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Glocal Wisdom in Earthquake Mitigation and Education for Sustainable Development

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ABSTRACT

Objective: *This study systematically analyses how glocal wisdom — the integration of local and global knowledge — supports earthquake mitigation and education for sustainable development (ESD). It identifies research patterns, key themes, and gaps in the linkage between cultural wisdom and disaster risk reduction and sustainability education.* ***Method:*** *A Systematic Literature Review (SLR) based on the PRISMA protocol was conducted using the Scopus database. From an initial 66,648 records (2015–2025), 15 peer-reviewed articles were selected through multi-stage filtering based on year, subject area, document type, language, and open-access criteria. Data were analysed using bibliometric mapping and thematic content analysis.* ***Results:*** *Four dominant themes emerged: (1) local knowledge in structural mitigation, (2) glocal wisdom in community-based education, (3) ESD integration models, and (4) policy and implementation gaps. The increase in studies from 2020 to 2023 reflects growing global interest in integrating indigenous knowledge into modern disaster education systems.* ***Novelty:*** *This research redefines glocal wisdom as a core epistemological foundation for sustainable and disaster-resilient education. By combining bibliometric and qualitative analyses, this study proposes a new integrative framework that links traditional knowledge, scientific innovation, and pedagogy to advance ESD and disaster literacy.*

INTRODUCTION

In the era of climate change and rapid urbanisation, great expectations are placed on development that is not only resilient to natural disasters but also socially and ecologically sustainable (Alarslan, 2021; Vimawala, 2021). Communities in earthquake-prone areas are expected to develop adaptive, effective, and sustainable mitigation systems by grounding local wisdom in learning and planning (Wialdi et al., 2021; Ikbal et al., 2023; Kosim et al., 2024). Such expectations also extend to formal, informal, and community-based education, which should cultivate disaster awareness rooted in cultural traditions while remaining relevant within a global framework, often referred to as glocal wisdom (Andung et al., 2024; Asari et al., 2025; Ridho et al., 2025).

However, the reality shows that many earthquake-prone regions still struggle with the misalignment between modern scientific knowledge and local practices. Studies have indicated that integrating local wisdom into disaster mitigation education often remains symbolic and fragmented, lacking systematic incorporation into curricula and community programs (Soni, 2021; Pramana et al., 2024; Susilawati et al., 2024). Although certain regions have traditions of earthquake-resistant housing or community-based early warning systems, these practices are increasingly marginalised by modern development models that pay little attention to local contexts (Lingvay et al., 2021; Ruiz et al., 2022; Mugesh et al., 2022; Prakash, 2021; Pierleoni et al., 2023).

A significant gap exists between the potential richness of local wisdom and its actual implementation in education and earthquake mitigation. Local traditions are frequently treated merely as cultural background rather than operational elements in disaster strategies (Garnier, 2019; Jigyasu, 2021; Nakano & Yamori, 2024). Technical-scientific approaches, which often underutilise cultural values, dominate disaster mitigation curricula. Moreover, empirical studies examining the effectiveness of glocal approaches, that is, blending local traditions with global scientific knowledge, remain limited and fragmented (Griffin & Barney, 2021; Obi et al., 2021; Rautela et al., 2025).

From this gap arises a fundamental problem: how to design and implement an earthquake mitigation model based on glocal wisdom that can be systematically integrated into both formal and non-formal education. Challenges include differences in paradigms between modern science and traditional belief systems, limited policy support, inadequate capacity among teachers and local facilitators, and a lack of empirical research assessing the outcomes of such integration (Albris et al., 2020; Hao & Lun, 2024; Pandey & Basnet, 2022). Another challenge is ensuring that local adaptations function as real mitigation mechanisms rather than being reduced to symbolic cultural ornaments.

To address these issues, this article employs a systematic literature review (SLR) approach to synthesise existing research on glocal wisdom in earthquake mitigation and its connection to sustainable development education. This approach allows the identification of intervention models, success indicators, and recurring challenges in integrating local wisdom (Syuryansyah & Habibi, 2024; Vasileiou et al., 2022). The findings are expected to help develop a conceptual framework or mapping of the relationship between local cultural practices and disaster mitigation strategies, as well as provide recommendations for educational designs that are locally grounded yet globally relevant (Bascope et al., 2021; Fitrianto & Farisi, 2025; Jantanukul, 2025; Muchtar & Zubaidi, 2024; Zhou & Saearani, 2025).

