A Bibliometric and Thematic Network Analysis of Faculty–Student Mentoring in Undergraduate Medical Education

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Abstract: This bibliometric analysis maps the global research landscape of faculty-student mentorship in undergraduate medical education from 2000 to 2024. Analysing 167 publications from the Scopus database, the study identifies key international trends and thematic network patterns, including professional development, career guidance, and mentor-mentee dynamics across diverse educational contexts. The findings show that scholarly discourse frequently addresses mentorship in relation to educational equity, access, and institutional development within medical training systems. The study highlights growing attention to mentoring in relation to professional development, career progression, diversity, and educational development. It underscores the need for further research to inform context-specific strategies that address equity challenges and formalise mentorship programmes, offering significant relevance for scholars, practitioners, and policy-makers in international medical education.

Keywords*:* mentors, curriculum, physician's role, program development, interprofessional relations

Introduction

Mentorship is widely recognised as an important component of medical education, particularly in the context of increasing complexity in healthcare systems and training environments (Teo et al., 2024). The literature frequently associates mentorship with areas such as academic development, professional identity formation, career planning, and psychosocial support (Frei et al., 2010; Preovolos et al., 2024; Sambunjak et al., 2006, 2010). Mentoring relationships are also commonly discussed in relation to supporting students through key transitions, including entry into medical school and progression into clinical training (Preovolos et al., 2024). In response, many institutions have introduced structured faculty–student mentorship programmes within undergraduate medical education (Mubuuke et al., 2020).

The concept of faculty–student mentoring has evolved from informal relationships to more structured, institutionalised programmes, reflecting broader shifts in educational priorities and an increasing emphasis on holistic development (Akinla et al., 2018; Fornari et al., 2014; Frei et al., 2010). In medical education, mentoring is characterised by a dual focus on professional formation and psychosocial support within complex, high-stakes learning environments (Sambunjak et al., 2010; Skjevik et al., 2024). Prior scholarship highlights the adaptive, context-dependent nature of mentoring systems, shaped by interpersonal, institutional, and cultural factors (Kalén et al., 2010;

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Sambunjak et al., 2010). Ongoing discussions also address variations in mentoring models, including formal, informal, peer, and virtual approaches, particularly following shifts during the COVID-19 pandemic (Bishop et al., 2023; Farrukh & Hoor, 2022).

Literature Review

Studies on Mentoring in Medical Education

Despite increasing scholarly attention, research on mentorship in undergraduate medical education remains fragmented. Existing studies have examined diverse aspects such as research engagement, equity, and well-being, but findings are dispersed across methodological approaches. Most prior reviews have been systematic, narrative, or scoping in nature, with limited application of bibliometric techniques (Appendix A). Previous work has documented four main thematic areas. First, studies examining programme models, e.g. group-based mentoring, and their outcomes (Fornari et al., 2014; Frei et al., 2010; Skjevik et al., 2020). These reviews collectively indicate that while mentoring is widely endorsed, evidence-based effectiveness remains limited by heterogeneity in programme design and outcome measurement. Second, peer and near-peer mentoring as an alternative or complement to faculty mentoring, which may support transition and academic adjustment (Fornari et al., 2014; Frei et al., 2010; Akinla et al., 2018; Preovolos et al., 2024). Third, the growing literature examining equity in mentoring, especially for underrepresented groups (Farkas, Allenbaugh, et al., 2019; Farkas, Bonifacino, et al., 2019; Feeley et al., 2024; Shen et al., 2022). Fourth, mentor training and preparation, identifying approaches, providing practical guidance, and aligning mentor-mentee expectations (Hee et al., 2020; Ramani et al., 2006; Sheri et al., 2019).

However, bibliometric analyses in this area remain scarce, particularly those focusing on faculty–student mentoring in medical schools, as shown in Appendix B. This gap limits a comprehensive understanding of research trends, influential contributors, and thematic developments within the field. Mentorship research also intersects with broader discussions on educational equity, workforce development, and academic socialisation (Chua et al., 2020), including efforts to address disparities in access to professional opportunities (Feeley et al., 2024).

Knowledge Production and Transferability in International and Comparative Education

Bibliometric findings raise comparative questions about whose knowledge is most visible, how mentoring models transfer across contexts, and what conditions shape adaptation. Comparative education offers conceptual resources for interpreting these patterns, particularly because educational policies and practices do not simply transfer across national boundaries but undergo translation, adaptation, and legitimisation, emphasising selective borrowing (Phillips & Ochs, 2004; Steiner-Khamsi, 2016). Hence, models developed in well-resourced settings often assume protected faculty time, formal coordination, manageable student groups, and established networks. Where these conditions do not hold, transfer requires careful attention to local institutional, cultural, and professional contexts.

A second comparative concern is the geopolitics of knowledge production, in which Global North institutions and English-language publications dominate international databases (Demeter & Goyanes, 2021). Consequently, bibliometric analyses in mentoring research may overrepresent research from well-resourced settings and under-represent scholarship from low- and middle-income countries, offering limited insight into contexts with different institutional capacity, faculty availability, and educational resources. This may reinforce knowledge hierarchies when partners from underrepresented settings are treated as sites for implementation rather than as sources of knowledge (Shiyama et al., 2026).

The Present Study

There are three key gaps to address. First, research on mentoring programme design, outcomes, and challenges remains fragmented across systematic, scoping, and thematic reviews, with different focuses and methodological approaches. Second, existing bibliometric analyses have not focused specifically on faculty–student mentoring in undergraduate medical education, leaving unanswered questions about publication trends, influential contributors, and thematic patterns in this field. Third, to our knowledge, the international distribution of mentoring research and its implications for transferability and contextual adaptation have not been systematically examined from a comparative education perspective.

