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Applications of artificial intelligence in hospital quality management: a review of digital strategies in healthcare settings

Aplicaciones de inteligencia artificial en la gestión de la calidad hospitalaria: una revisión de estrategias digitales en entornos de salud

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ABSTRACT

This study analyzes the application of artificial intelligence (AI) in improving hospital quality management through a systematic review of 31 scientific articles indexed in Scopus. An exploratory methodology was used with selection criteria based on recency, thematic relevance, and methodological rigor. The research identifies the main applications of AI in the automation of clinical and administrative processes, clinical decision support, triage optimization, and detection of adverse events. The most widely used technologies include machine learning, deep neural networks, expert systems, and natural language processing. The results show measurable improvements in operational efficiency, diagnostic accuracy, patient safety, and strategic hospital planning. However, significant challenges remain regarding system interoperability, data quality, staff training, and ethical implications of automated decision-making. The study concludes that AI is a key tool for advancing toward more intelligent and quality-focused hospital models, although its adoption requires comprehensive strategies that address technical and regulatory barriers to ensure ethical, safe, and sustainable implementation.

Keywords: clinical decision support, digital transformation, hospital efficiency, patient outcomes, process automation, risk prediction

RESUMEN

Este estudio analiza la aplicación de la inteligencia artificial (IA) en la mejora de la gestión de la calidad hospitalaria mediante una revisión sistemática de 31 artículos científicos indexados en Scopus. Se empleó una metodología exploratoria con criterios de selección basados en actualidad, relevancia temática y rigor metodológico. La investigación identifica las principales aplicaciones de la IA en la automatización de procesos clínicos y administrativos, el soporte a la toma de decisiones médicas, la mejora del triaje, y la detección de eventos adversos. Entre las tecnologías más utilizadas destacan el aprendizaje automático, las redes neuronales profundas, los sistemas expertos y el procesamiento de lenguaje natural. Los resultados muestran mejoras cuantificables en la eficiencia operativa, la precisión diagnóstica, la seguridad del paciente y la planificación estratégica en hospitales. No obstante, se identifican desafíos importantes relacionados con la interoperabilidad de sistemas, la calidad de los datos, la capacitación del personal y las implicancias éticas en la toma de decisiones automatizadas. Se concluye que la IA constituye una herramienta clave para avanzar hacia modelos hospitalarios más inteligentes y centrados en la calidad, aunque su adopción requiere estrategias integrales que aborden sus barreras técnicas y normativas para asegurar una implementación ética, segura y sostenible.

Palabras clave: apoyo a decisiones clínicas, automatización de procesos, eficiencia hospitalaria, predicción de riesgos, resultados en pacientes, transformación digital

1. INTRODUCTION

Artificial Intelligence (AI) has become a transformative pillar in the healthcare sector, with applications that go beyond clinical diagnosis and extend to hospital management processes, particularly in the area of quality of care (Alowais et al., 2023; Bajwa et al., 2021). Advanced algorithms such as supervised and unsupervised machine learning, expert systems, process mining, and natural language processing enable the automation of data collection, analysis, and interpretation from large volumes of clinical and administrative information, facilitating the continuous improvement of healthcare delivery (Karalis, 2024; Navarro-Cabrera et al., 2025; Valles-Coral et al., 2024).

The integration of AI into hospital quality management systems has allowed for the real-time detection of deviations, optimization of workflows, prediction of adverse events, and generation of early alerts to support evidence-based managerial decision-making (Al Kuwaiti et al., 2023; Alowais et al., 2023). These technologies have shown potential to positively impact key indicators such as patient safety, operational efficiency, process traceability, and user satisfaction, thereby strengthening accreditation systems and regulatory compliance in hospital settings (Stoumpos et al., 2023).

Scientific interest in the use of AI for hospital management has grown exponentially, especially in contexts where healthcare systems face structural limitations and pressure to improve quality standards (Ali et al., 2023). However, its effective implementation faces multiple challenges, including integration with legacy information systems, shortage of specialized digital health talent, and the need to adapt regulatory frameworks to new algorithmic management models (Hazra & Bora, 2025; Kumar et al., 2025).

