Journal of Scientometric Research, 2026; 15(2):374-385.
https://www.jscires.org

Research Article

Artificial Intelligence in Biliary Atresia Diagnosis: A Bibliometric Analysis and Categorization of Approaches for the Use of Low-Complexity Techniques in Primary Care

Jorge Antonio Moya Reyes, Cristiano Hora de Oliveira Fontes*, Marcio André Fernandes Martins, Jorge Laureano Moya Rodríguez

Programa de Engenharia Industrial (Graduate Program in Industrial Engineering), Escola Politécnica (Polytechnic Institute), Universidade Federal da Bahia (Federal University of Bahia), City of Salvador, BRAZIL.

ABSTRACT

Biliary Atresia (BA) is a rare but serious neonatal cholestatic disease that requires early diagnosis to avoid undesirable long-term prognoses. Although Artificial Intelligence (AI) has shown promise in aiding the diagnosis of various pathologies, its application in BA remains limited. This study conducted a bibliometric and content analysis to map the current landscape of AI approaches for the diagnosis of biliary atresia and to identify research gaps, with particular attention to low-complexity techniques suitable for use in primary care centers. Searches were performed in the Scopus database (2014-2024). An initial comprehensive search on AI applications in the healthcare sector resulted in 8,253 publications. Subsequently, more specific searches identified 92 studies related to the use of Case-Based Reasoning (CBR) in healthcare and 266 to the use of CBR combined with fuzzy logic. Only eight studies specifically addressed the diagnosis of biliary atresia. Bibliometric analysis using VOSviewer revealed a strong concentration of studies on deep learning models (particularly convolutional neural networks) applied to gallbladder ultrasound images and conventional machine learning models using clinical and laboratory data. Content analysis of the eight articles related to biliary atresia confirmed that the proposed approaches rely heavily on the availability of large image samples or multiple laboratory analyses, making them impractical for use in resource-limited primary care settings. Additionally, no studies were found related to the use of expert systems, fuzzy inference systems, or case-based reasoning in the diagnosis of biliary atresia. These less complex techniques require fewer input variables and smaller training samples and represent underexplored alternatives with research potential to support the early detection of biliary atresia in primary care, especially in resource-limited settings.

Keywords: Artificial Intelligence, Bibliometric Analysis, Biliary Atresia, Case-Based Reasoning, Fuzzy Logic, Medical Diagnosis, Primary Care.

Correspondence:
Cristiano Hora de Oliveira Fontes
Programa de Engenharia Industrial (Graduate Program in Industrial Engineering), Escola Politécnica (Polytechnic Institute), Universidade Federal da Bahia (Federal University of Bahia), City of Salvador, BRAZIL.
Email: cfontes@ufba.br

Received: 08-01-2026;
Revised: 16-03-2026;
Accepted: 28-05-2026.

INTRODUCTION

Diagnostic reasoning is one of the most complex and critical components in clinical decision-making. In pediatrics, the timely and accurate diagnosis of rare but serious diseases such as Biliary Atresia (BA) remains a particularly difficult challenge. Biliary atresia is a progressive fibroinflammatory disease of the bile ducts that affects infants, leading to cholestasis, liver failure, and the need for liver transplantation if not diagnosed and treated early, ideally before 45 to 60 days of life (Brahee and Lampl, 2022; Chen *et al*., 2022; Harpavat *et al*., 2025; Vij and Rela, 2020; Yerimova *et al*., 2025). Classic indicators include prolonged conjugated hyperbilirubinemia, acholic stools, and dark urine. However, initial symptoms are often subtle and frequently misdiagnosed as physiological jaundice, resulting in delayed diagnosis, especially in primary care services located in remote areas.

In recent years, Artificial Intelligence (AI) has emerged as a promising tool to support clinical decision-making across various medical domains (Alowais *et al*., 2023; Lüscher *et al*., 2024; Ouanes and Farhah, 2024). Applications range from deep learning models based on ultrasound images to machine learning algorithms that seek to correlate the impact of clinical variables on diagnosis. The level of maturity and applicability of these techniques vary significantly depending on the disease and clinical context. Specifically for biliary atresia, existing AI studies have predominantly focused on two approaches: (i) Convolutional Neural Networks (CNNs) trained from gallbladder ultrasound images, and (ii) conventional machine learning models based

DOI: 10.5530/jscires.20260499

on laboratory parameters and ultrasonographic features (Duan *et al.*, 2023; Halimi *et al.*, 2026; Niu *et al.*, 2024a). Although these approaches have demonstrated solid performance in specialized centers, they often require large datasets, advanced imaging equipment, and advanced computing resources, namely requirements that limit their viability for primary care and in resource-poor regions.

Low-complexity AI techniques, such as fuzzy inference systems and Case-Based Reasoning (CBR), offer theoretical advantages in such contexts (Benamina *et al.*, 2018; Gupta *et al.*, 2022; Saadi *et al.*, 2023). These methods typically require fewer input variables, do not depend on large training datasets, and can incorporate expert knowledge more explicitly. However, the use of these approaches for the diagnosis of biliary atresia has not been reported.

This study presents a bibliometric and content analysis of the scientific literature on AI applications in the healthcare sector (pathology diagnosis), focusing on biliary atresia. The objectives are: (1) To map the evolution and current trends in AI research in healthcare; (2) To examine the use of Case-Based Reasoning and fuzzy logic in medical diagnosis; and (3) To categorize and critically analyze existing AI approaches for biliary atresia diagnosis, identifying opportunities for low-complexity solutions suitable for primary care settings.

METHODOLOGY

The methodology followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for the search and selection of references (Figure 1). A staged search strategy was adopted to progressively limit the scope, from broad AI applications in healthcare to studies involving specific diseases (this study was based exclusively on the analysis of publicly available scientific literature and ethical approval was not required).

Data Source and Search Strategy

The SCOPUS database was used for the systematic review, considering its comprehensiveness and quality of bibliometric data, as well as its use in various areas of knowledge (Azizan and Yusof, 2024; Donthu and Lim, 2021; Paul and Bresciani, 2021; Zahidi and Bin Othman, 2025). Furthermore, the SCOPUS database has tools that allow the tracking, analysis, and visualization of works, providing a broad view of global scientific production (Brahimi and Sarirete, 2023; Buchanan, 2006; Scimago, 2006).

The Scopus database was selected as the primary source due to its comprehensive coverage of both medical and computer science literature, the availability of high-quality bibliometric metadata, and its use as a benchmark database in numerous bibliometric studies. Searches were carried out in November 2024, covering the period from 2014 to 2024. A four-stage search strategy was implemented:

- **Step 1:** Broad search for AI applications in the medical/healthcare field.
- **Step 2:** Search focused on Case-Based Reasoning (CBR) in healthcare.
- **Step 3:** Search focused on CBR combined with Fuzzy Logic in the diagnosis of pathologies.
- **Step 4:** Specific search for AI applications for the diagnosis of biliary atresia.

The detailed search strategies, inclusion and exclusion criteria, and the number of records retrieved at each stage are presented in Table A1 (Appendix). All searches were limited to documents published in English. Duplicate items were identified and removed manually at all stages.

RESULTS

Bibliometric Analysis

Bibliometric analysis was performed using VOSviewer software (version 1.6.20). This tool was chosen for its ability to generate high-quality visualizations of scientific networks, especially keyword co-occurrence maps. This tool supports the development, visualization, and analysis of bibliometric network maps (Arruda *et al.*, 2022; Van Eck and Waltman, 2010; Wong, 2018), including graphical representations of co-authorship, citation, and co-citation relationships, as well as keyword-based networks (Huang *et al.*, 2022; Liu *et al.*, 2025).

Bibliometric analysis is a well-established quantitative approach used to evaluate multiple indicators, such as keyword occurrence, citation intensity, and the contribution of prominent authors, among other metrics (Elbanna, 2025; Kumar and Sahoo, 2025; Nan *et al.*, 2025; Röper *et al.*, 2025). This approach is capable of identifying the relevance attributed by peers to the new knowledge generated, identifies the main keywords, authors, most productive countries and the most prominent topics, in addition to recognizing the chronological evolution of the subject analyzed.