Therefore, there is a need to systematically map the structure and evolution of research on faculty–student mentoring in undergraduate medical education. This study employs a bibliometric approach to analyse publication trends, key contributors, and thematic patterns in the literature. The research addresses the following questions: (1) What are the publication trends in this field over time? (2) Which institutions and countries are most active, and how do these patterns vary? (3) Which keywords and themes are most frequently used, and how have they evolved? (4) What thematic structures emerge from co-occurrence analyses of terms?

Bibliometric analysis offers a systematic approach to mapping research trends and identifying knowledge gaps by examining publication patterns, citation networks, and keyword relationships (Maggio et al., 2021). This method enables the visualisation of a field's intellectual structure, clarifying how faculty–student mentorship is represented in medical education research and highlighting areas for future investigation.

Methods

Data Search

This bibliometric analysis investigated trends in research on faculty-student mentorship in undergraduate medical education. We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) reporting guidelines, adapted for bibliometric analysis to ensure transparent identification and screening of records (Page et al., 2021). We collected data from the Scopus database, a well-regarded source of peer-reviewed publications, on 26th November 2024. Scopus was selected for its broad coverage of peer-reviewed scientific content, including a substantial medical education literature (Baas et al., 2020). The keyword search strings used were as follows: (mentor* PRE/3 medical AND students) OR (mentor* PRE/3 undergraduate AND medical AND education) OR (mentor* PRE/3 medical AND school*) OR (mentor* PRE/3 medical AND training) OR (mentor* PRE/3 medical AND curriculum) OR (mentor* PRE/3 mbbs) OR (mentor* PRE/3 md) OR (mentor?mentee* PRE/3 medical AND students) OR (mentor?mentee PRE/3 undergraduate AND medical AND education) OR (mentor?mentee PRE/3 medical AND school) OR (mentor?mentee PRE/3 medical AND training) OR (mentor?mentee PRE/3 medical AND curriculum) OR (mentor?mentee PRE/3 mbbs) OR (mentor?mentee PRE/3 md) in TITLE-ABS-KEY. In total, we identified 567 documents from the Scopus database for our initial dataset.

Data Screening

Two co-authors independently screened the dataset to ensure relevance and accuracy, as shown in Figure 1.

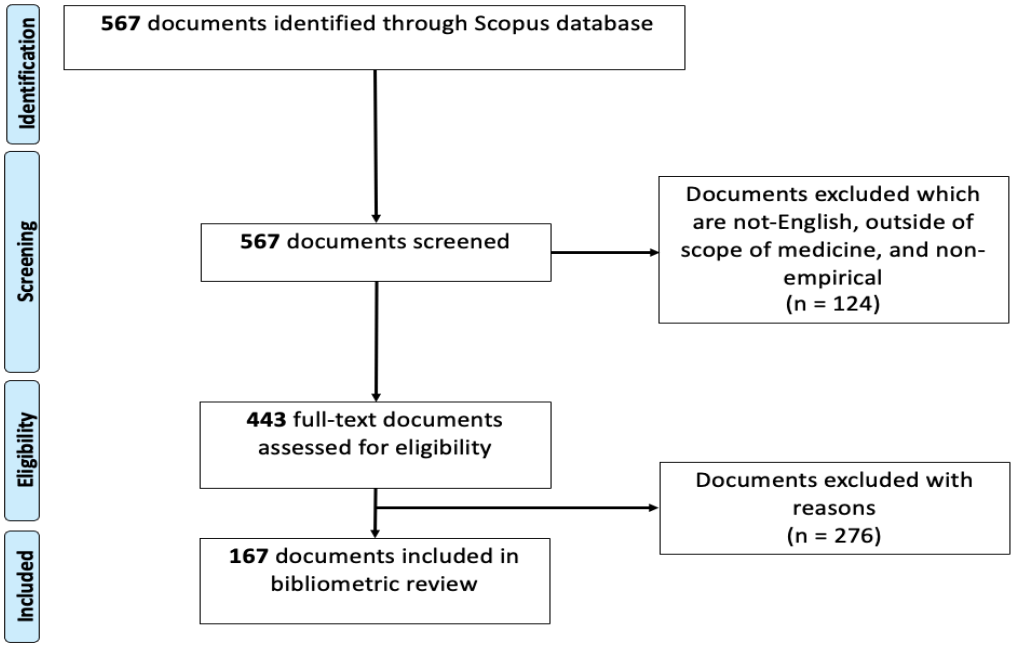


Figure 1. PRISMA Flow Chart for Bibliometric Analysis of Faculty-Student Mentoring in Undergraduate Medical Education

Discrepancies were resolved through negotiation. Duplicates and publications outside the scope of medicine, e.g. nursing, business, and engineering, were excluded, reducing the number to 499. We also excluded non-empirical materials such as technical reports, letters, and editorials, leaving 460 publications. We then restricted the dataset to English-language publications, further narrowing it to 443. The inclusion and exclusion criteria are listed in Table 1 below. The remaining 443 records were screened against the predefined population, educational level, mentoring relationship, publication period, and document eligibility criteria, resulting in 167 documents for the final analysis. We included articles from 2000 onwards, a period during which structured, formalised mentorship programmes began gaining global traction in medical education, as reflected in the growing literature from this period (Farahani et al., 2021; Rambaree, 2018). The dataset was exported from the Scopus database in comma-separated values (.csv) format for further analyses.