Moreover, the adoption of AI in hospital environments raises ethical and technical questions, such as the explainability of algorithms used in clinical and administrative decisions, the protection of sensitive data, and the external validation of predictive models prior to operational deployment (Mennella et al., 2024; Mohammed & Malhotra, 2025; Navarro-Vega et al., 2022). The opacity of certain black-box models and the risk of replicating systemic biases may undermine the reliability of quality systems unless robust audit and control mechanisms are established.

Although numerous studies highlight the potential benefits of AI in hospital quality management, the literature also reveals significant gaps regarding its sustainable implementation, especially in public secondary-level hospitals where technological and human resources are limited (Maleki Varnosfaderani & Forouzanfar, 2024; Roppelt et al., 2024). Discrepancies in reported results are often due to the lack of standardized metrics, regulatory frameworks, and best practice guidelines for impact evaluation (Palaniappan et al., 2024).

In this context, it is necessary to conduct a thorough analysis of the current state of knowledge on AI applications for quality improvement in hospitals. This review aims to examine the scientific output indexed in databases such as Scopus between 2020 and 2025, identifying usage patterns, technical limitations, documented benefits, and emerging research areas. The goal is to provide a comprehensive framework to support future digital transformation strategies in hospital institutions, prioritizing the ethical, efficient, and context-aware integration of artificial intelligence into quality management processes.

2. METHODOLOGY

To conduct this research, an exploratory systematic review was employed—a methodological approach that allows for a structured analysis of the existing scientific literature, identifying emerging patterns and detecting knowledge gaps within a specific field (Chigbu et al., 2023). This type of review is particularly suitable for evolving topics such as artificial intelligence (AI) applied to hospital management, as it facilitates the integration of relevant findings from multiple perspectives and organizational levels. Furthermore, it provides a solid foundation for guiding future research, institutional interventions, and digital transformation policies in the health sector (Xiao & Watson, 2019).

The review process was organized according to the methodological guidelines proposed by Carrera-Rivera et al. (2022), following two main phases: planning and execution. In the planning phase, the key elements of the review protocol were defined, including the formulation of research questions, selection of terms and synonyms, identification of relevant bibliographic sources, establishment of inclusion and exclusion criteria, and the design of a data collection instrument. A quality assessment guideline was also defined to ensure rigor in the selection of scientific documents.

Search strategy

During the execution phase, an advanced search string was applied in the Scopus database, selected for its multidisciplinary coverage and high indexing level. The search string used was as follows:

("artificial intelligence" OR "ai" OR "machine learning" OR "deep learning") AND ("hospital" OR "healthcare" OR "medical" OR "clinic") AND ("quality management" OR "quality assurance" OR "performance improvement" OR "patient safety") AND ("data analysis" OR "predictive analytics" OR "decision support" OR "process optimization") AND ("workflow" OR "efficiency" OR "outcomes" OR "service delivery").

This initial search yielded a total of 13,420 documents.

Inclusion and exclusion criteria

To narrow the selection to highly relevant and scientifically rigorous articles, specific filters were applied using the TITLE-ABS-KEY field. Only documents published between 2020 and 2025, written in English or Spanish, classified as scientific articles (ar), and available in final version or open access (OA) were considered. After applying these criteria, the number of results was reduced to 72 articles.

Study selection and evaluation

A three-stage filtering process was then carried out:

(1) application of the eligibility criteria defined during planning;

(2) critical reading of titles, abstracts, and key sections of the articles; and

(3) methodological evaluation using the established quality guideline.

As a result of this process, 31 articles (Annex 1) were identified that met all requirements and explicitly addressed the application of artificial intelligence technologies in improving hospital quality.

Data organization and analysis

The selected studies were organized into a structured database (Microsoft Excel), where key information was recorded, such as: identification code, article title, journal name, year of publication, country of origin, type of AI technology used, hospital area of application, results obtained, and reported impact on care quality. This matrix enabled a systematic analysis of technological trends, observed benefits, identified challenges, and improvement opportunities in the implementation of AI in hospitals.

Research questions

In line with the objectives of this review, the following research questions were formulated to guide the analysis process:

(1) What are the main applications of artificial intelligence in improving hospital quality management?

(2) Which AI technologies have proven most effective in optimizing clinical and administrative processes related to care quality?

(3) In which hospital areas is AI being implemented to improve quality indicators, patient safety, and operational efficiency?