In the first (broader) stage, 8,253 references were identified, and there was a significant increase in the number of publications (papers, books, book chapters, conference papers, etc.) over the period considered (Figure 2). Among the publications verified in this first stage of the broad search, 37% refer to journal articles, with emphasis on the journals Lecture Notes in Computer Science (105) and Artificial Intelligence in Medicine (76), followed by review papers (28%). As illustrated in Figure 3, among the 8,253 references identified in this first stage, approximately 50% are directly associated with the broad field of medicine.

The keyword with the highest incidence in the title and abstract was "Artificial intelligence" (8,084), followed by "Human" (6,498) (Figure 4). Other keywords with relative prominence highlight the context of the applications ("Personalized medicine", "Machine learning", "Deep learning", "Precision medicine"). The keyword co-occurrence map (Figure 4) suggests the existence of three predominant clusters related to research fronts involving AI applications in the medical field: i) Application of AI in imaging diagnosis, mainly deep learning through convolutional neural networks (red); ii) Application of AI in clinical decision-making and patient care (green); and iii) Personalized medicine, precision, and risk assessment (blue).

Table 1 presents the criteria and filters applied in the second stage, in which 92 references of specific CBR applications in healthcare were identified, presenting an oscillatory behavior throughout the period considered (Figure 5). 57% of the identified references refer to papers in journals, with emphasis on Journal Lecture Notes in Computer Science (11). The healthcare area once again accounts for the majority of applications involving CBR (Figure 6), covering 35% of the identified references.

The keywords with the highest frequency in the title and abstract were "Case-based Reasoning" (59), "Human" (46), "Diagnosis" (21), "Artificial intelligence" (20) and Decision-making (18). The keyword co-occurrence map (Figure 7) suggests the existence of three clusters or research fronts within the scope of CBR applications in the medical field: i) medical education (clinical reasoning and learning methods) (red); ii) artificial intelligence for decision support (green); and iii) demographic and population studies (patient data) (blue).

Table 2 presents the criteria and filters applied in the third stage (CBR and fuzzy logic), in which 266 references were identified. An increasing trend in the number of papers is also observed if we consider the potential for new references in 2025 (Figure 8). The areas of medicine and computer science account for the majority of applications involving CBR and fuzzy logic (Figure 9), covering 48% of the identified references.

The keyword co-occurrence map (Figure 10), considering applications of CBR and fuzzy logic in the medical field, highlights the focus on two research fronts already identified in

Table 1: Search criteria (CBR applications in medicine).

(KEY (case AND based AND reasoning) AND TITLE-ABS-KEY (medicine)) AND PUBYEAR > 2014 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA, "MEDI") OR LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "ENGI"))

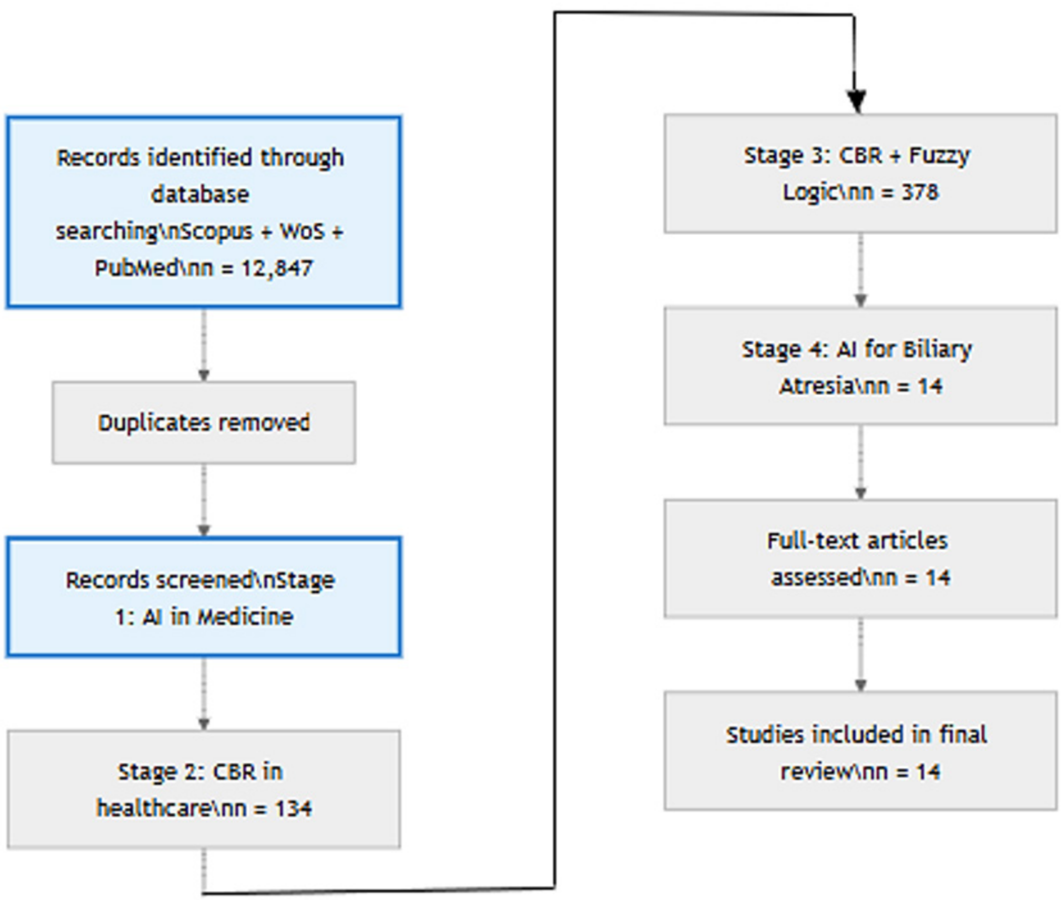

Figure 1: PRISMA flow diagram of the staged literature search and selection process.

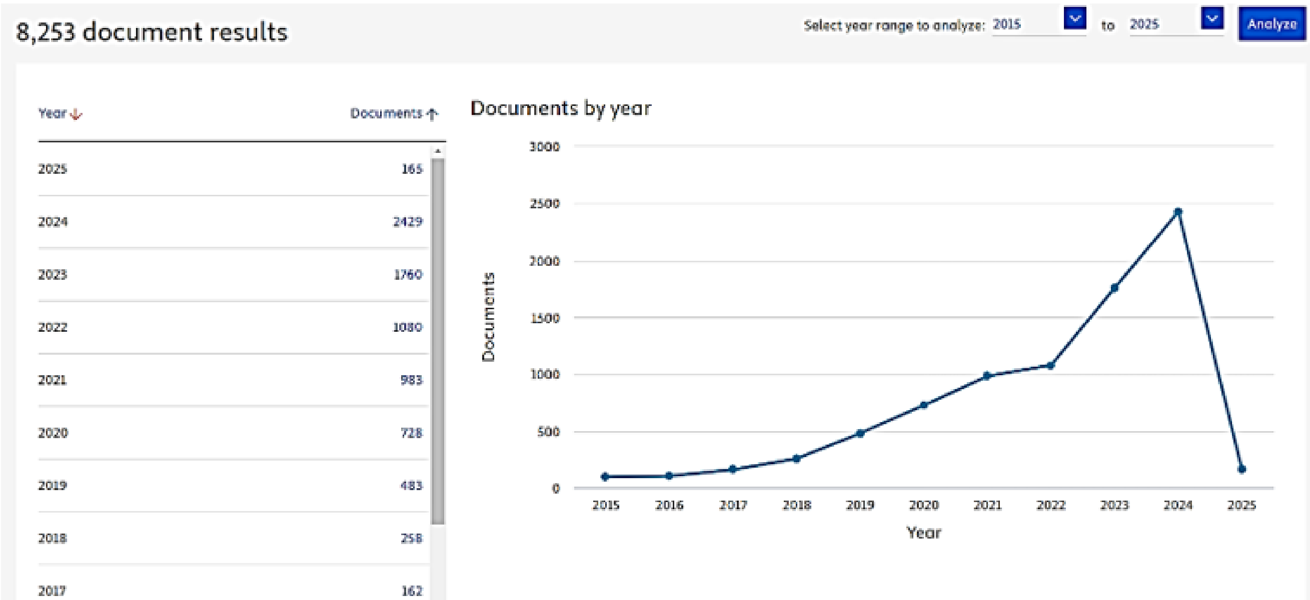

Figure 2: Number of publications over ten years related to the use of Artificial Intelligence in the medical field.