Table 1. Inclusion and Exclusion Criteria for Bibliometric Analysis of Faculty-Student Mentoring in Undergraduate Medical Education

Inclusion criteria	Exclusion criteria
Original articles, reviews, conference proceedings, books.	Non-empirical materials such as technical reports, letters and editorials, abstract only with no full article available
English articles	Non-english documents without english translation
Investigate undergraduate medical students	Non-medical population
Documents published between 2000 to 2024	Before 2000 or after 2024
Documents focusing on faculty-undergraduate student mentoring in medical school including one-to-one/didactic, group, informal, formal or structured mentoring	Documents focusing on post-graduate mentoring, or peer/near-peer mentoring only

Data Analyses

Data analyses and visualisation of the dataset were conducted using several bibliometric tools, including Scopus analyser, VOSviewer version 1.6.20 (http://www.vosviewer.com), Bibliometrix (http://www.bibliometrix.org), an R-based package for quantitative bibliometric analysis, and the web interface Biblioshiny (Aria & Cuccurullo, 2017; van Eck & Waltman, 2010). The .csv file was imported into VOSviewer and Bibliometrix. These tools supported the identification of keyword patterns, keyword co-occurrence, citation trends, and thematic network analysis and visualisation to explore research connections and patterns.

Keyword co-occurrence analysis was conducted using VOSviewer to identify major conceptual groupings and thematic structures within the literature, combining quantitative keyword co-occurrence analysis with interpretive examination of the resulting clusters (Farahani et al., 2021; Rambaree, 2018). Synonyms and singular/plural forms were harmonised to standardised keywords. This visualised structure illustrates how themes such as professional development, diversity, and academic performance are interlinked within the literature. The resulting dataset provided a clear basis for understanding relationships and thematic network areas within the literature, offering insight into how mentorship is represented in medical education research. The minimum number of keyword co-occurrences was set at 5 at full counting. The threshold was selected to retain recurring terms while limiting very low-frequency associations; alternative thresholds may yield somewhat different cluster structures. The selected keywords were verified to preserve only relevant terms. Generic terms (e.g. humans), situational terms (e.g. COVID-19), overly specialty-specific terms (e.g. orthopaedics), regional terms (e.g. United States (US)), indexing-related terms (e.g. Medline), and technical terms (e.g. organisation) were excluded from final analyses. To ensure the trustworthiness of the results generated by VOSviewer, the co-authors cross-examined the thematic network clusters. Discrepancies were resolved through discussion.

Results

Publication Trends and Citation Profiles

We retrieved a total of 145 articles (86.8%), 19 review papers (11.4%), one book chapter (0.6%) and one conference proceeding (0.6%) from 94 sources (journals and books). The average age of the documents is 6.62 years. The documents were written by 810 authors, with an average of 5.06 co-authors per document. Of these, ten authors single-authored some documents. Multi-national co-authorship, defined as a publication containing author affiliations from two or more countries, accounts for 9.1% of the documents.

By subject area, the majority of publications on faculty-student mentorship in medical schools were in Medicine (77.0%) and Social Sciences (52.0%). Other subject areas included Health Professions, Psychology, multidisciplinary, and others. In general, the number of publications has steadily increased since 2000, as shown in Figure 2. Between 2000 and 2010, the number of publications fluctuated between 0 and 5 per year. From 2010 to 2019, the number increased to a range of 6-10, with a decline in 2014 (n=3). Since 2020, the number has risen steadily to more than ten per year, with a peak of 21 publications in 2023.

As of the time of analysis, these documents had been cited 38,384 times in total. The most-cited document was a systematic review of types, objectives, and effects of mentoring programmes for medical students, with 313 citations (Frei et al., 2010). This was followed by a review of the types, goals, effectiveness, and efficiency of structured mentoring programmes among medical students and doctors, with 170 citations (Buddeberg-Fischer & Herta, 2006). The third most-cited publication offered tips for developing effective mentors, with 145 citations (Ramani et al., 2006).

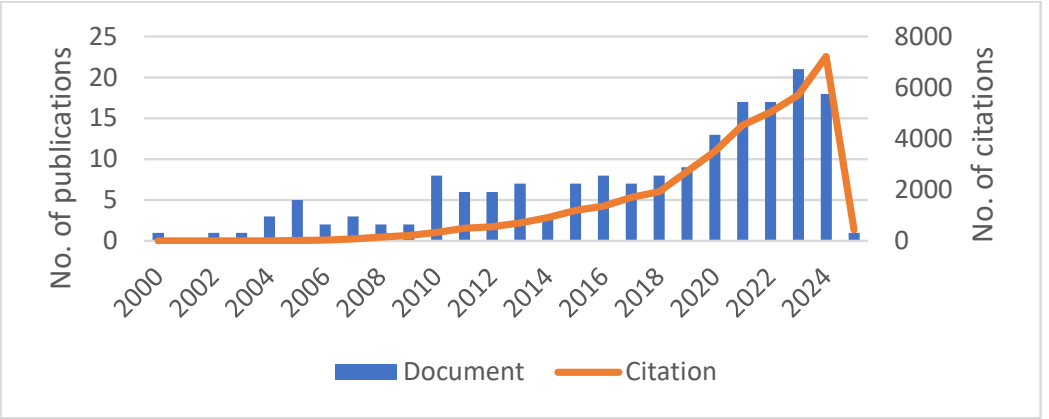


Figure 2. Number of Publications and Citations per Year from 2000 to 2024

Source: Authors

Countries and Institutional Contributions

In total, authors from 25 countries published on this topic. The country with the highest number of publications was the US (97), followed by the United Kingdom, Germany, Sweden and Canada (Appendix C). In parallel, the US also dominated citation impact, with 85 cited publications and a total of 2359 citations. Sweden recorded the highest citation-per-publication ratio (28.5) among the countries represented in the dataset, although this estimate should be interpreted cautiously given its smaller publication volume (n=8). Notably, all publications from Sweden were affiliated with Karolinska Institutet, which was also the institution with the highest affiliation in this field.

