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Global Research on Digital Platforms in Rural Knowledge Transfer During 2003-2025: A Bibliometric Analysis

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HIGHLIGHTS

- Research output on digital platforms for rural knowledge transfer increased rapidly after 2015.
- USA, China, and UK lead global contributions with strong institutional collaborations.
- Major themes include digital agriculture, mobile advisory tools, AI learning, and knowledge management.
- Emerging topics involve digital literacy and participatory knowledge systems.
- Bibliometric mapping highlights the need for inclusive digital ecosystems in rural extension.

ARTICLE INFO

Keywords: Agricultural extension, Bibliometric analysis, Digital platforms, Knowledge management, Knowledge transfer.

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ABSTRACT

The study mapped global research on digital platforms in rural knowledge transfer using Scopus-indexed publications published between 2003 and 2025. A total of 251 peer-reviewed documents were analysed using descriptive indicators, citation patterns, and network visualisations. The analysis indicated a consistent increase in research output after 2015, with notable peaks in 2021 and 2023, reflecting the growing adoption of ICTs, mobile applications, and e-learning in agricultural extension. Highly cited publications demonstrated strong scholarly influence in digital learning and technology-enabled advisory frameworks. Country-level analysis identified the United States, China, and the United Kingdom as leading contributors, supported by key institutions such as Wageningen University and the International Institute of Tropical Agriculture (IITA). Keyword co-occurrence mapping revealed dominant themes related to digital agriculture, mobile-based extension, AI-enabled learning, and knowledge management, alongside emerging areas such as digital literacy and participatory knowledge systems. Despite India's extensive digital agriculture initiatives, the limited presence of high-impact Indian studies highlights a critical research gap. The findings underscore the need for context-specific and inclusive digital extension research in India, while outlining future prospects focused on impact evaluation, digital literacy, and participatory platform design.

INTRODUCTION

Rural knowledge transfer remains a cornerstone of agricultural development and extension education, yet many smallholder and marginal farmers in India lack timely and relevant information on agronomic practices, market behaviour, weather advisories, and emerging agricultural technologies, which are essential for productivity and resilience. Surveys indicate that only about 40% of farmers have access to any agricultural information, and fewer than one in ten receive advice from state extension agents, leaving the majority without adequate technical guidance (Singh et al., 2023; Khatri et al., 2024; Krishna & Naik, 2020). Digital platforms including mobile advisory applications, interactive web portals, and social media channels offer mechanisms to enhance information

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dissemination, reach marginalized farmers, and support evidence-based decision-making (Sharma et al., 2025; Yuan & Sun, 2024; Wang & Dong, 2023).

In India, policy initiatives such as the Digital Agriculture Mission, e-NAM, and Kisan Call Centres have accelerated the integration of information and communication technologies into agricultural extension systems, enabling wider access to real-time data, expert guidance, and decision-support tools. Despite these advances, persistent challenges related to digital literacy, connectivity gaps, affordability constraints, and socio-economic disparities continue to influence how rural communities engage with and benefit from digital platforms (Suman et al., 2025; Anteneh & Malek, 2024). Consequently, while digital technologies offer significant opportunities for strengthening advisory services, they also present limitations that necessitate systematic assessment of their research evolution and implications for extension practice (Roy et al., 2024).

Although numerous studies have examined ICT adoption and digital interventions in agriculture, research on digital platforms for rural knowledge transfer remains fragmented across geographical contexts, theoretical perspectives, methodological approaches, and thematic priorities. In India, evidence on the effectiveness, reach, and adoption of these platforms among smallholder farmers is limited, with few studies systematically analysing publication trends, collaborative networks, and thematic directions specific to the country (Ayim et al., 2022; Vishwakarma et al., 2025). Addressing these gaps requires a comprehensive synthesis to identify productivity trends, influential contributors, collaboration patterns, and emerging themes, particularly in India, to inform context-specific strategies and policy interventions (Khatri et al., 2024; Pippi et al., 2025).

Bibliometric analysis provides a rigorous and systematic approach for mapping the intellectual structure and developmental trajectory of a research field. By examining publication patterns, citation influence, co-authorship networks, and keyword co-occurrence relationships, bibliometric techniques offer valuable insights into the evolution of research on digital platforms and rural knowledge transfer (Suman et al., 2025; Roy et al., 2024; Vishwakarma et al., 2025). Such insights are particularly relevant for extension education, as they help identify underexplored themes and inform the design of inclusive, evidence-based digital advisory interventions.

