD, its effectiveness, and its limitations, guiding future studies and improving clinical practices.

**2.1.3. Document analysis.** A total of 498 article titles and abstracts were used for document analysis. This analysis was carried out in 5 stages. First, 5 different packages were created by dividing the articles into groups of 100. Thematic coding was done based on the titles and abstracts of 100 articles in each package. The themes obtained from each package were consolidated by combining them with the next package. At the end of this process, a total of 10 main theme groups were identified:

- Definition, Incidence, and Fundamentals of SD
- Risk Factors, Predictability, and Comprehensive Risk Assessment
- Complications, Outcomes, Injuries, and Associated Risks
- Management, Treatment, Techniques, and Clinical Approaches
- Training, Education, Simulation, Skill Development, and Retention
- Research, Epidemiology, Methods, Approaches, and Diverse Populations
- Prevention, Prophylaxis, Interventions, and Treatment Outcomes
- Reviews, Discussions, Perspectives, Commentaries, and Historical Aspects
- Tools, Equipment, Assessment Instruments, and Documentation
- Impact, Specific Populations, and Geographical Studies

The theme “Definition, Incidence and Key Characteristics of SD” addresses what SD is, its prevalence and key aspects. The theme “Risk Factors, Predictability and Comprehensive Risk Assessment” covers information on risk assessment techniques and diagnostic tools. The theme “Complications, Consequences, Injuries and Associated Risks” focuses on the potential consequences of SD. The theme “Management, Treatment, Techniques and Clinical Approaches” highlights clinical strategies and techniques. The theme “Training, Simulation, Skill Development and Retention” is focused on continuous learning and skill development. The theme “Research, Epidemiology, Methods, Approaches and Diverse Populations” addresses research methodologies and epidemiologic studies. The theme “Prevention, Prophylaxis, Interventions and Treatment Outcomes” covers preventive measures and interventions. The theme “Reviews, Debates, Perspectives, Interpretations and Historical Aspects” provides information on the scientific debate and the historical evolution of SD. The theme “Tools, Equipment, Assessment Tools and Documentation” focuses on the importance of medical tools and equipment used for diagnosis and management.

Finally, the theme “Impact and Geographical Studies” examines the broad societal and geographical implications of SD. These themes aim to fill knowledge gaps in the literature on shoulder dystocia and provide a holistic understanding of the topic.

### 3. Discussion

SD is considered a critical part of obstetric practice, and research on its management, risk factors, and outcomes suggests that this complication requires a multifaceted approach. The findings of the 3 separate analyses will be discussed in the discussion section. In order to achieve this goal, we identified studies that were published in 2023 but were not included in the visualization and were not included in the dataset we downloaded. As a result of the examination of the articles, new themes “Training and Simulation,” “Risk Factors and Incidence Analysis,” “Technical and Management,” “Machine Learning and Prediction,” and “Medico-legal Issues” were identified through thematic coding. These themes were compared and discussed with the findings and results of co-citation, co-word, and consolidated themes. Now, first of all, the similarities and differences between the clusters found as a result of the co-citation analysis and the new themes and the reasons for this will be analyzed. In the next stage, the common vocabulary and consolidated themes will be discussed together with the themes of the new studies. This analysis identified similarities, differences, and emerging themes between older and newer studies. This assessment was made to show how the scientific literature on shoulder dystocia has evolved and which topics have become prominent. The summary of themes from 2023 publications is as follows:

Scientific studies on SD address many different sub-themes in this field. In particular, the impact of simulation education was emphasized in studies such as Kaijomaa et al<sup>[55]</sup> and Horasanlı et al.<sup>[56]</sup> Furthermore, Stieglitz et al<sup>[57]</sup> discussed how to improve the ability to act in obstetric emergencies through e-learning. On the topic of risk factors and incidence analysis, Youssefzadeh et al<sup>[12]</sup> and Mollberg et al<sup>[58]</sup> have provided an in-depth review of incidence trends and risk factors of SD. Technical and management approaches were presented by Allen<sup>[59]</sup> with videographic training, while Diack et al<sup>[9]</sup> investigated the effects of fetal manipulation. On machine learning and prediction, Lan et al<sup>[60]</sup> and Griffin et al<sup>[61]</sup> examined risk factors of SD using interpretable machine learning techniques. Finally, on medico-legal issues, Habek et al<sup>[62]</sup> addressed the legal aspects of shoulder dystocia. These studies reflect the wide range of research areas on SD and scientific developments in this field.