As illustrated by the collaboration map (Appendix D), where blue shades denote national publication volume and brown line thickness represents cross-country co-authorship, very few inter-country collaborations were recorded. The highest level of collaboration was between Singapore and the United Kingdom, with five publications, followed by Canada-Norway and Sweden-Norway, each with two publications. Meanwhile, other countries, such as the United Kingdom, Germany, and Australia, recorded one international collaboration each.

Keyword Analysis

A total of 856 keywords were used by authors across these publications. The frequency of authors' keywords is shown in Appendix E. In line with our search terms used to identify the documents, the top keywords revolve around "mentoring", "mentorship", "medical student", "medical students", and "mentor". However, several emerging keywords are specialty-based, such as "surgical education", "surgery", and "neurosurgery"; role of mentoring, e.g. "career choice", "professional development", and "diversity"; and further training, such as "residents" and "residency". Although less frequent, these emerging keywords indicate that the topic extends into specialty training, career development, and diversity-related discussions.

Thematic Co-occurrence Analysis

Of the 856 keywords identified, 123 met the inclusion threshold. In the network visualisation (Figure 3), node size represents frequency, link strength indicates co-occurrence, and colours denote clusters of related terms. Three central, frequently co-occurring terms were "mentorship," "mentoring," and "medical students," forming the core of the network. Although closely related, "mentorship"

and "mentoring" appear in distinct clusters, suggesting variation in their use within the literature. Because the analysis is based on author-supplied keywords, the resulting clusters reflect patterns of terminology and conceptual associations in the indexed literature rather than definitive boundaries between mentoring practices.

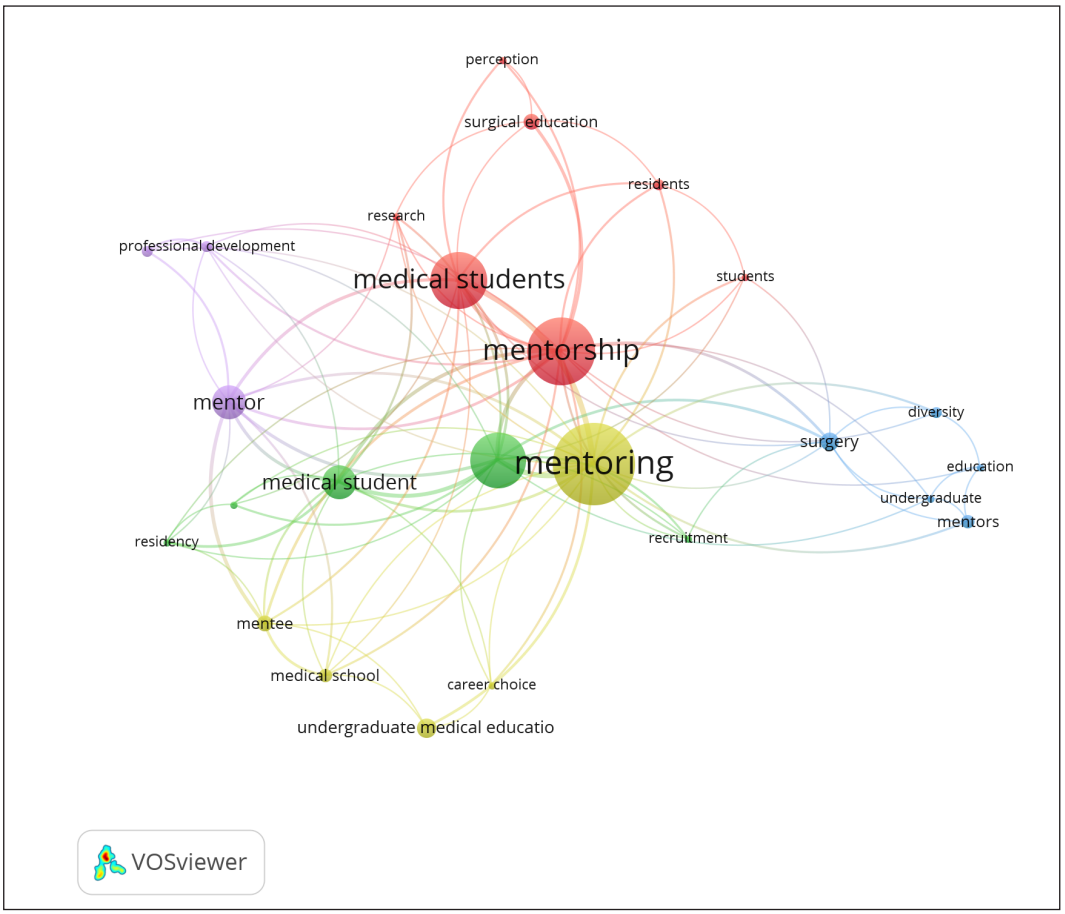


Figure 3. Co-occurrence Analysis of Author Keywords

Source: Image generated using VOSviewer software

Five clusters were identified. The first cluster (red) groups terms related to mentorship, medical students, research, and residency, reflecting associations with academic and specialty-related contexts. The second cluster (green) includes mentoring, recruitment, and residency, reflecting associations with career pathways. The third cluster (purple) centres on mentorship and professional development, highlighting the mentor–mentee relationship. The fourth cluster (blue) includes education, diversity, and surgical fields, indicating links between mentoring and educational contexts. The fifth cluster (yellow) focuses on mentees, career choice, and undergraduate medical education, reflecting transitions into residency. Overall, the clusters demonstrate interconnected themes across mentoring, career development, education, and diversity within medical education research.