Against this background, the present study undertakes a comprehensive bibliometric analysis of global literature on digital platforms in rural knowledge transfer, with the aim of examining publication and citation trends, identifying leading countries, institutions, and authors, and exploring the thematic structure of the research domain. The findings are expected to provide meaningful insights for researchers, extension professionals, and policymakers seeking to strengthen digital knowledge systems for rural development.

METHODOLOGY

The study adopted a bibliometric approach to analyse global research on digital platforms in rural knowledge transfer. Bibliographic data were retrieved from the Scopus database, a widely used source for large-scale quantitative analysis of scientific publications. A structured search strategy was applied using the following query: (TITLE-ABS-KEY (“digital platform” OR “online platform” OR “ICT platform” OR “mobile application” OR “e-learning” OR “digital technology”) AND TITLE-ABS-KEY (“rural knowledge” OR “knowledge transfer” OR “extension education” OR “agricultural extension” OR “knowledge dissemination “farmer learning”). The initial search covered publications from 2000 to 2025, yielding 1,360 documents. However, the analysis considered only publications from 2003 onwards, as the first relevant study appeared in that year. The dataset was further refined by including only peer-reviewed journal articles and review papers, while conference papers, book chapters, editorials, and other document types were excluded. Subject-area filtering was applied to retain publications indexed under Agricultural and Biological Sciences and Social Sciences, resulting in a final dataset of 251 English-language documents used for analysis. It is acknowledged that Scopus coverage may not include all regional journals or gray literature, which could limit the comprehensiveness of the dataset.

The bibliographic data were exported in CSV format and analysed using VOSviewer and the Biblioshiny interface of the Bibliometrix R-package (Aria & Cuccurullo, 2017; Van Eck & Waltman, 2014). Analyses included publication and citation trends, co-authorship networks, country and institutional contributions, keyword co-occurrence, and thematic structures. Co-occurrence mapping and network visualization techniques were applied to identify collaborative patterns, influential contributors, and emerging thematic directions. This approach allows the identification of underexplored themes, knowledge gaps, and the intellectual structure of research on digital platforms in rural knowledge transfer.

The methodology provides a systematic, transparent, and reproducible framework for mapping the evolution of global research, which is particularly relevant for informing extension strategies and digital advisory interventions, including insights applicable to India and other developing-country contexts.

RESULTS

Publication and citation trends

Research on digital platforms in rural knowledge transfer commenced in 2003 with a single publication receiving 19 citations. Between 2003 and 2006, publication activity remained limited, with typically one article per year. A gradual increase was observed from 2007, with intermittent fluctuations until 2014, which recorded 10 publications generating 348 citations. From 2015 to 2020, annual outputs ranged from 4 to 21 publications, reflecting steady growth. A notable peak occurred in 2021, with 23 publications contributing 750 citations, indicating heightened scholarly engagement. Subsequent expansion was observed in 2023 and 2024, with 37 and 32 publications, respectively, and the highest output occurred in 2025 with 41publications; citation counts for these recent years remain low due to the shorter citation window.

Globally, research activity reflects increasing academic attention to this area, with India contributing 25 publications over 2003–2025, representing approximately 9.2% of the total output. Indian research exhibited gradual growth, with notable contributions