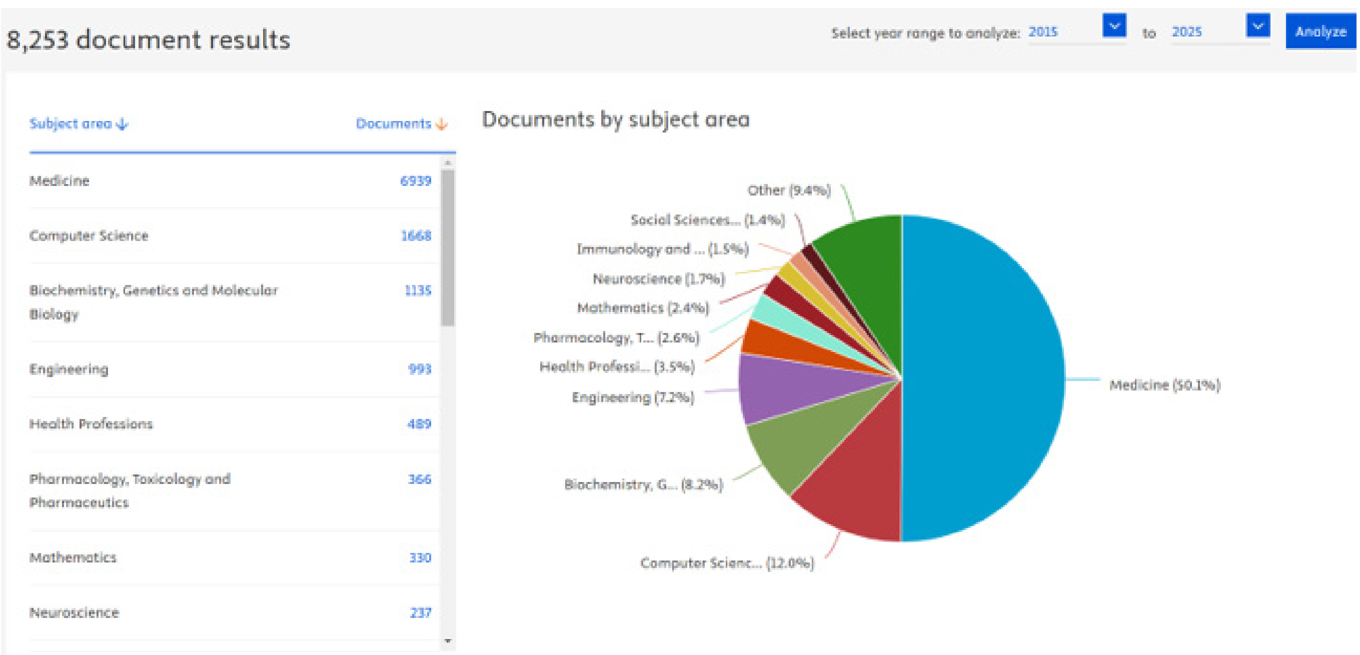

Figure 3: Distribution of publications by area of knowledge related to the use of Artificial Intelligence in the medical field.

Figure 7 (applications in clinical diagnosis, red, and demographic data, green).

Only 8 references related to the use of AI specifically in the diagnosis of biliary atresia were identified (distributed in the years 2016 and 2021-2024, Figure 11), and none of these involve the use of CBR and fuzzy logic.

Content Analysis

The bibliometric results confirm a remarkable growth in AI-related publications in healthcare over the last decade, consistent with global trends in digital health. Keyword co-occurrence analyses revealed three dominant research fronts: deep learning for medical imaging, AI-supported clinical decision-making, and precision medicine.

Regarding biliary atresia specifically, only eight studies related to the diagnosis of BA were identified. A deductive categorization framework was developed based on the following dimensions:

- Type of AI technique (Deep Learning, Conventional Machine Learning, Hybrid, etc.).
- Primary input data (ultrasound images, laboratory/clinical data, multimodal).
- Level of model complexity (High vs. Low).

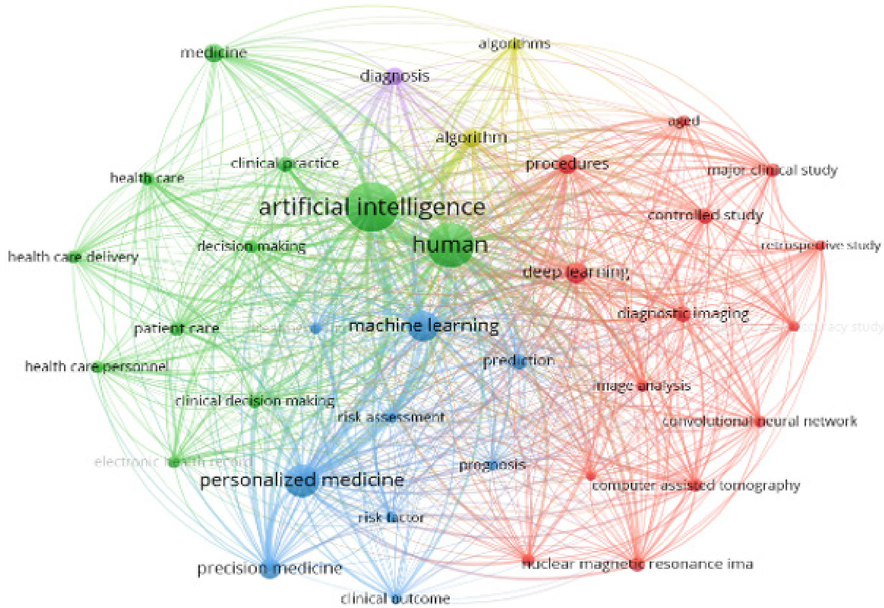

Figure 4: Keyword co-occurrence map in studies on AI in the medical field.

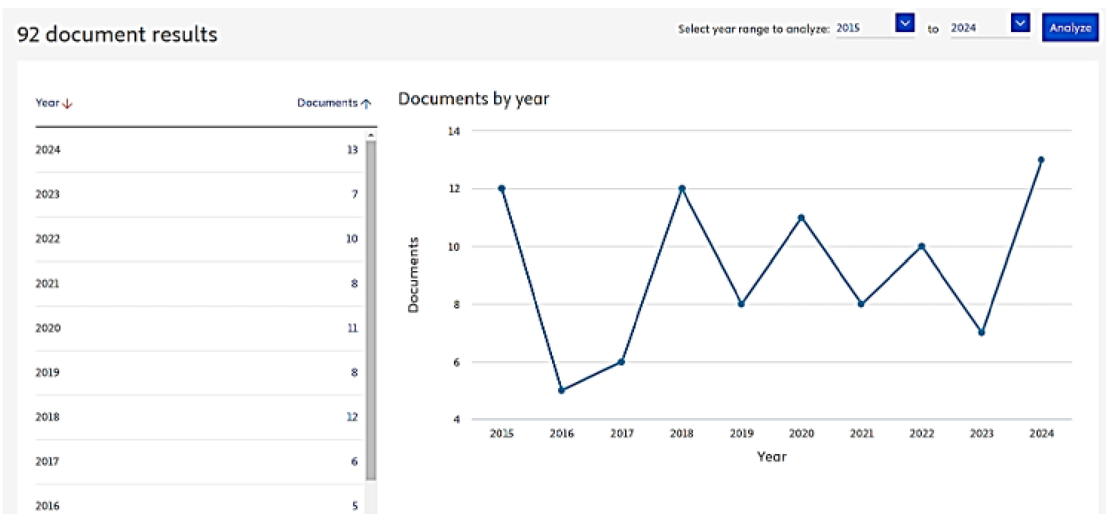

Figure 5: Number of publications over ten years related to the use of CBR in the medical field.