Co-occurrence Terms

The co-occurrence term network (Figure 4) illustrates relationships between key terms across the dataset, with node size indicating frequency and links indicating co-occurrence strength. Three major

clusters were identified. The red cluster comprises terms related to medical education processes and training frameworks. The green cluster reflects career-related themes, including speciality and survey-based research. The blue cluster captures perceptual and response-based terms, indicating a focus on feedback and evaluative approaches. These clusters broadly represent methodological, career-oriented, and perception-based dimensions within the literature.

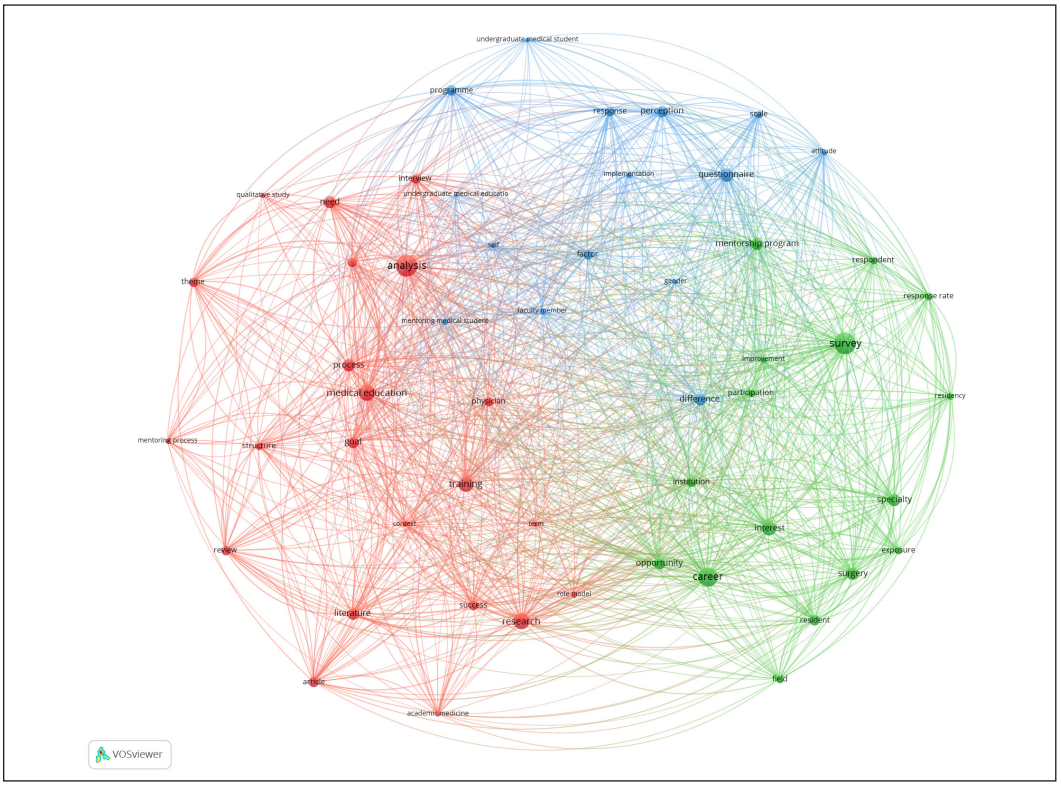


Figure 4. Analyses of Co-occurrence Terms

Source: Image generated using VOSviewer software

Discussion

Global growth and uneven knowledge base on faculty–student mentoring

The growth of scholarship on faculty–student mentoring suggests that mentoring has become an increasingly visible area of medical education research. More importantly, the thematic breadth of the literature indicates that mentoring is increasingly linked to professional development, career progression, diversity, educational development, and transitions through medical training, consistent with earlier scholarship that described mentoring as a multidimensional component of medical education (Kalén et al., 2010; Sambunjak et al., 2010).

The geographical distribution of the literature, however, presents a more complex picture. Research output is concentrated in a relatively small number of countries, with the US accounting for the largest share of publications, while countries such as Sweden contribute fewer publications yet demonstrate comparatively high citation visibility. This contrast suggests that research productivity and scholarly influence do not necessarily develop in parallel. More importantly, it raises a question about whose knowledge becomes most visible within the international mentoring literature. The

geographical concentration should not be interpreted as evidence that mentoring is less developed in countries with fewer publications. Rather, it reflects the distribution of indexed scholarship and may be influenced by structural and contextual factors discussed below. Previous work on mentoring and international research environments similarly highlights the importance of institutional and contextual conditions, including cultural and linguistic diversity, research capacity, networking, and the practical constraints affecting research development (Oikarainen et al., 2018; Olopade et al., 2018). Because this study analysed English-language publications indexed in Scopus, the observed geographical pattern should therefore be understood as the distribution of visible research rather than the distribution of mentoring practices worldwide.