(4) What quantitative or qualitative results have been reported in recent studies on the impact of AI in quality management in hospitals?

(5) What are the main technical, ethical, and organizational challenges in adopting AI as a tool for continuous quality improvement in hospitals?.

3. RESULTS AND DISCUSSIONS

The review of the 32 articles allowed for the identification of a diverse set of applications, technical frameworks, and algorithmic models related to the use of artificial intelligence for improving hospital quality. The evidence gathered highlights how these technologies are being utilized to optimize clinical and administrative processes, enhance diagnostic accuracy, strengthen patient safety, and expedite medical decision-making. Additionally, there has been an increase in the adoption of intelligent systems aimed at clinical support, predictive risk analysis, and efficient management of hospital resources. These developments focus not only on automation but also on integrating advanced analytical capabilities to reduce care variability and promote more adaptive hospital environments.

Based on the analysis of the selected articles, the findings were organized into five main thematic axes that reflect the most common areas of application, the AI models used, their benefits in terms of efficiency and clinical outcomes, as well as the most common technical and organizational challenges. It was evident that although the implementation of artificial intelligence in hospital settings has led to substantial improvements in quality and performance, limitations persist—particularly related to access to interoperable data, the need for adequate technological

infrastructure, and the training of clinical staff. The results are presented below according to the previously defined research questions, with an analytical approach aimed at understanding the current scope of AI in the health sector and its future projections.

Applications of artificial intelligence in hospital quality improvement

Findings from the systematic review reveal a wide range of artificial intelligence (AI) applications aimed at enhancing quality in hospital management. One of the most widespread applications is the automation of clinical and administrative processes, which has improved the operational efficiency of healthcare centers by reducing repetitive tasks, minimizing human errors, and integrating digital workflows. This automation has facilitated system interoperability, the use of electronic health records, and the intelligent monitoring of critical operations, thus promoting more agile and outcome-oriented hospital management (Table 1).

Other relevant applications identified include the optimization of triage and patient classification, support for clinical decision-making, enhancement of patient safety, and predictive analytics for institutional planning. AI has enabled the development of smart triage systems that appropriately prioritize patients based on urgency, as well as clinical support platforms that assist in diagnosis, therapeutic choices, and follow-up. In parallel, its integration into patient safety tasks has been crucial for preventing adverse events and optimizing clinical risk management. Finally, predictive analytics—based on algorithms trained with large volumes of hospital data—have proven useful for forecasting resource demands, projecting lengths of stay, and designing continuous improvement strategies. These applications, summarized in Table 1, demonstrate the cross-cutting and strategic role of artificial intelligence in the digital transformation of hospital systems.

Table 1. Technologies applied in predictive models

AI Applications	Article codes
Clinical decision support	A1, A2, A3, A4, A7, A9, A10, A11, A17, A20, A21, A26
Medical error detection and prevention	A1, A6, A11, A17, A22, A23, A26, A27
Optimization of triage and care flows	A7, A8, A10, A13, A14, A25, A31
Predictive analytics for risk and adverse event reduction	A1, A3, A5, A6, A7, A15, A16, A19, A20, A23, A24, A28
Automated assessment and quality management in nursing	A2, A12, A18, A27
Improving hospital operational efficiency	A3, A4, A5, A7, A9, A14, A16, A18, A21, A30
Integration of social determinants of health into predictive models	A8, A20
Personalization of clinical treatments or interventions	A4, A6, A13, A19, A24, A29
Clinical documentation assistants and reduction of administrative burden	A5, A9, A11, A15, A29
Development of platforms to support continuous improvement	A3, A12, A16, A18, A21, A30

Most effective artificial intelligence technologies in hospital optimization

The analysis of the selected studies identified a diverse set of artificial intelligence technologies successfully applied to the optimization of clinical and administrative processes related to care quality. Among them, machine learning and deep learning stand out as the most widely implemented tools. These technologies have been used to recognize complex clinical patterns,

anticipate adverse events, improve resource allocation, and prioritize medical care based on both historical and real-time data. Algorithms such as random forest, support vector machines (SVM), and deep neural networks have proven effective in analyzing both structured and unstructured data, enhancing diagnostic accuracy and response efficiency in hospital settings.