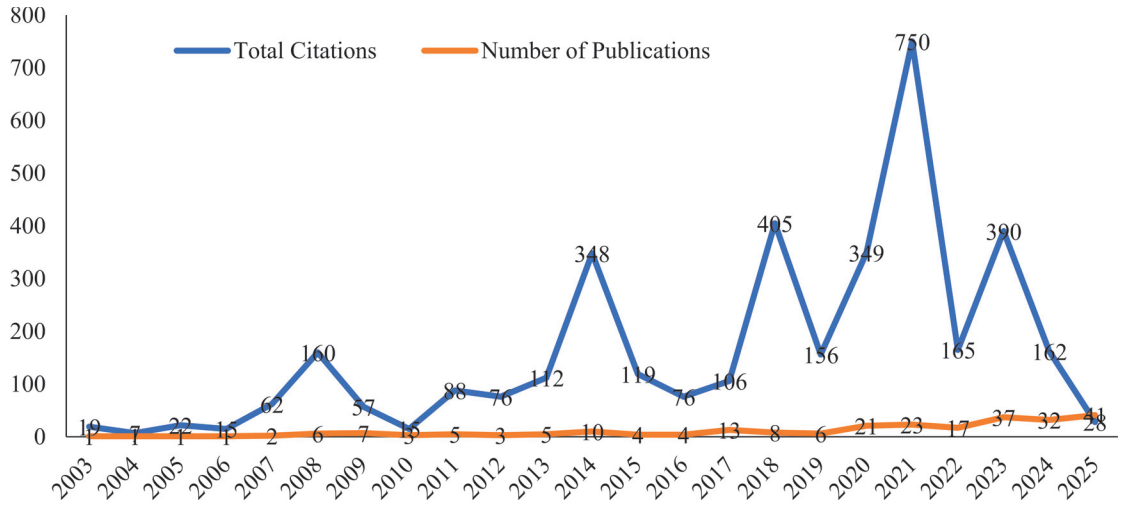

Figure 1. Annual trends in publications and citations in digital platforms for rural knowledge transfer

emerging in recent years, highlighting a growing national interest in digital agricultural advisory systems.

Citation trends revealed early peaks in 2008 (160 citations), 2011 (88 citations), and 2014 (348 citations), followed by substantial increases in 2018 (405 citations) and 2021 (750 citations). The decline in citations during 2023–2025 reflects recency effects rather than reduced research interest. Overall, the results indicate sustained growth in both publication and citation activity globally, alongside an emerging focus in India.

Table 1 presents the most highly cited publications in the field. Zhao et al. (2014) received the highest number of citations (184), followed by Christiaensen et al. (2021) with 155 citations. Other influential contributions included studies by Baceviciute et al. (2021); Demetriadis et al. (2008) and Leszczynski et al. (2017), reflecting the prominence of research on digital learning technologies, multimedia applications, and technology-enabled knowledge dissemination.

Productivity of countries, institutions, and authors

The distribution of research output across countries, institutions, and authors is summarized in Table 2 and 3. At the country level, the United States emerged as the leading contributor with 81 publications and 322 citations, demonstrating both high productivity and scholarly impact. China ranked second with 45 publications and 95 citations, followed by the United Kingdom with 43 publications and 180 citations. Canada contributed 29 publications with 86 citations. Notably, India produced 25 publications with 55 citations, representing approximately 9% of the global research output and highlighting its emerging role in digital platforms for rural knowledge transfer. This indicates a growing research interest in India, but also points to potential for increasing the visibility and impact of Indian studies in the field.

Institutional analysis showed that Wageningen University ranked highest in terms of citation influence, with five publications generating 256 citations. King Khalid University and the International Institute of Tropical Agriculture (IITA) also demonstrated notable scholarly impact despite a smaller number of publications, with citation counts of 177 and 198, respectively. Other institutions, including the University of Zambia and the University of Belgrade, exhibited emerging contributions with fewer

Table 2. Country-Level Productivity

Country	Number of Publications	Number of Citations
USA	81	322
China	45	95
United Kingdom	43	180
Canada	29	86
India	25	55

Table 1. Most cited documents on digital platforms in rural knowledge transfer

Author(s)	Title of the article	Year of publication	Journal	Total citations
Zhao et al. (2014)	Online Transfer Learning	2014	*Artificial Intelligence*	184
Christiaensen et al. (2021)	Viewpoint: The Future of Work in Agri-Food	2021	*Food Policy*	155
Baceviciute et al. (2021)	Remediating Learning from Non-Immersive to Immersive Media: Using EEG to Investigate the Effects of Environmental Embeddedness on Reading in Virtual Reality	2021	*Computers & Education*	123
Demetriadis et al. (2008)	The Effect of Scaffolding Students' Context-Generating Cognitive Activity in Technology-Enhanced Case-Based Learning	2008	*Computers & Education*	110
Leszczynski et al. (2017)	Multimedia and Interactivity in Distance Learning of Resuscitation Guidelines: A Randomised Controlled Trial	2017	*Interactive Learning Environments*	92

Source: Compiled from Scopus database (authors' analysis)

Table 3. Affiliation Productivity

Affiliations	Number of Publications	Number of Citations
Wageningen University	5	256
King Khalid University	4	177
International Institute of Tropical Agriculture (IITA)	3	198
University of Zambia	3	39
University of Belgrade	2	27

publications and citations. Notably, no Indian institutions appeared among the top contributors, indicating an opportunity for Indian research organizations to increase both output and visibility in the area of digital platforms for rural knowledge transfer. This underscores a research gap in India and highlights the potential for strengthening institutional participation and scholarly impact in this domain.