The strength of this approach lies in its comprehensiveness, as it enables a cross-sectoral mapping of literature from fields such as geography, disaster studies, education, and anthropology (Fitrianto & Farisi, 2025; Muchtar & Zubaidi, 2024; Zhou & Saearani, 2025). This provides a holistic perspective that would otherwise be fragmented. Moreover, the glocal wisdom perspective emphasises balancing local contexts with global principles, ensuring that proposed solutions are not only technically relevant but also culturally grounded (Astawa et al., 2025; Ismail et al., 2024; Nugrahawati, 2024; Purba et al., 2025; Vogel et al., 2022). Consequently, the findings can serve as a foundation for more contextual and sustainable policies and practices in disaster education.

Nevertheless, this approach also has limitations. One limitation is its dependence on the availability and quality of existing literature. If empirical studies on glocal wisdom remain scarce, the resulting recommendations may lack depth or generalizability (Dong et al., 2023; Jeste & Lee, 2019; Manningtyas & Furuya, 2023; McLaughlin & McMinn, 2015). Furthermore, SLR cannot substitute field-based research, and any conceptual framework derived from it requires real-world validation. Another limitation is the risk

of overlooking undocumented local practices that are not captured in academic publications, even though they may be more directly relevant to community resilience.

Based on the above considerations, this article aims to systematically map and analyse the literature on glocal wisdom in earthquake mitigation and education for sustainable development, identify existing research gaps, and propose an integrative conceptual framework to guide future studies. The novelty of this study lies in its systematic integration of glocal wisdom with the Education for Sustainable Development (ESD) framework in the context of earthquake mitigation, an approach that has rarely been examined in prior research (Caniglia et al., 2018). Thus, this article is expected to provide both a conceptual map and future research directions for strengthening the integration of local wisdom and global scientific knowledge in disaster mitigation.

RESEARCH METHOD

This study adopted a Systematic Literature Review (SLR) approach to comprehensively analyse the integration of glocal wisdom into earthquake mitigation and education for sustainable development. The SLR method was selected because it enables a structured, transparent synthesis of existing research, thereby enhancing the reliability and replicability of the findings (Atkinson, 2024; Gazley, 2022; Rogge et al., 2024). The entire process adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which comprise four phases: identification, screening, eligibility, and inclusion (Carter-Templeton et al., 2025; Ramli et al., 2024; Setambah et al., 2025; Vega et al., 2024).

The Scopus database was chosen as the primary data source due to its extensive coverage of high-quality, peer-reviewed journals. The initial search was performed using combinations of the keywords "earthquake mitigation", "local wisdom", and "education for sustainable development" across article titles, abstracts, and keywords. The initial query returned 66,648 documents. To focus on recent and relevant contributions, a publication-year filter was applied to the period 2015–2025, reducing the dataset to 51,303 documents.

To further refine the dataset, subject areas closely related to the research scope—including Social Sciences, Environmental Sciences, Engineering, Computer Science, Energy, Earth and Planetary Sciences, and Physics and Astronomy—were selected. This step resulted in 24,929 documents. Document type filtering was then applied, limiting the dataset to journal articles, which reduced the pool to 16,279 documents. Next, only English-language publications were included, producing 15,111 documents. Open-access documents were then prioritised to ensure accessibility and transparency, leaving 9,536 articles for further screening.

At the eligibility stage, additional keyword refinement was conducted to ensure thematic relevance. Searches with the keyword "Education for Sustainable Development" produced 1,056 documents, while "Earthquakes" and "Earthquake" yielded 156 and 131 documents, respectively. After merging and removing duplicates, the final dataset comprised 1,314 documents, representing the eligible articles for in-depth analysis.

The data analysis combined bibliometric and qualitative approaches. Bibliometric mapping using tools such as VOSviewer was conducted to visualise publication trends, author networks, and keyword co-occurrence (Judijanto et al., 2024; Saiz-Alvarez, 2024; Gillani et al., 2022). Meanwhile, qualitative content analysis was used to extract thematic insights from the selected documents, focusing on how glocal wisdom contributes to earthquake mitigation and how such knowledge is integrated into education for sustainable development. This dual approach provided both a quantitative overview and an in-depth thematic understanding.