*Discussion on the themes of co-citation analysis:* Definition and Risks of SD, both old and new literature have focused on the definition of SD and the risks of this condition for both mother and baby. Older studies such as Hill et al<sup>[1]</sup> and Harari et al<sup>[3]</sup> reported that this complication can lead to fetal injury, oxygen deprivation and sometimes fetal death. Kaijomaa et al<sup>[55]</sup> addressed these risks in more detail, examining the impact of simulation training on SD management and the incidence of permanent brachial plexus birth injury, suggesting that the risks identified in the older literature are still relevant.

In terms of the Importance of Training, the older literature has a specific focus on the technique and management of SD. In particular, studies such as Benedetti and Gabbe<sup>[36]</sup> noted that fetal macrosomia and prolonged second stage of labor associated with midpelvic delivery can cause SD. However, recent studies, such as Allen,<sup>[59]</sup> have presented these management strategies through technical and videographic training, demonstrating how technological advances and training methods have evolved in this field.

In terms of Technological Advances and Innovations, both the themes of the co-citation analysis and the new literature emphasized the critical role of education in SD management. Older studies such as Draycott et al<sup>[50]</sup> noted how practical SD

education can improve neonatal outcomes. Stieglitz et al<sup>[57]</sup> discussed how the ability to act in obstetric emergencies can be achieved through e-learning, demonstrating how the technological aspects of training are evolving and innovation in this field is ongoing.

The management of SD, its risk factors and associated complications is a critical part of obstetric practice. Scientific research in this area is vital to protect the health of both mothers and infants. This study shows how the scientific literature on this topic has evolved over time and which topics have become prominent.

Scientific studies on SD show that many different themes have emerged in this field. In particular, the studies by Allen<sup>[59]</sup> and Diack et al<sup>[9]</sup> have made significant contributions and provided valuable information to the literature. Moreover, there is a specific theme of machine learning and prediction in the titles of the papers presented. This highlights the growing importance of using interpretable machine learning techniques to better understand and predict the risk factors of SD. Studies such as Lan et al<sup>[60]</sup> and Griffin et al<sup>[61]</sup> show how these technological advances and machine learning techniques can be used effectively in this field. On the other hand, a theme focusing on medico-legal issues is also noteworthy. Studies such as Habek et al<sup>[62]</sup> reflect the necessity of addressing SD from a medico-legal perspective and the importance of this issue in clinical practice as well as in legal aspects. The emergence of these themes shows that SD is a complex issue that requires a multidisciplinary approach and that research in this field is constantly evolving.

*Discussion on the themes of the Co-Occurrence analysis:* The literature review reveals the existence of several sub-themes that have been addressed in this topic. When we evaluate how these themes relate to the results of the co-occurrence analysis, we reach the following conclusions:

The studies on training and simulation are particularly aligned with the Red Cluster, which is organized under the heading “SD Management and Clinical Practice.” Studies included in this cluster emphasize the critical importance of simulation training in the management of SD as well as clinical practice. The risk factors and incidence analysis themes align with the Blue Cluster, which is categorized under the heading “Fetal Macrosomia and SD Risk Factors.” This cluster offers an in-depth review of the etiology and risk factors of SD. Technical and management-oriented studies overlap with the Green Cluster, titled “Obstetric Maneuvers and Brachial Plexus Injury.” Articles in this cluster highlight clinical maneuvers and potential injuries associated with this condition. Studies on machine learning and prediction can be associated with the Purple Cluster, which is organized under the title “Clinical Trends and Risks in SD.” This cluster provides a detailed analysis of clinical trends and risks related to SD. Studies focusing on medico-legal issues can be paralleled with the Orange Cluster entitled “Comprehensive Care in SD.” This cluster provides a perspective focused on the overall care and management of SD. Finally, the Brown Cluster, categorized under “SD and Upper Extremity Complications,” specializes in upper extremity complications during SD.

*Discussion on consolidated themes:* A comparison of the studies published in 2023 on SD with the 10 predefined main theme groups reveals the dynamic nature and evolution of the scientific literature in this field.