Additionally, clinical decision support systems (CDSS) have been key to enabling safer and more timely medical decision-making. These systems, when integrated with predictive models and continuous monitoring platforms, enhance the responsiveness of clinical teams, contributing to more personalized and evidence-based care. Complementary technologies were also identified, such as natural language processing (NLP), which is useful for automating medical documentation and analyzing clinical texts, and expert systems, especially applied to the automated evaluation of nursing processes and clinical protocols. Together, these technologies—summarized in Table 2—reflect a convergence toward smarter hospital ecosystems, where AI acts as a catalyst for improving the quality, safety, and efficiency of healthcare services.

Table 2. AI technologies used in the optimization of clinical and administrative processes

Applied AI technologies	Article codes
Machine learning	A1, A3, A4, A6, A7, A9, A13, A15, A16, A20, A23, A24, A28
Deep learning	A4, A5, A6, A10, A13, A15, A16, A19, A28
Clinical decision support systems (CDSS)	A1, A2, A3, A7, A10, A11, A17, A20, A21, A22, A26
Natural language processing (NLP)	A9, A11, A14, A15, A29
Predictive models based on regression and multivariate analysis	A1, A3, A5, A7, A16, A19, A24, A25, A27
Supervised algorithms (decision trees, random forests, SVM, etc.)	A3, A6, A8, A16, A23, A24
Unsupervised algorithms (clustering, dimensionality reduction)	A5, A10, A13, A24
Intelligent real-time analysis platforms	A4, A9, A12, A16, A18, A21, A30
Integration of chatbots and clinical assistants with AI	A9, A11, A15, A29
Expert systems for automated evaluation	A2, A12, A18, A27

Hospital areas for the implementation of artificial intelligence focused on quality and safety

The results obtained in this systematic review show that the implementation of artificial intelligence in hospital settings is primarily concentrated in five critical areas: emergency rooms, intensive care units (ICUs), nursing services, medical diagnosis and treatment, and administrative planning. In emergency rooms and triage, AI systems have played a key role in prioritizing patients based on the severity of their symptoms, optimizing initial response times, and contributing to more efficient management of human and material resources. These applications have led to improvements in key indicators such as response time, patient satisfaction, and the reduction of critical events in emergency services.

In intensive care units, AI has been directed toward real-time monitoring, analysis of complex physiological parameters, and prediction of clinical outcomes, which has enhanced patient safety in highly critical environments. In parallel, nursing services have incorporated intelligent tools for the automated management of assessments, clinical records, and therapeutic follow-up, significantly improving care quality and traceability.

In the area of diagnosis and medical treatment, AI has supported clinical decision-making through algorithms that enhance disease identification accuracy, personalize treatments, and enable more timely interventions. Finally, in administrative management, predictive models and automated systems have supported processes such as resource allocation, demand planning, and monitoring of institutional indicators. These findings are summarized in Table 3.

Table 3. Hospital areas of AI application

Hospital areas of AI application	Article codes
Emergency Rooms and Triage	A5, A7, A17, A22, A28
Intensive Care Units (ICU)	A3, A4, A14, A18, A23, A24
Nursing Services	A2, A6, A20, A30
Medical Diagnosis and Treatment	A9, A10, A16, A19, A25, A27, A31
Administrative management and hospital planning	A1, A12, A15, A29

Analysis of reported impact in the scientific literature

The collected findings reveal a variety of quantitative and qualitative outcomes that demonstrate the impact of artificial intelligence (AI) on improving hospital quality management. One of the most notable improvements is the significant reduction in triage and clinical response times, thanks to automatic classification systems and predictive algorithms applied in critical areas such as emergency departments and intensive care units (A5, A7, A17, A22). These advances have contributed to more timely care, which is crucial for reducing hospital mortality rates.

Another major outcome is the improvement in diagnostic accuracy. Through machine learning techniques and image processing, several studies (A2, A4, A14, A18) report a greater capacity for early identification of diseases, which has strengthened patient safety and reduced human error margins.

In addition, several studies highlight a decrease in medical errors and adverse events through the use of AI for continuous monitoring and the automatic identification of clinical risks (A3, A6, A10, A16, A19). A substantial improvement in operational efficiency has also been documented through the optimization of hospital resources—such as beds, staff, and medication (A1, A12, A15, A29)—enabling more strategic planning.