From a comparative education perspective, this pattern reflects what has been described as the geopolitics of knowledge production, namely the dominance of high-income countries in global academic publishing (Demeter & Goyanes, 2021). In parallel, international research partnerships often reproduce rather than challenge knowledge hierarchies, with scholars from well-resourced institutions occupying positions of visibility and authority (Shiyama et al., 2026). Consequently, the international evidence base on mentoring is likewise a product of unequal opportunities to produce, publish, and circulate educational knowledge. The underrepresentation of resource-constrained settings in scholarly networks has likewise been recognised in studies examining mentorship capacity and academic development in low- and middle-income countries (Nakanjako et al., 2011; Noormahomed et al., 2019).

From Knowledge Production to Transferability Across Educational Systems

Much of the literature remains closely tied to national or institutional contexts, while only a small proportion of publications involve multinational co-authorship. This pattern does not necessarily signal a weakness in individual studies; rather, it suggests that opportunities to examine mentoring comparatively across educational systems remain limited. Mentoring scholarship has long recognised the influence of local educational, professional, cultural, and interpersonal contexts on how mentoring relationships are developed and experienced (Oikarainen et al., 2018; Pérez-Martinot, 2024).

The comparative education literature on policy borrowing provides a framework for understanding why transferability requires careful consideration, as it involves complex dynamics of translation, adaptation, and legitimisation rather than being straightforward (Phillips & Ochs, 2004). Furthermore, borrowing involves selectively extracting educational practices embedded in specific institutional and cultural contexts, which are then adapted to local circumstances (Steiner-Khamsi, 2016). Mentoring may involve broadly transferable principles, while the conditions under which those principles are enacted can differ substantially. Faculty availability, student numbers, workload, institutional hierarchy, programme structure, professional expectations, and access to career networks may all influence how mentoring is organised and experienced. Earlier research has similarly emphasised the importance of mentor preparation, institutional support, and clearly defined mentoring structures in determining how mentoring relationships function (Mubuuke et al., 2020; Ramani et al., 2006).

The cases below illustrate how these conditions vary. In Sweden, mentoring research is closely associated with Karolinska Institutet, the institution with the most publications and the highest citation-per-publication ratio in the present dataset. Longitudinal mentoring has been examined as part of professional development during clinical training (Kalén et al., 2010). In Singapore, the National University of Singapore is among the most active institutions and accounts for the strongest international collaboration in the dataset, with the United Kingdom, suggesting a mentoring research agenda embedded in international networks. By contrast, studies from Uganda and Mozambique describe mentoring in settings where limited faculty capacity, competing workloads, and constrained research infrastructure shape what mentoring can be provided (Mubuuke et al., 2020; Nakanjako et al., 2011; Noormahomed et al., 2019). These cases suggest that similar mentoring aims may be

pursued under very different institutional conditions, making transferability an empirical question rather than an assumption.

A mentoring model developed within a highly resourced medical school may assume protected faculty time, formal programme coordination, manageable student groups, and established professional networks. These assumptions may not hold in institutions with larger student cohorts, faculty shortages, or different organisational structures. Evidence from resource-limited academic settings shows that limited institutional capacity and competing professional demands can shape mentoring provision (Bhatia et al., 2013; Nakanjako et al., 2011). The issue, therefore, is not whether one system is a "better" mentoring model, but whether the conditions that support a particular model are understood when it is transferred elsewhere.

This has important implications for comparative education. International mentoring research should move beyond identifying successful programmes towards examining the conditions for transferability. Comparative studies could ask which elements of mentoring are broadly applicable across contexts and which need to be adapted to local institutional, cultural, and professional conditions. Such an approach would reduce the risk of treating mentoring frameworks developed in highly represented countries as universal solutions.

Mentoring as a Multidimensional Educational Practice

The thematic network offers further insight into why transferability requires careful consideration. The co-occurrence patterns link mentoring to multiple themes. Rather than representing unrelated applications, these themes indicate that mentoring serves several interconnected functions within medical education. Mentoring appears to sit between the formal curriculum and informal professional socialisation. Students encounter formal teaching, assessment, clinical training, and institutional requirements, while mentoring may provide a space in which they interpret these experiences, develop professional identities, understand expectations, and consider future career pathways (Frei et al., 2010; Kalén et al., 2010; Sambunjak et al., 2010).

The prominence of career- and transition-related themes is therefore significant. It suggests that mentoring is often situated within the broader educational trajectory from undergraduate study to postgraduate training, rather than treated as a separate student-support activity. This aligns with the literature on mentoring in relation to career planning, residency transitions, professional development, and near-peer support (Akinla et al., 2018; Preovolos et al., 2024).

At the same time, the presence of diversity and equity-related themes indicates that mentoring is also connected to questions of participation, access, and professional opportunity. Studies of structured mentoring programmes have described mentoring as a means of supporting students from underrepresented groups and addressing barriers to educational and professional progression (Farkas, Bonifacino, et al., 2019; Feeley et al., 2024). However, the bibliometric evidence does not establish the effectiveness of mentoring in addressing these inequalities. Rather, it shows that equity and diversity have become part of the conceptual space in which mentoring is discussed.

The literature also highlights functions beyond academic guidance. In some contexts, mentoring is discussed in relation to psychosocial support, professional values, moral development, and students' sense of belonging (Bhatia et al., 2013; Ismawi et al., 2026; Nebhinani et al., 2020). This broader framing is particularly relevant to international and comparative education, as the balance among academic, professional, psychosocial, and relational functions may vary with educational structures and cultural expectations.

The diversity of themes therefore shows that what constitutes an important mentoring function in a particular educational system depends on how that system organises professional socialisation, career guidance, student support, and transition into postgraduate training. A function central to mentoring in one setting may already be supported by other institutional structures in another. This supports the view of mentoring as a multidimensional educational practice, whose meaning is partly shaped by context.