The theme “Definition, Incidence, and Fundamentals of SD” overlaps with the studies published in 2023 under the title “Risk Factors and Incidence Analysis.” In particular, the studies by Youssefzadeh et al<sup>[12]</sup> and Mollberg et al<sup>[58]</sup> provide critical information on the definition, incidence, and fundamentals of SD. The theme “Training, Education, Simulation, Skill Development, and Retention” and the literature on training and simulation overlap in the sub-topics of this theme. The studies presented by Kaijomaa et al<sup>[55]</sup> Horasanlı et al<sup>[56]</sup> and Stieglitz

et al<sup>[57]</sup> emphasize the critical role of simulation training in SD management.

The studies discussed under the “Management, Treatment, Techniques, and Clinical Approaches” theme, “Techniques and Management” overlap with this theme. In particular, studies by Allen<sup>[59]</sup> and Diack et al<sup>[9]</sup> discuss in detail the clinical approaches, management techniques, and treatment strategies of SD. Risk Factors, Predictability, and Comprehensive Risk Assessment: This theme is fully in line with the studies discussed under the heading “Risk Factors and Incidence Analysis.” Especially the studies by Youssefzadeh et al<sup>[12]</sup> and Mollberg et al<sup>[58]</sup> cover the subheadings of this theme.

Those that are in the themes of the consolidated theme analysis but not in the themes for 2023 publications: In 2023, there are no specific studies under the themes “Tools, Equipment, Assessment Instruments, and Documentation,” “Impact, Specific Populations, and Geographical Studies,” “Reviews, Discussions, Perspectives, Commentaries, and Historical Aspects” and “Research, Epidemiology, Methods, Approaches, and Diverse Populations.” This suggests that more research is needed on these topics.

*Partially overlapping themes:* Prevention, Prophylaxis, Interventions, and Treatment Outcomes and Complications, Outcomes, Injuries, and Associated Risks may overlap with the studies covered under “Techniques and Management” in general, but this theme was not specifically addressed in the 2023 studies.

In conclusion, the scientific literature on SD overlaps with some of the main themes identified. However, the fact that some themes are not specifically addressed reveals the need for further research on these issues. The reasons for these differences include technological advances, changes in clinical practice, and changing interests of researchers. The analysis of these themes shows that shoulder dystocia is a complex topic requiring a multidisciplinary approach and that research in this field constantly evolves.

#### 4. Limitations and future research

This study has some limitations. First, limited terms and vocabulary were used to identify articles on SD. New conceptualizations and nomenclatures evolve, and accepting these changes may take time. The use of different key terms may bring a different perspective to the results of the research.<sup>[63,64]</sup> Future studies could use different search strategies to address these potential shortcomings. A second limitation is that bibliometric analysis focuses on the most cited articles from a retrospective perspective.<sup>[18]</sup> This approach may ignore the potential contributions of new articles and different research. Future research could use bibliographic coupling (BC) analyses for a more comprehensive perspective on this issue.

Third, only the Web of Science database was used. Potential contributions from other databases such as Dimension, Scopus, EBSCO, and Proquest were ignored. Future studies can comprehensively assess SD by including these databases.<sup>[65]</sup> Finally, our study focused only on articles in English. The potential contributions of literature in different languages were ignored. Future research could enrich the body of knowledge in this area by examining literature in different languages and comparing studies conducted in international contexts.

#### 5. Conclusion

This study illuminated co-citation and co-occurrence patterns in SD through bibliometric analysis. It also identified prominent themes in SD through document analysis. The results show the current limitations of SD research. According to the analysis, SD remains a critical component of obstetric practice. The analysis

of studies published in 2023 shows that the scientific literature on this topic constantly evolves, with specific themes emerging. Themes such as training and simulation, risk factors, and technical and management approaches are consistently emphasized. Studies on how technological developments and machine learning techniques can be used effectively in this field reflect innovative approaches in the scientific literature. There is also a consideration of medico-legal issues, suggesting that SD is not only a clinical problem but also an issue with legal dimensions. This analysis confirms that SD is a complex issue requiring a multidisciplinary approach and that research in this field constantly evolves.

## Author contributions

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