From a qualitative perspective, there has been an increase in medical staff satisfaction and trust regarding the use of intelligent tools (A20, A24, A27, A31), as well as improved patient perception of the quality of services received (A18, A25, A30). Finally, studies emphasize how AI has strengthened strategic clinical decision-making (A9, A10, A23, A26) and fostered a culture of innovation and digital transformation within hospitals (A13, A21, A28), reinforcing its role as a key component in the digital transformation of the healthcare sector. These results are summarized in Table 4.

Table 4. Reported outcomes on the impact of ai in hospital quality management

Type of outcome reported	Article codes
Reduced triage and clinical response time	A5, A7, A17, A22
Improved diagnostic accuracy	A2, A4, A14, A18
Reduced medical errors and adverse events	A3, A6, A10, A16, A19
Optimized hospital resources (beds, staff, medications)	A1, A12, A15, A29
Increased medical staff satisfaction and confidence	A20, A24, A27, A31

Improved patient perception of service quality	A18, A25, A30
Support for strategic clinical decision-making	A9, A10, A23, A26
Promoting a culture of innovation and digitalization in hospitals	A13, A21, A28

Main barriers to the adoption of artificial intelligence in healthcare

The analyzed studies agree that although artificial intelligence (AI) represents a promising tool for transforming hospital management, its adoption faces multiple challenges that compromise its sustainability and scalability. On a technical level, one of the main barriers is the lack of interoperability between hospital systems and AI-based platforms, which hinders the seamless integration of clinical data from diverse sources (A2, A6, A10). Added to this is the limited availability of structured and high-quality data, which restricts the ability to train robust and reliable models (A8, A11, A14). Furthermore, several studies emphasize that most institutions lack adequate technological infrastructure, preventing the efficient processing of large volumes of data (A4, A15, A17).

On the ethical and organizational front, challenges relate to patient privacy protection, informed consent for the use of sensitive data, and algorithmic transparency in automated decision-making (A9, A13, A18). The absence of clear regulations and frameworks tailored to AI use in clinical contexts increases the risk of discriminatory biases and generates resistance from healthcare personnel (A12, A16, A20). From an organizational perspective, there is also a significant gap in the digital competencies of healthcare professionals, along with a limited culture of innovation that hampers technological adoption (A1, A5, A7). These factors—along with weak coordination between technical and clinical teams—hinder the effective implementation of intelligent systems aimed at the continuous improvement of care quality. The main identified challenges are summarized in Table 5.

Table 5. Technical, Ethical, and Organizational Challenges in the Adoption of AI in Hospitals

Type of challenge	Article codes
Interoperability and system fragmentation	A2, A6, A10
Insufficient clinical data quality	A8, A11, A14
Limited technological infrastructure	A4, A15, A17
Data privacy and informed consent	A9, A13, A18
Lack of transparency and risk of algorithmic bias	A12, A16, A20
Gap in staff digital skills	A1, A5, A7
Resistance to change and a low culture of innovation	A5, A7, A12
Weak coordination between clinical and technical areas	A6, A14, A19

The body of reviewed studies demonstrates that artificial intelligence (AI) has been successfully implemented in various areas of hospital management to improve the quality of care. Among the most recurrent applications are the automation of clinical and administrative processes (Bai et al., 2025; Vueghs et al., 2024), support for triage and patient classification (Shah et al., 2021; Sheikh et al., 2024), as well as clinical decision support through predictive models (Cho et al., 2023; Woo et al., 2020). These tools have contributed to increased operational efficiency, reduced human error, and strengthened medical decision-making, establishing themselves as strategic elements in hospitals committed to digital transformation.

Regarding the technologies used, machine learning and deep learning have been dominant as the foundation for intelligent systems development. Algorithms such as deep neural networks, random forest, and support vector machines (SVM) have been widely applied in tasks such as image-assisted diagnosis (Rai et al., 2024; Arora et al., 2023) and prediction of clinical complications (Hinson et al., 2025; Vodrahalli et al., 2023). Other notable technologies include expert systems (Corny et al., 2020) and natural language processing (NLP), which have enabled the automation of clinical documentation and textual analysis, particularly useful in reducing the administrative burden on healthcare professionals.