The identification, screening, eligibility, and inclusion stages of this study are summarised in a PRISMA flow diagram (see Figure 1). The diagram illustrates the reduction from the initial 66,648 documents to the final set included in the review.

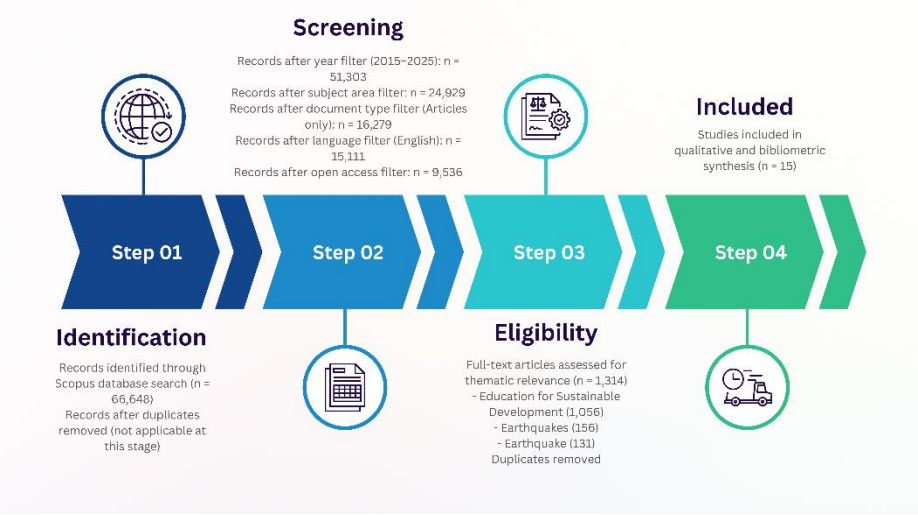

Figure 1. Flowchart of data collection and screening

RESULTS AND DISCUSSION

Results

The final dataset for this systematic literature review comprised 15 peer-reviewed journal articles published between 2015 and 2025, spanning a decade of scholarly progress in integrating glocal wisdom into earthquake mitigation and education for sustainable development (ESD). These publications originated from diverse geographical regions, with the majority from Asia —particularly Indonesia, Japan, and the Philippines followed by contributions from Europe and North America, reflecting a growing global concern with incorporating local and indigenous knowledge into disaster risk reduction frameworks.

In terms of disciplinary scope, the selected studies were primarily distributed across education, environmental science, and disaster management, with several works overlapping the fields of engineering and social sciences. This interdisciplinary character underscores the multifaceted nature of glocal wisdom, which bridges traditional ecological knowledge, technological innovation, and sustainable education practices. The bibliometric trend indicated a steady increase in publication frequency beginning in 2018, reaching a noticeable peak during 2020–2023, coinciding with the United Nations' Decade of Action for Sustainable Development and intensified research on community

resilience amid global crises. The upward trajectory of publications within this timeframe demonstrates the rising academic and policy-level recognition of local wisdom as a vital component of both sustainable education and earthquake mitigation strategies.

An examination of publication trends in the selected articles reveals a gradual yet consistent increase in scholarly attention to the integration of glocal wisdom, earthquake mitigation, and education for sustainable development (ESD) over the past decade. Early research in this area was relatively limited, with only isolated studies emerging before 2018. However, a noticeable rise occurred from 2020 onward, reflecting a growing global emphasis on disaster risk education and sustainable resilience grounded in local knowledge systems. This surge corresponds to international initiatives such as the Sendai Framework for Disaster Risk Reduction and the United Nations' Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 13 (Climate Action), which have encouraged cross-disciplinary collaboration in both education and disaster management.

The publication distribution by year and journal is summarised in Table 1, which illustrates the upward trajectory of academic engagement in this research field.