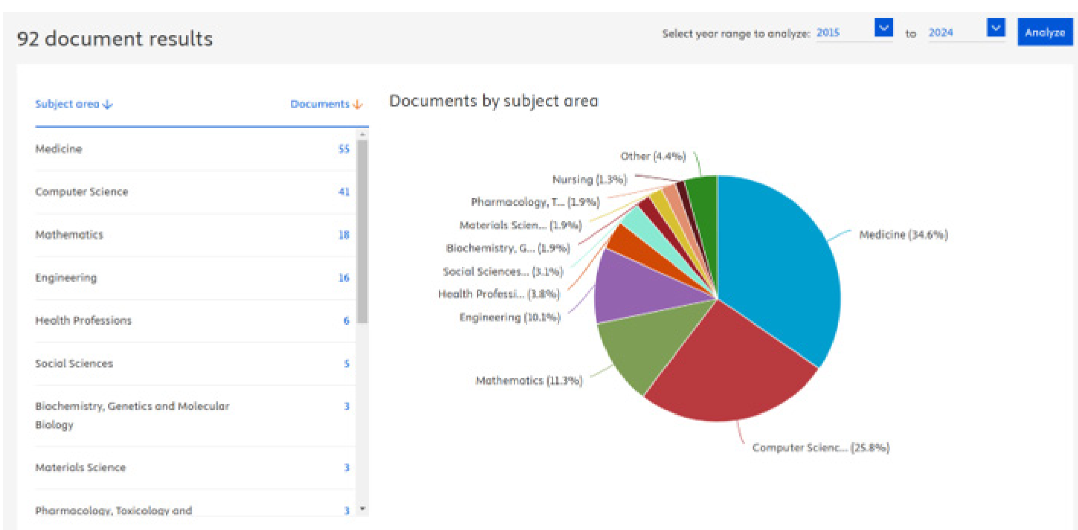

Figure 6: Distribution of publications by area of knowledge related to the use of CBR in the medical field.

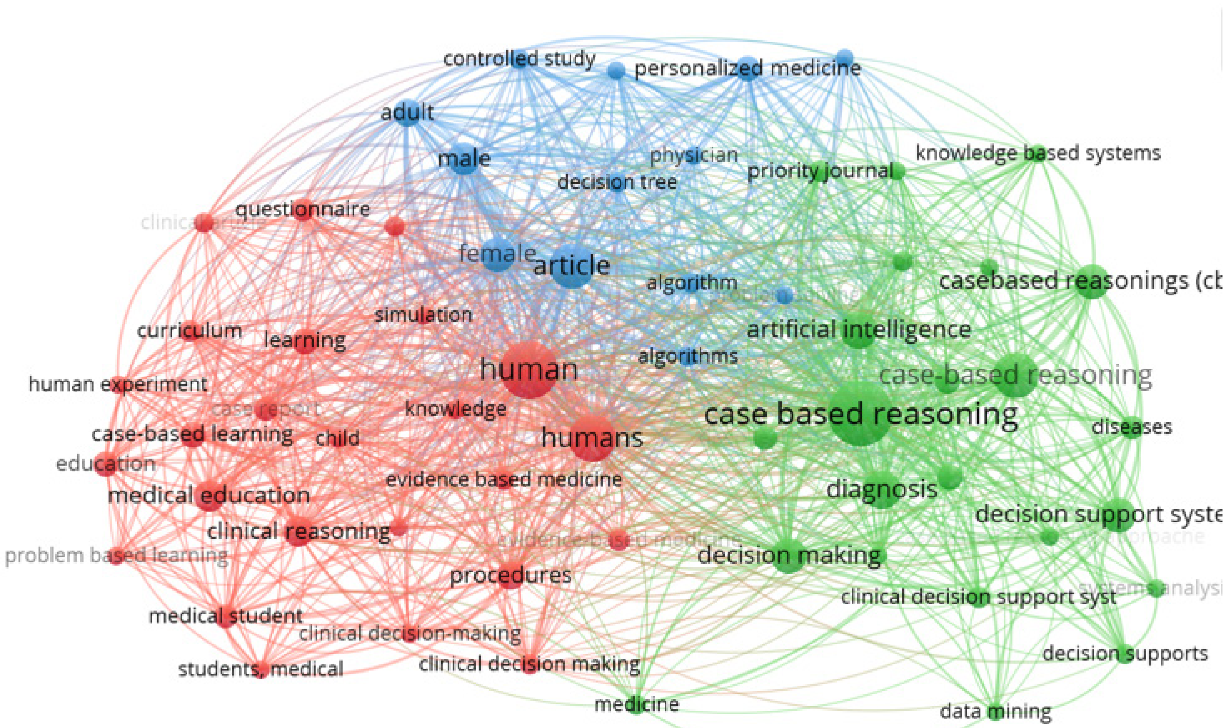

Figure 7: Keyword Co-occurrence Map in Studies on Case-Based Reasoning in the Medical Field.

- Target clinical setting (Specialized vs. Primary care).
- Feasibility in resource-limited environments.

Two researchers independently reviewed and extracted data from the papers using a standardized extraction form. This analysis allowed us to identify the dominant approaches and critical research gaps, confirming a clear lack of work involving low-complexity AI methods in primary care.

Table 3 presents a summary of references focusing on the use of AI in biliary atresia, more specifically on the application of convolutional neural networks (LeCun *et al.*, 2002) for binary classification (positive and negative cases) from specific ultrasound images of the gallbladder.

Considering that the broad scope of Artificial Intelligence also encompasses conventional machine learning techniques (statistical learning, e.g., logistic regression, support vector machines, etc.), the references cited in Table 3 focus specifically on the use of deep neural networks (specifically CNNs with different combinations of convolutional and pooling layers, in line with one of the trends identified in Figure 3). In this case, the availability of a statistically informative sample of gallbladder ultrasound images of newborns is strictly necessary. Although the use of more sophisticated AI models (deep learning) generally provides more robust and better-performing classifiers, intrinsic challenges to image acquisition are still encountered, especially in developing countries. These challenges include access to technological resources and territorial extension, among others, and are discussed in recent studies related to biliary atresia

Table 2: Search criteria (CBR and fuzzy logic applications in medicine).

TITLE-ABS-KEY (Medical diagnosis and fuzzy or Case based reasoning) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (EXACTKEYWORD, "Diagnosis") OR LIMIT-TO (EXACTKEYWORD, "Clinical Reasoning") OR LIMIT-TO (EXACTKEYWORD, "Case Based Reasoning") OR LIMIT-TO (EXACTKEYWORD, "Artificial Intelligence") OR LIMIT-TO (EXACTKEYWORD, "Fuzzy Logic") OR LIMIT-TO (EXACTKEYWORD, "Clinical Decision Making") OR LIMIT-TO (EXACTKEYWORD, "Deep Learning") OR LIMIT-TO (EXACTKEYWORD, "Fuzzy Inference") OR LIMIT-TO (EXACTKEYWORD, "Medical Diagnostics") OR LIMIT-TO (EXACTKEYWORD, "Expert Systems") OR LIMIT-TO (EXACTKEYWORD, "Fuzzy Sets"))

(Arsena *et al.*, 2024; He *et al.*, 2025; Ma *et al.*, 2025; Niu *et al.*, 2024b; Zhou *et al.*, 2024).