Equity, Resource Constraints, and the International Evidence Base

The geopolitics of knowledge production also has implications for equity (Demeter & Goyanes, 2021; Shiyama et al., 2026). Because disproportionate scholarship on mentoring is generated by a limited number of well-resourced research environments, the literature may provide relatively little insight into how mentoring operates where institutional capacity, faculty availability, and educational resources differ. This highlights a gap in research representation rather than an absence of practice, and may reflect differences in research funding, publication opportunities, language, database indexing, institutional research priorities, or access to international scholarly networks (Noormahomed et al., 2019; Olopade et al., 2018). Studies from resource-constrained settings have also documented challenges associated with faculty workload, limited institutional support, and the development of sustainable mentoring capacity (Bhatia et al., 2013; Mubuuke et al., 2020).

At the same time, the literature indicates that mentoring arrangements can take various organisational forms. Near-peer, group-based, and other alternative approaches have been explored where conventional faculty-to-student arrangements may be difficult to sustain because of faculty availability or programme structure (Akinla et al., 2018; Farrukh & Hoor, 2022). These approaches should not be automatically characterised as universally scalable or cost-effective; rather, they illustrate how mentoring structures may be adapted to particular institutional conditions.

For international education scholarship, this distinction is significant. A globally relevant evidence base for mentoring requires not only more studies from underrepresented regions but also greater attention to locally defined priorities. More equitable collaboration would involve jointly defining research questions, recognising contextual expertise, and examining whether the assumptions underlying established mentoring models remain appropriate across different educational environments.

From Universal Models to Context-Sensitive Policy

Taken together, the findings suggest that the key policy challenge is to determine what constitutes an appropriate mentoring arrangement in particular educational contexts. This distinction is central to comparative education because it shifts attention from simple policy transfer to contextual adaptation.

The increasing visibility of mentoring research also aligns with broader educational concerns regarding inclusive and equitable access to quality education, including the principles articulated in Sustainable Development Goal 4 (Tatto, 2021). However, the bibliometric evidence should not be interpreted as demonstrating that mentoring has become a universally established component of educational quality assurance. Rather, the increasing attention to structured programmes, equity, professional development, and career progression suggests growing interest in institutionalising mentoring within medical education (Skjevik et al., 2020).

Institutional policies can provide structures, expectations, faculty development, and mechanisms for monitoring mentoring provision, but formalisation alone does not guarantee meaningful or equitable mentoring. Implementation needs to consider faculty workload, student numbers, institutional capacity, access to mentors, professional hierarchies, and the particular purposes assigned to mentoring. Previous studies of mentoring capacity in resource-constrained settings reinforce the importance of institutional support and feasible programme structures (Nakanjako et al., 2011; Noormahomed et al., 2019).

A more equitable research agenda would therefore involve researchers from underrepresented settings as partners in defining research questions, evaluating mentoring models, and interpreting findings. This would help move the field away from one-directional transfer of established models and towards reciprocal knowledge exchange in which local educational priorities are treated as sources of knowledge rather than simply as sites for implementation.

This principle of contextual adaptation is also evident in national policy contexts. For example, the human-centred orientation associated with the Falsafah Pendidikan Kebangsaan and the Malaysia MADANI framework offers a relevant policy context for considering mentoring as part of broader student development and relational educational practices (Iskandah et al., 2025). This should be understood as a contextual illustration rather than an empirical finding generated by the bibliometric analysis.

Similarly, the Malaysian Qualifications Agency's national standards provide a policy context in which faculty development and institutional quality assurance can be considered alongside mentoring provision (Malaysian Qualifications Agency, 2025). This illustrates the broader comparative principle that international evidence may be most useful when it is critically adapted to national educational priorities, institutional structures, and cultural expectations.

The international mentoring literature can therefore contribute to policy development by identifying recurring functions such as academic guidance, professional development, career support, psychosocial support, and professional socialisation while comparative research can examine how these functions are organised differently across educational systems. The international mentoring literature can therefore inform policy development by identifying recurring functions, including academic guidance, professional development, career support, psychosocial support, and professional socialisation. Comparative research can then examine how these functions are organised differently across educational systems. The value of international comparison lies not in identifying a universally superior model, but in understanding how mentoring can be meaningfully adapted across different educational environments. in understanding how mentoring can be meaningfully adapted across different educational environments.

Limitations and Future Research

Several limitations should be considered when interpreting these findings. First, the analysis relied on Scopus as the sole bibliographic database and may therefore have missed relevant publications indexed elsewhere. Second, the inclusion of English-language publications may have under-represented non-English-speaking educational contexts. These limitations are particularly important given that the study's central contribution concerns the international distribution and visibility of mentoring research.

Third, bibliometric analysis identifies patterns of publication, citation, and thematic association, but it cannot establish how mentoring programmes operate in practice or whether particular models yield better educational outcomes. Keyword co-occurrence can reveal conceptual relationships within the literature, but it does not, on its own, demonstrate differences in mentoring practices between countries or regions.

Future research should therefore move from mapping the field towards examining how mentoring works, for whom, under what conditions, and with what degree of transferability across educational systems. Comparative and mixed-methods studies could investigate mentoring programmes across different institutional and resource contexts, while longitudinal research could examine relationships with professional identity formation, career decisions, postgraduate transitions, and student participation. Such work would complement existing evidence concerning mentoring, professional development, peer support, and student transitions (Akinla et al., 2018; Preovolos et al., 2024).