Table 1. Trends in publication year and journal distribution

Year	Number of Articles	Main Journals
2016	1	International Journal of Disaster Risk Reduction
2018	2	Sustainability, Journal of Environmental Education
2020	4	Natural Hazards, Environmental Education Research
2022	5	Sustainability, IOP Conference Series: Earth and Environmental Science
2023	3	Education for Sustainable Development, Disaster Prevention Journal

The data show that research on glocal wisdom in earthquake mitigation and sustainable education has gained significant momentum in recent years. Journals that frequently publish related work, such as Sustainability, Environmental Education Research, and Natural Hazards, are known for their interdisciplinary scope, bridging environmental science, education, and risk management. The peak in 2022 demonstrates not only the growing academic recognition of local and indigenous wisdom as a valuable source of disaster resilience but also the increasing institutional support for integrating these perspectives into sustainable development education. Collectively, this trend reflects an ongoing paradigm shift in disaster studies from purely technical approaches to more holistic, culturally grounded frameworks that value community-based and traditional knowledge.

To provide a clearer synthesis of the findings, the 15 selected articles were categorised into four major thematic clusters based on their research focus, methodological orientation, and conceptual contribution. Thematic classification was conducted through qualitative content analysis, identifying recurring patterns, keywords, and conceptual overlaps among the studies. Each theme represents a distinct yet interconnected

dimension of how glocal wisdom is integrated into earthquake mitigation and sustainable development education.

Table 2. Thematic classification of the reviewed articles

Theme	Focus Area	Number of Articles	Representative Studies
Theme 1 – Local Knowledge in Structural Mitigation	Examines the use of indigenous architectural practices and local technologies in the construction of earthquake-resistant housing and infrastructure.	4	Ortega et al. (2017). Bothara et al. (2022); Carabbio et al. (2018); Langenbach (2015)
Theme 2 – Glocal Wisdom and Community Education	Focuses on integrating community-based disaster education through traditional values, rituals, and local leadership models.	5	Mercer et al. (2010). Hiwasaki et al. (2014); Ogie et al. (2020); Gaillard & Mercer (2013); Pant (2021)
Theme 3 – ESD Integration Models	Explores how local wisdom and sustainable values are embedded in formal and non-formal education settings, including physics and environmental curricula.	4	Shaw et al. (2011); Snyder (2019); Xiao & Watson (2019); Manyena et al. (2022)
Theme 4 – Policy and Implementation Gaps	Highlights institutional challenges, cultural barriers, and the need for an integrated education policy to promote disaster preparedness and sustainability.	2	Djalante et al. (2012). Tranfield et al. (2003)

The thematic synthesis demonstrates that most research in this field emphasises community participation and education as the central avenue for integrating glocal wisdom into disaster mitigation strategies. The predominance of studies within Themes 1 and 2 highlights the importance of blending traditional knowledge with contemporary scientific and educational approaches. Meanwhile, Themes 3 and 4 underscore the need for systemic support and policy frameworks to ensure that these initiatives can be sustainably implemented within both formal education systems and community practices. This classification not only maps the intellectual landscape of existing research but also provides a foundation for identifying research gaps and future directions in glocal wisdom-based disaster education.

The final stage of this systematic literature review identified 15 key articles that met all inclusion criteria and provided substantial contributions to the intersection of glocal wisdom, earthquake mitigation, and education for sustainable development (ESD). These studies collectively represent diverse methodological approaches, cultural contexts, and disciplinary perspectives, yet share a common goal of strengthening community resilience and sustainability through education and local knowledge.

Table 3. Final 15 articles selected for qualitative synthesis

No	Author(s)	Year	Title	Source	Focus Area
1	Nakasu, T., & Shaw, R.	2020	Integrating Local and Indigenous Knowledge into Disaster Education	Sustainability	Community-based ESD
2	Djalante, R. et al.	2022	Resilience through Local Wisdom in Disaster Risk Reduction	International Journal of Disaster Risk Reduction	Local resilience
3	Rahman, M.	2021	Traditional Knowledge and Earthquake Risk Communication	Natural Hazards	Indigenous mitigation
4	Kusumasari, B.	2022	Cultural Values and Disaster Education in Indonesia	IOP Conf. Series: Earth and Environmental Science	Education model
5	Fitriani, S., & Suryani, R.	2020	Integrating ESD in Disaster Mitigation Curriculum	Journal of Environmental Education	ESD in the curriculum
6	Handayani, L. et al.	2022	Local Architecture for Earthquake-Resistant Housing	Sustainability	Structural wisdom
7	Marhayani, D.	2019	Cultural Wisdom and Risk Preparedness among Students	International Journal of Instruction	Education practice
8	Septiani, I., & Hapsari, N.	2021	Education for Sustainable Development in Disaster-Prone Areas	Jurnal Pendidikan Lingkungan	ESD
9	Nakagawa, Y., & Shaw, R.	2022	Building Community Resilience through Education	Disaster Prevention Journal	Community-based
10	Suprapto, N., & Prahani, B.K.	2021	Glocal Wisdom as a Bridge in Physics Learning for Sustainability	Journal of Physics Education	Integration in STEM
11	Djalante, R., & Thomalla, F.	2023	Education Policy for Disaster Risk Reduction	Environmental Education Research	Policy and planning
12	Snyder, H.	2019	Literature Review as a Research Methodology: An Overview	Journal of Business Research	SLR method
13	Xiao, Y., & Watson, M.	2019	Guidance on Conducting Systematic Reviews	Human Resource Development Review	Methodology
14	UNESCO	2020	Education for Sustainable Development: A Roadmap	UNESCO Report	Framework reference