Other studies involve the application of conventional machine learning techniques for the diagnosis of AB from clinical data, with or without the incorporation of ultrasound features into the modeling (many of which are highlighted in the work of Zhou and Zhou (2022)). Duan *et al.*, 2023 present an innovative proposal for the diagnosis of AB using multimodal machine learning combining different types of clinical data (laboratory data, clinical features, and images, when available) and different statistical learning techniques (Random Forest, Support Vector Machine, Logistic Regression, Multilayer Perceptron). A shallow neural network (Feed Forward Neural Networks) was trained from laboratory data (total bilirubin, direct bilirubin, and Gamma-glutamyl transpeptidase, GGT) for binary classification

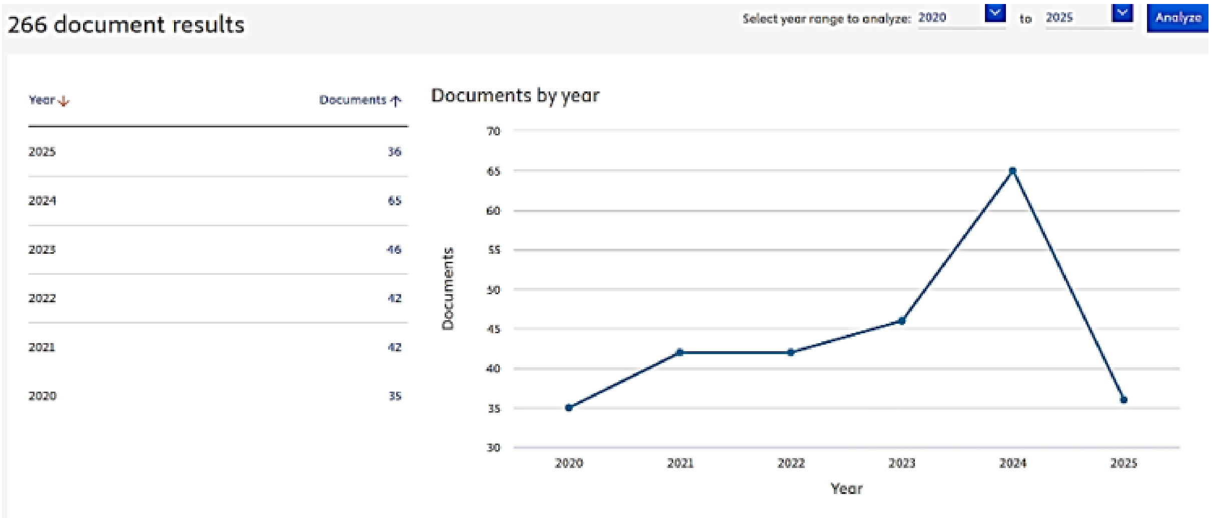

Figure 8: Number of publications over five years related to the use of CBR and fuzzy logic in healthcare.

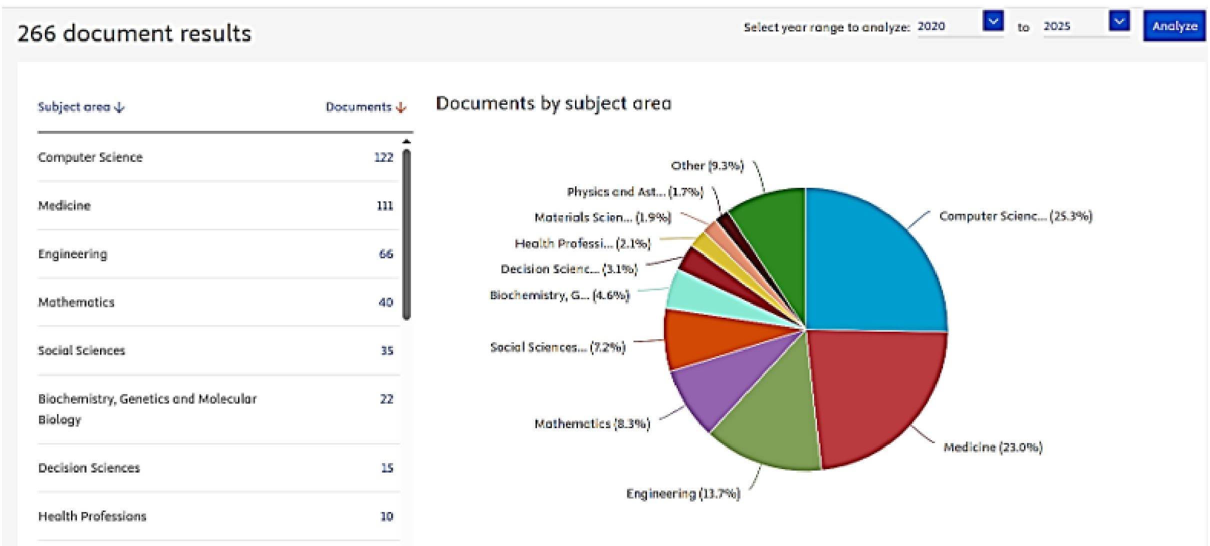

Figure 9: Distribution of publications by area of knowledge related to the use of CBR and fuzzy logic.

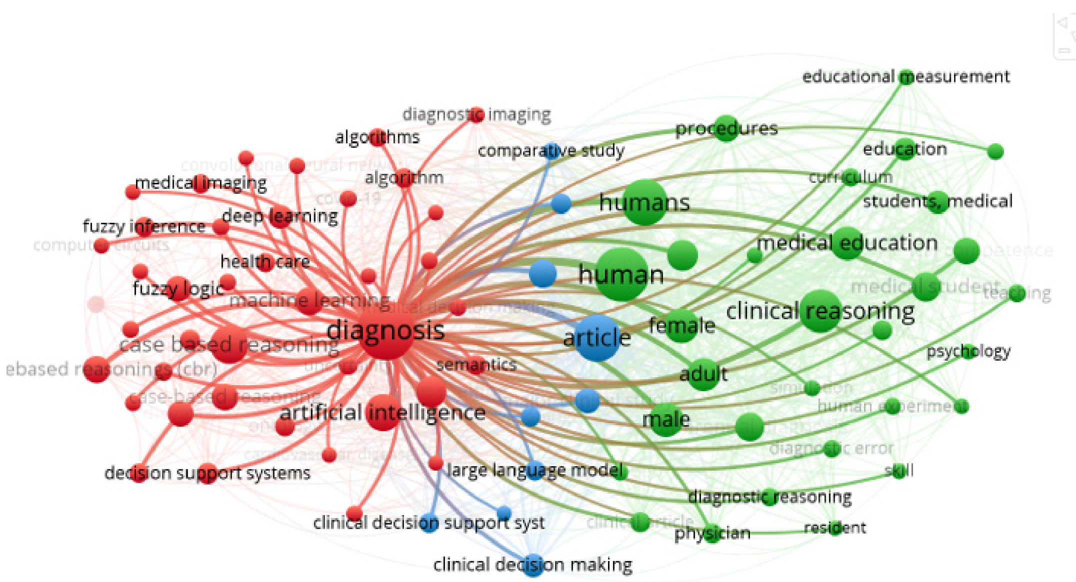

Figure 10: Keyword Co-occurrence Map in Studies on Case-Based Reasoning and fuzzy logic in the Medical Field

involving the diagnosis of biliary atresia (Liu *et al.*, 2020). Other recent work also involves the use of machine learning techniques using laboratory data as input variables (Dong *et al.*, 2018; Liu *et al.*, 2019; Nakamura and Yamataka, 2018).

On the other hand, in the primary care sector the initial diagnosis for suspected biliary atresia is based essentially on stool color, urine color, and direct bilirubin (Harpavat *et al.*, 2025; Rabbani *et al.*, 2021). These data can be obtained even in remote regions, far from large urban centers in developing countries. The observation of dark urine and light/acholic stools in primary care (visit "up to 1 month" or between 2-4 weeks of life) is a fundamental starting point for suspected biliary atresia. When these parameters are assessed early along with bilirubin, the prognosis and possible intervention (Kasai procedure) will be more effective, significantly improving outcomes (Rabbani *et al.*, 2021; Ranucci *et al.*, 2022).