Analysis of authors' contributions revealed that Zhang X, Wang Y, and Chen Y were the most productive, each publishing three articles. These authors are recognized experts in innovation systems and agricultural extension, and their work emphasizes the importance of contextualized approaches to rural knowledge transfer. Leeuwis C and Van Mele P, with two publications each, demonstrated high scholarly impact, receiving 139 and 57 citations, respectively. Notably, no Indian authors appeared among the top contributors, highlighting a research gap and an opportunity for Indian researchers to increase both productivity and influence in the field. This underscores the potential for strengthening India's contribution to global research on digital platforms in rural knowledge transfer.

Table 4. Author productivity

Author	Number of Publications	Number of Citations
Zhang X	3	21
Wang Y	3	12
Chen Y	3	3
Leeuwis C	2	139
Van Mele P	2	57

Thematic structure of research based on keyword co-occurrence analysis

The thematic structure of the literature was examined using keyword co-occurrence analysis, and the resulting clusters are illustrated in Figure 2. The analysis revealed ten distinct thematic clusters representing the major research streams in digital platforms for rural knowledge transfer. Cluster 1 (red) focuses on digital platforms, extension, higher education, information and communication, internet, and social networks, highlighting the role of digital infrastructures in facilitating knowledge dissemination. Cluster 2 (green) emphasizes agricultural extension, digital agriculture, ICT, rural development, and technology adoption, representing the application of digital tools in agricultural and rural contexts. Cluster 3 (blue) links digitalization, sustainability, smallholder farmers, and COVID-19, indicating research attention to technology adoption and resilience in crisis situations.

Education-oriented themes dominate several clusters. Cluster 4 (yellow) centers on e-learning, distance learning, mobile learning, and educational technology, while Cluster 5 (purple) captures online learning, social media, Facebook, and medical education, reflecting platform-specific learning environments, particularly during the COVID-19 pandemic. Cluster 6 (light blue) integrates knowledge management, knowledge sharing, and tacit knowledge, underscoring organizational and cognitive dimensions of knowledge exchange. Cluster 7 (orange) highlights emerging pedagogical approaches through artificial intelligence, blended learning, and digital technologies in education. Cluster 8 (light grey) connects digital literacy, knowledge transfer, and organizational learning, reinforcing capacity-building perspectives. Finally, Clusters 9 (light pink) and 10 (light yellow) represent niche but evolving themes related to lifelong learning, pedagogical issues, and Moodle, respectively.