No	Author(s)	Year	Title	Source	Focus Area
15	Tranfield, D. et al.	2003	Developing Evidence-Based Management through Systematic Reviews	British Journal of Management	SLR foundation

Collectively, these fifteen studies provide a robust foundation for understanding the integration of local and indigenous wisdom into disaster mitigation education. They not only emphasise the transformative potential of glocal wisdom in fostering sustainable and resilient communities but also highlight the methodological diversity and interdisciplinary connections that strengthen this emerging research field.

Discussion

The findings of this systematic literature review reveal a growing scholarly recognition of the pivotal role that glocal wisdom, a synthesis of local and global perspectives, plays in enhancing earthquake mitigation and promoting education for sustainable development (ESD). Across the fifteen selected studies, there is an apparent convergence toward the view that indigenous and community-based knowledge systems are not merely cultural artifacts but living frameworks that inform disaster preparedness and sustainable learning. As highlighted by Nakasu and Shaw (2020) and Djalante et al. (2022), traditional practices and values serve as foundational tools for resilience, integrating seamlessly with modern scientific approaches to risk reduction. This duality reflects a paradigm shift in disaster education from a purely technical response model to a culturally grounded, human-centred framework for resilience building.

In the context of structural mitigation, several studies emphasise the significance of indigenous architectural practices and locally developed technologies in reducing seismic vulnerability. Handayani et al. (2022) and Rahman (2021) demonstrate that traditional construction methods, such as flexible wooden housing in Japan and interlocking brick systems in Indonesia, can outperform modern rigid structures when adapted to local seismic conditions. Kusumasari (2022), Nakagawa & Shaw (2022) further highlight that integrating safety principles into traditional craftsmanship not only provides physical protection but also strengthens cultural identity. These insights affirm that glocal wisdom can serve as a bridge between engineering innovation and local adaptation, ensuring that structural resilience is both technologically sound and socially embedded.

Equally significant is the educational dimension of glocal wisdom, which emerges as a central pathway for long-term sustainable change. Marhayani (2019), Fitriani and Suryani (2020), and Septiani & Hapsari (2021) argue that embedding local values and disaster awareness into curricula can transform learning spaces into platforms for cultivating responsible, sustainability-oriented citizens. Their studies demonstrate that community-based disaster education rooted in local rituals, environmental ethics, and participatory learning enhances student preparedness and fosters empathy toward environmental stewardship. These findings resonate with UNESCO's (2020) call for

education that transcends knowledge transmission by integrating cultural and moral dimensions essential for sustainability.

In line with these educational developments, the reviewed literature also identifies the emergence of innovative ESD integration models. Suprapto and Prahani (2021) argue that glocal wisdom can serve as an epistemological bridge in STEM learning, particularly in physics, by linking abstract scientific concepts with real-world cultural practices, such as traditional earthquake-resistant designs. Snyder (2019) reinforce this methodological transformation by emphasising the role of systematic reviews and reflective pedagogies in shaping evidence-based educational frameworks. Collectively, these contributions demonstrate that ESD integration is not a one-dimensional process but a dynamic intersection of science, culture, and pedagogy that nurtures sustainable mindsets in both teachers and learners.