A review of the literature on biliary atresia diagnosis indicates that, although significant progress has been made in classification approaches relying on imaging findings or laboratory and ultrasonographic data, there remains a shortage of simple and practical classification tools. In particular, models that can

Figure 11: Number of publications related to the use of AI for the diagnosis of biliary atresia.

Table 3: References involving Artificial Intelligence in the diagnosis of biliary atresia.

Paper (journal)	Author	Abstract
Is the diagnostic model based on convolutional neural network superior to pediatric radiologists in the ultrasonic diagnosis of biliary atresia? (Frontiers in Medicine)	(Duan *et al.*, 2023)	The authors propose and evaluate an intelligent diagnostic model based on Convolutional Neural Networks (CNNs) for identifying Biliary Atresia (BA) from gallbladder ultrasound images in infants. A total of 4,887 gallbladder ultrasound images were collected from infants with and without hyperbilirubinemia associated with biliary atresia, as well as from healthy infants. Two CNN architectures were tested, and the results were compared with the classification/diagnosis of pediatric radiology experts.
The application of artificial intelligence to support biliary atresia screening by ultrasound images: A study based on deep learning models (PLoS ONE)	(Hsu *et al.*, 2022)	This work also uses CNN to focus on gallbladder ultrasound images (abdominal B-mode ultrasounds of 330 patients, 104 with AB and 226 without AB). The image labels used for CNN training were defined by experts, and the final classification models were validated by three experienced pediatric radiologists. This work also included the generation of synthetic images for testing and validation, aiming to improve model performance.
Pilot study of artificial intelligence ultrasound diagnosis of biliary atresia based on deep learning (Chinese Journal of Ultrasonography)	(Yang *et al.*, 2021)	The authors explore the feasibility of CNN-assisted ultrasound for the diagnosis of biliary atresia. The sample comprised 531 gallbladder images from 177 positive patients (with BA) and 585 images from 195 negative patients. The final model was also validated by comparing it with expert diagnoses.

Paper (journal)	Author	Abstract
Ensembled deep learning model outperforms human experts in diagnosing biliary atresia from sonographic gallbladder images (Nature Communications)	(Zhou *et al.*, 2021)	The authors present an ensemble model comprising a combination of several convolutional networks trained separately with different samples, thus learning different features of the problem. The final result is based on the classifications of five individual models. The images also focus on the gallbladder region. The development of a smartphone app enabled the use of the model in remote regions with a shortage of specialists.
Interpretable artificial intelligence-based app assists inexperienced radiologists in diagnosing biliary atresia from sonographic gallbladder images (BMC Medicine)	(Zhou *et al.*, 2024)	Similar to the work of Zhou *et al.* (2021), a rectangular region of interest covering the gallbladder was defined. The database comprised 11,459 images from 1,927 patients (training, validation, and testing). A specific CNN architecture was adopted, and synthetic images were also generated using random techniques (e.g., RandomResizedCrop) from the training sample.
Ultrasound for the diagnosis of biliary atresia: From conventional ultrasound to artificial intelligence (Diagnostics)	(Zhou and Zhou, 2022)	The authors present a review of established imaging methods for diagnosing BA (e.g., abdominal ultrasound, magnetic resonance cholangiography, and percutaneous or intraoperative cholangiography). A diagnostic support algorithm is proposed based on hybrid technologies, combining conventional ultrasound, elastography, and contrast-enhanced ultrasound. Unlike other references, this work does not involve the development of a deep neural network (CNN) to support the diagnosis of biliary atresia.

support effective clinical decision-making during the initial patient encounter in primary care, using a limited number of easily obtainable categorical and numerical variables, are still lacking. Still within the scope of AI, two alternatives would be suitable for this purpose: a) Modeling a system of rules using fuzzy logic and b) Case-Based Reasoning. In the first case, a set of rules using direct bilirubin and the color intensity of feces and urine as antecedents can be proposed in such a way that each rule's output (consequent) provides a probability or level of suspicion of biliary atresia. The proposed set of rules can be adjusted and tuned through consultation with experts and, like any fuzzy inference system, it has the ability to activate two or more rules simultaneously, depending on the uncertainty represented by the antecedents' membership functions, and provide a final result (diagnostic estimate). Case-Based Reasoning (CBR), in contrast, addresses new problems, such as establishing novel diagnoses, by drawing on solutions derived from previously encountered cases. This approach does not depend on the construction of a definitive expert-driven model, rather, it identifies patterns and similarities by analyzing generalized relationships between problem attributes and their corresponding outcomes (Choudhury and Begum, 2016; Dhatterwal *et al.*, 2024). Despite work involving the application of fuzzy inference systems and Case-Based Reasoning to support decision-making for the diagnosis of various pathologies (Ayo *et al.*, 2023; Jayade *et al.*, 2021), there are no studies on the application of these two AI approaches specifically in the diagnosis of biliary atresia, which suggests the feasibility of developing effective tools with a low degree of complexity to address this pathology in the primary care sector.

Most successful CBR systems are built around a combination of CBR and other artificial intelligence methods. Soft computing techniques, namely fuzzy logic, artificial neural networks, and evolutionary strategies, have proven to be very effective in enhancing the capabilities of CBR systems. Using these techniques, knowledge can be automatically acquired from cases, leading to greater robustness.

CONCLUSION

This bibliometric and content analysis shows that current AI research for the diagnosis of biliary atresia is heavily concentrated on highly complex approaches based on ultrasound images and various clinical/laboratory analysis results. While these decision models show good predictive performance in referral centers, their implementation in primary care and in resource-limited settings remains a challenge.

This study identifies a lack of open-source literature on the application of low-complexity AI techniques (more specifically, fuzzy inference systems and case-based reasoning) to support the early diagnosis of biliary atresia.

PRACTICAL IMPLICATIONS

The development of simple and interpretable decision support tools, based on readily available clinical variables, can help reduce diagnostic delays in regions with limited access to imaging and laboratory analysis resources. In practical terms, this work points to a different perspective in addressing biliary atresia that may be crucial for identifying this disease and appropriately managing the neonate.

FUTURE RESEARCH DIRECTIONS

Future studies should focus on: (1) the design and validation of fuzzy logic and CBR systems for BA screening; (2) comparative effectiveness studies between high- and low-complexity AI approaches in real-world primary care settings; and (3) multi-database bibliometric analyses to provide a more comprehensive view of the state of the art.

LIMITATIONS

This study was based on a single database (Scopus) and a staged search strategy. The conclusions are therefore limited to the retrieved literature and should be interpreted with appropriate caution. Furthermore, the development of decision models based on fuzzy or CBR systems requires rigorous validation, expert input for rule/case base construction, and prospective clinical evaluation.

ACKNOWLEDGEMENT

The authors acknowledge the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq-BRAZIL - Productivity of Research Funds 304312/2021-5) for their financial support.

ABBREVIATIONS

AB: Biliary Atresia (as used in some sections of the text); **AI:** Artificial Intelligence; **BA:** Biliary Atresia; **CBR:** Case-Based Reasoning; **CNNs:** Convolutional Neural Networks; **GGT:** Gamma-glutamyl Transpeptidase; **PRISMA:** Preferred Reporting Items for Systematic Reviews and Meta-Analyses; **SCOPUS:** Elsevier's abstract and citation database for scientific literature.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Alowais, S., Alghamdi, S., Alsuhebany, N., Alqahtani, T., Alshaya, A., Almohareb, S., ... Albekairy, A. (2023). Revolutionizing healthcare: the role of artificial intelligence in clinical practice. BMC Medical Education, 23. Retrieved from https://consensus.app/papers/revolutionizing-healthcare-the-role-of-artificial-alowais-alghamdi/4e53e4791ae25a278b07544b72ad6552/. doi:10.1186/s12909-023-04698-z

Arruda, H., Silva, E. R., Lessa, M., Proença Jr, D., and Bartholo, R. (2022). VOSviewer and bibliometrix. Journal of the Medical Library Association: JMLA, 110, 392.