With regard to hospital areas where AI adoption is concentrated, studies reveal a trend toward implementation in critical care services such as intensive care units, emergency departments, medical imaging, and pharmacovigilance (Dai et al., 2024; Kehayias et al., 2023). AI has also been incorporated into continuous monitoring, bed management, and risk analysis functions, contributing to more strategic and efficient hospital resource management (Davazdahemami et al., 2022; Joshi et al., 2022). Qualitative findings indicate an improvement in medical staff perceptions regarding the usefulness of these tools, which has facilitated their progressive acceptance.

However, significant challenges to full adoption have also been identified. The main barriers include the lack of interoperability between systems (Abukhadijah & Nashwan, 2024), the low quality of available data (Lee et al., 2024), ethical concerns regarding patient privacy (Guerra, 2024), and the limited digital competencies of healthcare personnel (Amador-Fernández et al., 2023). These limitations highlight the need for strong institutional policies, training programs, and regulatory frameworks that support the ethical and effective implementation of AI in hospital settings. Taken together, the evidence suggests that while the potential of these technologies is high, successful adoption requires an integrated and context-aware strategy.

CONCLUSIONS

The findings of this systematic review highlight that artificial intelligence (AI) has become a key tool for quality improvement in hospital management. Its implementation has demonstrated significant impacts in critical areas such as triage, clinical diagnosis, optimization of administrative processes, and strengthening patient safety. The most widely used technologies include machine and deep learning, as well as expert systems and natural language processing, which have enabled the automation of complex tasks, reduced human error, and provided real-time clinical decision-making support.

Furthermore, evidence shows that AI applications tend to be concentrated in high-demand and high-risk hospital units, such as emergency departments, intensive care, and diagnostic imaging. These technologies have contributed to improving key indicators of operational efficiency, reducing adverse events, and increasing the satisfaction of both medical staff and patients. However, adoption has been inconsistent; factors such as limited technological infrastructure, poor data quality, lack of clear regulation, and resistance to change constitute persistent challenges that affect its scalability. From an ethical and organizational perspective, the implementation of AI raises important questions regarding algorithmic transparency, informed consent, and equity in access to digital solutions. Overcoming these challenges requires the development of robust public policies, strengthening healthcare personnel training in digital skills, and creating institutional environments that promote responsible innovation and data governance.

In terms of future implications, AI is expected not only to continue expanding into new clinical areas but also to evolve toward more integrated, adaptive, and explainable models. This opens up opportunities for the development of smarter and more resilient hospital systems, capable of responding quickly to health crises, personalizing medical care, and optimizing strategic planning. As ethical and regulatory frameworks advance, it will be crucial to maintain a patient-centered approach that balances technological efficiency with the human quality of healthcare.

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CONFLICT OF INTEREST

There is no conflict of interest related to the subject matter of the work.

AUTHORSHIP CONTRIBUTION

Conceptualization, data curation, formal analysis, research, visualization, writing -original draft, writing -correction and editing: García-García, R. E.

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ANNEXES

Annexe A.1. Coded list of articles included in the review

Code	Autors	Code	Autors
A1	(Bai et al., 2025)	A17	(Petch et al., 2023)
A2	(You et al., 2025)	A18	(Kehayias et al., 2023)
A3	(Hinson et al., 2025)	A19	(Davazdahemami et al., 2022)
A4	(Li et al., 2025)	A20	(Joshi et al., 2022)
A5	(Vueghs et al., 2024)	A21	(de Vries et al., 2022)
A6	(Abukhadijah & Nashwan, 2024)	A22	(Burns et al., 2022)
A7	(Sheikh et al., 2024)	A23	(Afrash et al., 2022)
A8	(Dai et al., 2024)	A24	(García-Alonso et al., 2022)
A9	(Lee et al., 2024)	A25	(Shah et al., 2021)
A10	(Rai et al., 2024)	A26	(Agarwal et al., 2021)
A11	(Guerra, 2024)	A27	(Murphree et al., 2021)
A12	(Berge et al., 2023)	A28	(Zarkowsky et al., 2021)
A13	(Cho et al., 2023)	A29	(Baki Kocaballi et al., 2020)
A14	(Vodrahalli et al., 2023)	A30	(Corny et al., 2020)
A15	(Amador-Fernández et al., 2023)	A31	(Woo et al., 2020)
A16	(Arora et al., 2023)		