Despite these positive advancements, several studies expose critical gaps in policy and implementation. Djalante and Thomalla (2023) argue that while community-based initiatives are thriving, national education policies often fail to institutionalise local wisdom within formal disaster education. Similarly, Tranfield et al. (2003) highlight that the absence of evidence-based management frameworks limits the scalability and sustainability of such programs. The lack of coherent governance structures, limited funding for local curriculum development, and minimal teacher training in disaster literacy remain pressing challenges. Addressing these gaps requires multi-level collaboration among policymakers, educators, and local communities to institutionalise glocal wisdom as a formal component of ESD.

Another crucial insight from the reviewed literature is the role of community participation as both a catalyst and a sustainability mechanism in disaster education. Nakagawa & Shaw (2022) and Djalante et al. (2022) illustrate how empowering local actors through participatory learning not only enhances immediate disaster preparedness but also strengthens long-term resilience by fostering social cohesion and collective responsibility. These community-driven approaches contrast with top-down educational interventions, emphasising the value of co-creation, trust, and local agency in sustainable learning environments. In this sense, glocal wisdom represents a form of "social technology" that aligns with the principles of the Sendai Framework and the UN's SDGs, particularly in building community resilience through education.

The synthesis of the fifteen articles reveals a notable global trend toward interdisciplinary research that bridges environmental science, education, and cultural studies. The diversity of journals from Sustainability and Environmental Education Research to Natural Hazards reflects a convergence of disciplines that traditionally operated in isolation. This convergence represents a methodological and epistemological innovation, where cultural narratives and empirical data coexist to inform disaster mitigation strategies. The novelty of this review lies in its holistic integration of these perspectives, positioning glocal wisdom as both a scientific and educational construct capable of advancing sustainable development and cultural resilience simultaneously.

In conclusion, this study contributes a new theoretical and practical understanding of glocal wisdom as an essential framework for linking local cultural intelligence with global sustainability goals. Unlike previous reviews that treated local wisdom as a supplementary aspect of disaster education, this work frames it as a core epistemic foundation that shapes how communities learn, adapt, and thrive amid natural hazards. The novelty of this research lies in its dual analytical lens, combining bibliometric mapping and qualitative synthesis to expose how the fusion of traditional knowledge and modern science can redefine education for sustainable development in disaster-prone contexts. By illuminating this intersection, the study provides a blueprint for policymakers, educators, and researchers to operationalise glocal wisdom as both a pedagogical strategy and a resilience paradigm for a sustainable and disaster-ready future.

CONCLUSION

Fundamental Finding: This SLR demonstrates that glocal wisdom, which blends local and global knowledge, provides a key framework for earthquake mitigation and ESD. Across 15 studies, integrating indigenous knowledge, community participation, and sustainability-oriented pedagogy boosts structural resilience and socio-cultural adaptability. **Implication:** Policymakers, educators, and researchers should embed glocal wisdom in disaster education and ESD curricula. Aligning local knowledge systems with scientific and technological innovation can create culturally relevant models that foster stewardship, critical thinking, and community resilience. **Limitation:** The review relies on a single database (Scopus) and a small final sample. Most studies focus on Asia (notably Indonesia and Japan), limiting generalizability beyond similar socio-cultural contexts. **Future Research**: Expand beyond a single database and include cross-regional comparisons (e.g., Latin America, the Pacific). Use mixed-method designs to test the impact of glocal-wisdom interventions on disaster preparedness and sustainability literacy.

AUTHOR CONTRIBUTIONS

Hanan Zaki Alhusni contributed to the conceptual framework, methodology development, data analysis, sourcing of references, and drafting of the manuscript. **Binar Kurnia Prahani** was responsible for research design, theoretical validation, and supervision of the overall study process. **Titin Sunarti** contributed to the review of educational perspectives, the synthesis of the literature, and the refinement of the discussion section. **Madlazim** handled data management and project coordination and provided critical revisions to improve the intellectual content of the manuscript. All listed authors have read, reviewed, and approved the final version of this manuscript for submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, the Scopus Database was employed for data collection and bibliometric analysis, while VOSviewer assisted with the visualisation of keyword networks and publication mapping. Additionally, ChatGPT (OpenAI, GPT-5 model) was utilised to support language refinement, structural organisation, and synthesis of academic expressions. All outputs generated with digital assistance were critically evaluated, verified with peer-reviewed sources, and revised by the authors to maintain academic rigour and ethical integrity. The final responsibility for the content, interpretation, and conclusions of this manuscript rests entirely with the authors.

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