Arsena, H., Tedja, A. K., Gunarti, H., Leksono, T. P., Kuncoro, A. A. L., Amaragati, A. R., and Makhmudi, A. (2024). Diagnostic Accuracy of Ultrasound in Cholestatic Infants with Biliary Atresia. Turkish Archives of Pediatrics, 59(5), 449.

Ayo, F. E., Ogundokun, R. O., Awotunde, J. B., Adebiyi, M. O., and Adeniyi, A. E. (2020). Severe Acne Skin Disease: A Fuzzy-Based Method for Diagnosis. Paper presented at the Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics).

Azizan, A., Azmi, A., and Yusof, M. Y. P. M. (2024). Bibliometric Analysis on Geriatric Rehabilitation in Scopus Database (1948-2022). Topics in Geriatric Rehabilitation, 40, 60-68.

Benamina, M., Atmani, B., and Benbelkacem, S. (2018). Diabetes Diagnosis by Case-Based Reasoning and Fuzzy Logic. Int. J. Interact. Multim. Artif. Intell., 5, 72-80. Retrieved from https://consensus.app/papers/diabetes-diagnosis-by-casebased-reasoning-and-fuzzy-logic-benamina-atmani/63819294648f57b5bd2fa81edbc2e05a/. doi:10.9781/ijimai.2018.02.001

Brahee, D. D., and Lampl, B. S. (2022). Neonatal diagnosis of biliary atresia: a practical review and update. Pediatric radiology, 52(4), 685-692.

Brahimi, T., and Sarirete, A. (2023). A bibliometric analysis of GCC healthcare digital transformation. In Digital Transformation in Healthcare in Post-Covid-19 Times (pp. 217-239): Elsevier.

Buchanan, R. A. (2006). Accuracy of cited references: The role of citation databases. College and Research Libraries, 67(4), 292-303.

Chen, Z., Liu, J., Zhu, M., Woo, P. Y. M., and Yuan, Y. (2022). Instance importance-aware graph convolutional network for 3D medical diagnosis. Medical Image Analysis, 78, 102421.

Choudhury, N., and Begum, S. A. (2016). A survey on case-based reasoning in medicine. International Journal of Advanced Computer Science and Applications, 7(8), 136-144.

Dhatterwal, J. S., Malik, K., Das, P., and Kaswan, K. S. (2024). Medical Diagnostic System using Embedding JADE in jCOLIBRI.

Dong, R., Jiang, J., Zhang, S., Shen, Z., Chen, G., Huang, Y., ... Zheng, S. (2018). Development and validation of novel diagnostic models for biliary atresia in a large cohort of Chinese patients. EBioMedicine, 34, 223-230.

Donthu, N., Kumar, S., Pattnaik, D., and Lim, W. M. (2021). A bibliometric retrospection of marketing from the lens of psychology: Insights from Psychology and Marketing. . Psychology and Marketing, 38, 834-865.

Duan, X., Yang, L., Zhu, W., Yuan, H., Xu, X., Wen, H., ... Chen, M. (2023). Is the diagnostic model based on convolutional neural network superior to pediatric radiologists in the ultrasonic diagnosis of biliary atresia? Frontiers in Medicine, 10. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85182712900&doi=10.3389%2ffmed.2023.1308338&partnerID=40&d5=9faeca9fe6f5c2a3453de33553642757. doi:10.3389/fmed.2023.1308338

Elbanna, M. (2025). Islamic Education Models: A Bibliometric Analysis of Challenges and Prospects. Solo Universal Journal of Islamic Education and Multiculturalism, 3(01), 11-26.

Ghorbani, A., Davoodi, F., and Zamanifar, K. (2023). Using type-2 fuzzy ontology to improve semantic interoperability for healthcare and diagnosis of depression. Artificial Intelligence in Medicine, 135. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85142446673&doi=10.1016%2fj.artmed.2022.102452&partnerID=40&md5=222679fcf87f95d3191fcfa5264a9587. doi:10.1016/j.artmed.2022.102452

Gupta, N., Singh, H., and Singla, J. (2022). Fuzzy Logic-based Systems for Medical Diagnosis - A Review.

Halimi, A., Msherghi, A., Nounou, M., Elhabbasi, B. M., Abdulrahman, B., Abouelella, A., ... Elhadi, M. (2026). Artificial intelligence performance in image-based biliary atresia identification: a systematic review and meta-analysis. European journal of radiology, 195, 112651. Retrieved from https://consensus.app/papers/artificial-intelligence-performance-in-imagebased-halimi-msherghi/97c47a3657c05bc694c8f9637a76668c/. doi:10.1016/j.ejrad.2025.112651

Harpavat, S., Aucott, S. W., Karpen, S. J., Shneider, B. L., Wang, K., Section On Gastroenterology, H., ... Section On Surgery Davidoff Andrew Md, F. B. E. M. D. F. B. G. E. M. D. F. B. M. M. D. F. D. C. D. M. (2025). Guidance for the Primary Care Provider in Identifying Infants With Biliary Atresia by 2-4 Weeks of Life: Clinical Report. Pediatrics, 155(3), e2024070077.

He, F., Li, G., Zhang, Z., Yang, C., Yang, Z., Ding, H., ... Zeng, K. (2025). Transfer learning method for prenatal ultrasound diagnosis of biliary atresia. npj Digital Medicine, 8(1), 131.

Hsu, F. R., Dai, S. T., Chou, C. M., and Huang, S. Y. (2022). The application of artificial intelligence to support biliary atresia screening by ultrasound images: A study based on deep learning models. PLoS ONE, 17(10 October). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85140415756&doi=10.1371%2fjournal.pone.0276278&partnerID=40&md5=000c8959e02c256414232b77169fd01c. doi:10.1371/journal.pone.0276278

Huang, Y.-J., Cheng, S., Yang, F.-Q., and Chen, C. (2022). Analysis and visualization of research on resilient cities and communities based on VOSviewer. International Journal of Environmental Research and Public Health, 19(12), 7068.

Jayade, S., Ingole, D. T., Ingole, M. D., and Tohare, A. (2021). Cholera Disease Detection using Fuzzy Logic Technique. Paper presented at the ICECIE 2021 - 2021 International Conference on Electrical, Control and Instrumentation Engineering, Conference Proceedings.

Kumar, R., and Sahoo, S. K. (2025). A bibliometric analysis of agro-based industries: Trends and challenges in supply chain management. Decision Making Advances, 3(1), 200-215.

LeCun, Y., Bottou, L., Bengio, Y., and Haffner, P. (2002). Gradient-based learning applied to document recognition. Proceedings of the IEEE, 86(11), 2278-2324.

Liu, J., Dai, S., Chen, G., Sun, S., Jiang, J., Zheng, S., ... Dong, R. (2020). Diagnostic value and effectiveness of an artificial neural network in biliary atresia. Frontiers in Pediatrics, 8, 409.

Liu, Q., Ali, N. L., and Lee, H. Y. (2025). Applying VOSviewer in a bibliometric review on English language teacher education research: an analysis of narratives, networks and numbers. Cogent Education, 12(1), 2449728.

Liu, X., Peng, X., Huang, Y., Shu, C., Liu, P., Xie, W., and Dang, S. (2019). Design and validation of a noninvasive diagnostic criteria for biliary atresia in infants based on the STROBE compliant. Medicine, 98(6), e13837.

Lüscher, T., Wenzl, F., D'Ascenzo, F., Friedman, P., and Antoniades, C. (2024). Artificial intelligence in cardiovascular medicine: clinical applications. European heart journal. Retrieved from https://consensus.app/papers/artificial-intelligence-in-cardiovascular-medicine-lscher-wenzl/69fa046cb7a65015978487790d216cfd/. doi:10.1093/eurheartj/ehae465

Ma, Y., Yang, Y., Du, Y., Jin, L., Liang, B., Zhang, Y., ... Jin, Z. (2025). Development of an artificial intelligence-based multimodal diagnostic system for early detection of biliary atresia. BMC Medicine, 23(1), 127.