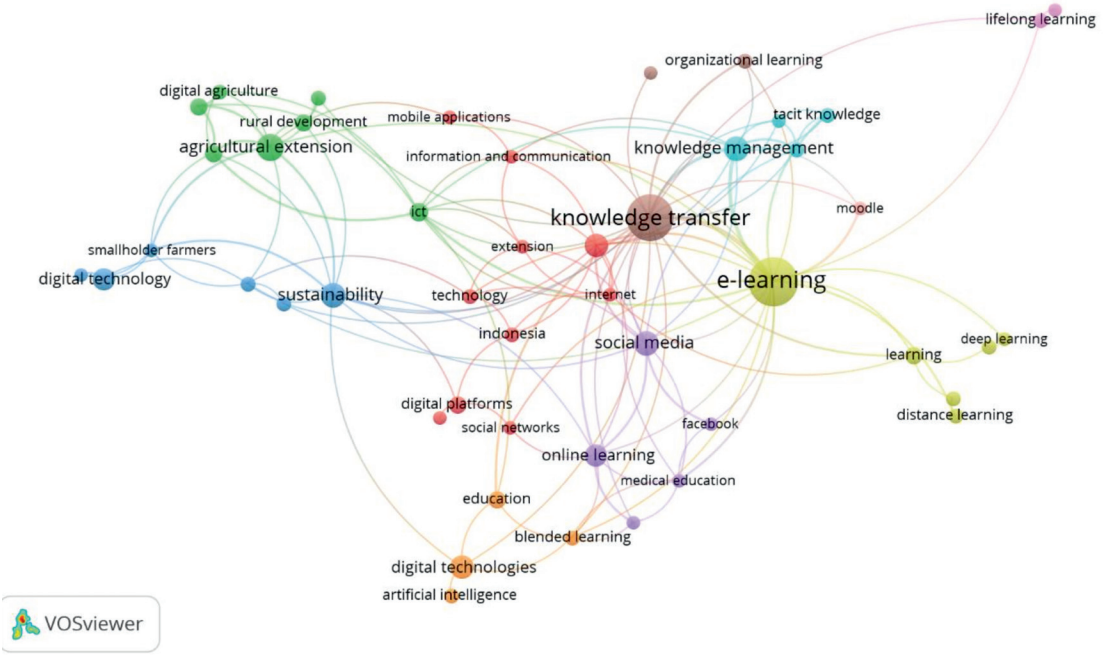

Figure 2. Network visualization of keyword co-occurrence clusters

Keyword density visualization of research themes

The keyword density visualization further reveals the intellectual hotspots of the field. The highest-density areas are centered on "knowledge transfer" and "e-learning," confirming their centrality in the literature. Strong concentrations around knowledge management, social media, online learning, and digital platforms indicate sustained scholarly focus on digital-mediated knowledge dissemination. Moderate-density themes such as agricultural extension, digital agriculture, sustainability, and smallholder farmers highlight applied research in rural and agricultural settings. In contrast, lower-density but emerging themes including artificial intelligence, blended learning, organizational learning, and lifelong learning point to evolving research directions. The density map demonstrates a convergence of education, agriculture, and digital technologies, reinforcing the growing role of digital platforms in rural knowledge transfer.

DISCUSSION

The study demonstrates a clear evolution in global research on digital platforms for rural knowledge transfer, highlighting how technological advancements continue to reshape extension discourse. Research output, which gradually emerged in the early 2000s and accelerated after 2015, reflects the increasing centrality of ICTs in agricultural knowledge systems, driven by the rapid expansion of mobile connectivity, declining data costs, and policy initiatives promoting digital agriculture and e-governance in rural development. These findings are consistent with prior evidence that mobile platforms, web-based systems, and AI tools improve accessibility and timeliness of advisory information for farmers, despite persistent structural challenges such as the digital divide and infrastructure gaps (Priya et al., 2025). The notable increase in publications during and after the COVID-19 pandemic corresponds with global shifts toward remote advisory services and virtual learning, reinforcing the observation that ICT adoption in agriculture accelerates under constrained traditional information channels (Aker, 2011). This surge also indicates the responsiveness of extension research to external disruptions, as conceptual frameworks adapt to new technological and societal conditions.

Differences in country-level contributions further illustrate uneven but widening global engagement with digital extension. While technologically advanced countries such as the United States, the United Kingdom, and China dominate output, growing contributions from Africa and Asia reflect broader recognition of digital platforms' role in strengthening advisory ecosystems. However, effective ICT integration depends not only on technological availability but also on institutional capacity, enabling policies, and user-oriented extension structures responsive to local needs (Khatri et al., 2024; Mukherjee et al., 2025), echoing extension scholarship that emphasizes innovation, localized knowledge, and continuous outreach (Nain, 2015). Authorship patterns further reveal distinctions between consistent publication output and citation influence, highlighting how sustained contributors shape empirical discourse while highly cited authors guide theoretical development, including technology adoption frameworks relevant to digital extension systems (Wang & Dong, 2023).

Thematic analysis of keywords indicates a shift from conventional dissemination models toward interactive, personalized, and data-driven advisory services. Prominent clusters related to digital agriculture, mobile technologies, artificial intelligence, and e-learning demonstrate that ICTs increasingly facilitate two-way communication, improve decision-making, and expand information access in rural contexts (Khwidzhilli et al., 2025; Reed et al., 2020). Knowledge management and organizational learning perspectives further suggest that digital platforms support participatory and networked systems, moving beyond one-way extension delivery toward collaborative learning environments. Nevertheless, persistent challenges such as digital literacy gaps, uneven connectivity, and socio-economic disparities continue to shape differential access and outcomes (Salemink et al., 2017), underscoring the need for context-sensitive digital interventions.

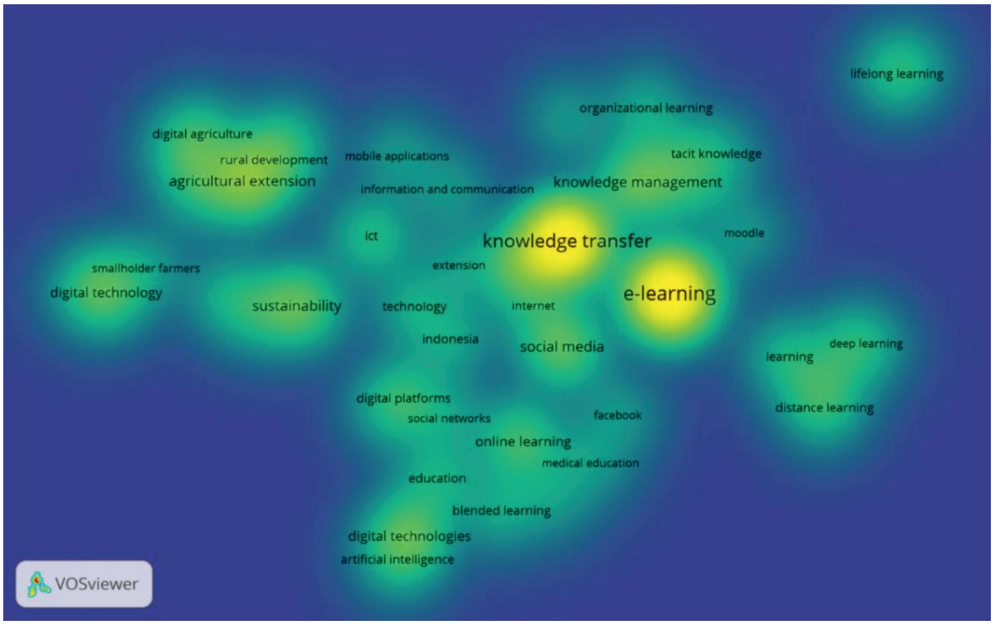

Figure 3. Density visualization of keyword occurrences in digital platforms in rural knowledge transfer (VOSviewer)

The findings suggest that future rural advisory systems will increasingly depend on hybrid knowledge environments that blend traditional extension approaches with digital intelligence. Strengthening digital competencies among extension professionals and farmers, designing locally relevant and user-friendly platforms, and integrating participatory feedback mechanisms are critical to ensuring inclusivity and effectiveness. For countries such as India, aligning digital extension initiatives with grassroots institutions and supportive policy frameworks can enhance scalability and sustainability. By synthesizing thematic evolution and contextual implications, this study provides actionable insights for policymakers, extension agencies, and researchers seeking to build resilient, inclusive, and equitable digital knowledge ecosystems.

CONCLUSION

Research on digital platforms for rural knowledge transfer has expanded substantially over the past two decades, reflecting the growing integration of technology in agricultural extension services. Thematic trends indicate a shift from traditional extension practices to technology-mediated, learner-centred approaches, including digital agriculture, mobile technologies, artificial intelligence, and e-learning systems. Despite these advancements, challenges such as digital literacy gaps, connectivity limitations, and socio-economic disparities continue to influence equitable access and adoption. These findings provide practical guidance for policymakers and extension practitioners to design scalable, hybrid advisory systems that combine conventional methods with innovative digital tools, enhancing knowledge access, community empowerment, and sustainable rural development while ensuring extension services remain inclusive, effective, and responsive to evolving technological and societal needs.

DECLARATIONS

Ethics approval and consent to participate: This study is based entirely on bibliometric analysis using the Scopus database accessed through IMI, Delhi. Publications were selected according to predefined inclusion and exclusion criteria. As no human or animal subjects were involved, formal ethical approval or informed consent was not required.

Conflict of interest: The author confirms that there are no commercial or financial relationships that could be interpreted as a potential conflict of interest.

Author contributions: The author conducted the literature search, analysis, and interpretation, and prepared, revised, and finalized the manuscript.

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