Nakamura, H., and Yamataka, A. (2018). Non-invasive and accurate diagnostic system for biliary atresia. EBioMedicine, 36, 16-17.

Nan, D., Zhao, X., Chen, C., Sun, S., Lee, K. R., and Kim, J. H. (2025). Bibliometric analysis on ChatGPT research with CiteSpace. Information, 16(1), 38.

Niu, Y., Li, J., Xu, X., Luo, P., Liu, P., Wang, J., and Mu, J. (2024a). Deep learning-driven ultrasound-assisted diagnosis: optimizing GallScopeNet for precise identification of biliary atresia. Frontiers in Medicine, 11. Retrieved from https://consensus.app/papers/deep-learningdriven-ultrasoundassisted-diagnosis-niu-li/f7c78978d0a153c29f1c33972eba6ae4/. doi:10.3389/fmed.2024.1445069

Niu, Y., Li, J., Xu, X., Luo, P., Liu, P., Wang, J., and Mu, J. (2024b). Deep learning-driven ultrasound-assisted diagnosis: optimizing GallScopeNet for precise identification of biliary atresia. Frontiers in Medicine, 11, 1445069.

Ouanes, K., and Farhah, N. (2024). Effectiveness of Artificial Intelligence (AI) in Clinical Decision Support Systems and Care Delivery. Journal of Medical Systems, 48. Retrieved from https://consensus.app/papers/effectiveness-of-artificial-intelligence-ai-in-clinical-ouanes-farhah/19b25aeb75ce5c9fb0bee33ec32afcb5/. doi:10.1007/s10916-024-02098-4

Paul, J., Lim, W. M., O'Cass, A., Hao, A. W., and Bresciani, S. (2021). Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR). International Journal of Consumer Studies, 45(4), O1-O16.

Rabbani, T., Guthery, S. L., Himes, R., Shneider, B. L., and Harpavat, S. (2021). Newborn screening for biliary atresia: a review of current methods. Current gastroenterology reports, 23(12), 28.

Ranucci, G., Della Corte, C., Alberti, D., Bondioni, M. P., Boroni, G., Calvo, P. L., ... D'Antiga, L. (2022). Diagnostic approach to neonatal and infantile cholestasis: a position paper by the SIGENP liver disease working group. Digestive and Liver Disease, 54(1), 40-53.

Röper, K., Kunz, N., and Gast, L. (2025). Renewable hydrogen in industrial production: A bibliometric analysis of current and future applications. International Journal of Hydrogen Energy, 98, 687-696.

Saadi, F., Atmani, B., and Henni, F. (2023). Improving Retrieval Performance of Case Based Reasoning Systems by Fuzzy Clustering. Int. J. Interact. Multim. Artif. Intell., 9, 84. Retrieved from https://consensus.app/papers/improving-retrieval-performance-of-case-based-reasoning-saadi-atmani/6a5c3fe6e1ba5ddfb34e2438834bf412/. doi:10.9781/ijimai.2023.07.002

Scimago, G. (2006). Análisis de la cobertura de la base de datos Scopus. El profesional de la información, 15(2), 144-145.

Van Eck, N., and Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. scientometrics, 84(2), 523-538.

Vij, M., and Rela, M. (2020). Biliary atresia: pathology, etiology and pathogenesis. Future Science OA, 6. Retrieved from https://consensus.app/papers/biliary-atresia-pathology-etiology-and-pathogenesis-vij-rela/9cd38b4a3c285e3d94a0d390af63cacb/. doi:10.2144/fsoa-2019-0153

Wong, D. (2018). VOSviewer. . Technical Services Quarterly, 35, 219-220. .

Yang, L., Du, C., Chen, W., Duan, X., Zhou, M., and Wen, H. (2021). Pilot study of artificial intelligence ultrasound diagnosis of biliary atresia based on deep learning. Chinese Journal of Ultrasonography, 30(5), 402-407. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107805552&doi=10.3760%2fcma.j.cn131148-20201204-00917&partnerID=40&md5=f59dc4821d1e14e6189f01060014ed32. doi:10.3760/cma.j.cn131148-20201204-00917

Yerimova, N., Baimakhanov, B., Shirtayev, B., Kurbanov, D., Azadbekova, Z., and Subhash, G. (2025). BILE DUCT ATRESIA. LITERATURE REVIEW. BULLETIN OF SURGERY IN KAZAKHSTAN. Retrieved from https://consensus.app/papers/bile-duct-atresia-literature-review-yerimova-baimakhanov/08a42cefc6e05222852fba833b953e9a/. doi:10.35805/bsk2025iii0012

Zahidi, M. S., and Bin Othman, M. F. (2025). A Bibliometric Analysis of Paradiplomacy Research on The Scopus Database Using the VOSviewer Application. . International Journal of Information Science and Management (IJISM),, 23, 125-146.

Zhou, W., Yang, Y., Yu, C., Liu, J., Duan, X., Weng, Z., ... Zhou, L. (2021). Ensembled deep learning model outperforms human experts in diagnosing biliary atresia from sonographic gallbladder images. Nature Communications, 12(1). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85101580048&doi=10.1038%2fs41467-021-21466-z&partnerID=40&md5=f07730b16b040caaab2b5e54a4698650. doi:10.1038/s41467-021-21466-z

Zhou, W., Ye, Z., Huang, G., Zhang, X., Xu, M., Liu, B., ... Zhou, L. (2024). Interpretable artificial intelligence-based app assists inexperienced radiologists in diagnosing biliary atresia from sonographic gallbladder images. BMC Medicine, 22(1). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85183002477&doi=10.1186%2fs12916-024-03247-9&partnerID=40&md5=2eef91976b0820a4bdf580748ad5c9b0. doi:10.1186/s12916-024-03247-9

Zhou, W., and Zhou, L. (2022). Ultrasound for the diagnosis of biliary atresia: From conventional ultrasound to artificial intelligence. Diagnostics, 12(1). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121986179&doi=10.3390%2fdiagnostics12010051&partnerID=40&md5=2b8acfa1b1311383f0033d8fd44c7ac2. doi:10.3390/diagnostics12010051

Cite this article: Reyes JAM, Fontes CHDO, Martins MAF, Rodríguez JLM. Artificial Intelligence in Biliary Atresia Diagnosis: A Bibliometric Analysis and Categorization of Approaches for the Use of Low-Complexity Techniques in Primary Care. J Scientometric Res. 2026;15(2):374-85.

Appendix

Table A1: Detailed search strategy and results by stage.

Stage	Search Query (Scopus)	Inclusion Criteria	Exclusion Criteria	Records Retrieved
1	(TITLE-ABS-KEY ("Artificial Intelligence" OR "Machine Learning" OR "deep learning") AND TITLE-ABS-KEY (medicine OR healthcare OR diagnosis)) AND PUBYEAR > 2013 AND PUBYEAR < 2025	Publications related to AI applications in healthcare	Non-English documents; clearly unrelated topics	8,253
2	(KEY ("case based reasoning" OR "case-based reasoning") AND TITLE-ABS-KEY (medicine OR healthcare)) AND PUBYEAR > 2013 AND PUBYEAR < 2025	Studies applying CBR in healthcare	Irrelevant to healthcare	92
3	(TITLE-ABS-KEY ("case based reasoning" OR "fuzzy logic" OR "fuzzy inference") AND TITLE-ABS-KEY (diagnosis OR "medical diagnosis" OR "clinical decision")) AND PUBYEAR > 2013 AND PUBYEAR < 2025	Studies involving CBR and/or Fuzzy Logic in medical diagnosis	Not related to diagnosis	266
4	(TITLE-ABS-KEY ("biliary atresia") AND TITLE-ABS-KEY ("artificial intelligence" OR "machine learning" OR "deep learning" OR "case-based reasoning" OR "fuzzy logic")) AND PUBYEAR > 2013 AND PUBYEAR < 2025	AI applications specifically for the diagnosis of biliary atresia	Not focused on BA diagnosis	8