Greater cross-country collaboration would enable researchers to distinguish between mentoring features that appear consistently across contexts and those that are context-dependent. Importantly, such collaboration should involve researchers from currently underrepresented settings as partners in defining research priorities and interpreting evidence, thereby building a more representative international evidence base. Overall, this study maps an expanding but uneven international research landscape and demonstrates why mentoring should be understood as an educational practice whose functions, implementation, and meaning are shaped by context. The next stage of scholarship should

therefore place greater emphasis on comparative evidence, contextual adaptation, and reciprocal international knowledge exchange.

Conclusion

In conclusion, this bibliometric analysis highlights research trends in faculty-student mentorship in undergraduate medical education. Despite the growing number of publications, the study found underrepresentation of studies from developing countries and limited international collaboration. Future research could explore how these elements interact over time and across different medical education systems, examining how these themes evolve and how access is discussed for diverse groups. Another underexplored area concerns regional disparities in mentoring within medical schools and their implications for cross-context collaborations.

Note

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Declaration on the Use of Artificial Intelligence

During the preparation of this manuscript, the authors manually conducted all data collection, screening, bibliometric analyses, and methodological interpretations. Generative artificial intelligence tools were used solely for literature searches, writing assistance, editing, and structural revisions. Specifically, Scopus AI was used to identify up-to-date and relevant literature. ChatGPT was used to organise paragraphs and ensure academic flow based on the original content, to perform language editing, and to organise points in response to reviewers' queries, which the authors then reviewed and finalised for accuracy. Gemini was used to suggest ways to consolidate text, reduce word counts, and optimise the reference list. Following the use of these tools, the authors thoroughly reviewed, edited, and verified the entire manuscript, taking full responsibility for the final content of the publication

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Appendix A. Summary of Previous Review on Faculty-Student Mentoring in Medical Schools

Type of review (Reference)	Search terms	Data source	No of documents	Attributes examined
Systematic (Skjevik et al., 2020)	(Mentor OR Mentors OR Mentoring OR Mentorship OR Physician apprenticeship) AND (Education OR Medical/ and education OR medical undergraduate OR (medical ADJ3 student*) OR (medical ADJ3 undergraduate)	Ovid MEDLINE, EMBASE, PsycINFO and ERIC	20	Aims, structures, contents and program evaluations group-based mentorship programs for undergraduate medical students.
Systematic (Farkas, Allenbaugh, et al., 2019)	Not disclosed	PubMed, PsycINFO, Education Resources Information Center, and Cochrane Databases of Systematic Reviews	30	Models of mentorship for US medical students.
Systematic (Feeley et al., 2024)	Ment,*" "Medical student," "undergraduate medical education," "Underrepresented minorities," "URM," "URG," "UIM," "underrepresented in Medicine," "URiM," "minorit,*"	PubMed, Ovid Medline, and EMBASE	17	Impact of mentoring programme on underrepresented groups in undergraduate medical education
Scoping (Preovolos et al., 2024)	medical student*, peer mentor* and medical education	Medline, ERIC, EMBASE, Web of Science, WorldWideScience and the British Library	20	Peer mentoring among medical students benefits, elements for success and challenge
Systematic (Akinla et al., 2018)	peer, buddy, mentor∗, counsel∗, advise∗, tutor∗, student, medical, school	PubMed, Embase, Scopus, ERIC, Ovid, PsycINFO, and the Cochrane Highly Sensitive Search Strategies	5	Outcomes of near-peer mentoring schemes for first-year medical students in the transition phase.
Thematic (Sng et al., 2017)	"mentor", "mentoring", "mentorship" "mentoring relationships" AND "medicine" or their combinations in Medicine.	PubMed, ERIC, Cochrane Database of Systematic Reviews, OVID and ScienceDirect	49	Key aspects of mentoring relationships between senior physicians and junior doctors and/or medical students to inform efforts to improve mentoring programs

Appendix A. Summary of Previous Review on Faculty-Student Mentoring in Medical Schools (continued)

Type of review (Reference)	Search terms	Data source	No of documents	Attributes examined
Scoping (Sheri et al., 2019)	'mentor training', 'mentorship training', 'mentoring competency', 'faculty development' AND 'medical faculty' and their combinations	PubMed, ERIC, EMBASE, SCOPUS, Google Scholar, and grey literature databases.	68	Available mentor training programs are in undergraduate and postgraduate medicine and how they may inform the creation of an evidenced-based framework for mentor training
Scoping (Wisdom et al., 2025)		Medline	93	Benefits and challenges of mentoring as described by mentors in a medical setting (physicians, residents, dentists, pharmacists, and nurses)
Systematic (Hee et al., 2020)	'matching', 'mentor', 'mentoring', 'mentorship', 'medical students', 'medical school' AND 'medicine' or their combinations	ERIC, Embase, Web of Science, PubMed, Cochrane Database of Systematic Reviews, CINAHL, OVID and Science Direct	36	Matching in novice mentoring in undergraduate and postgraduate medical and allied health programs
Systematic (Shen et al., 2022)	Concepts of mentoring, women, and academic medicine and used a combination of subject headings and keywords	MEDLINE, Embase, Scopus, Current Contents Connect via Web of Science, Cochrane Library, and PsycINFO.	91	Impact of mentoring on women's career outcomes in academic medicine.
Scoping ((Chua et al., 2020)	Not disclosed	PubMed, ScienceDirect, ERIC, Embase, Scopus, Mednar, and OpenGrey	71	Mentoring structures in novice mentoring among medical students and junior doctors in medicine and surgery postings

Appendix B. Bibliometric Analyses on Mentoring in Medical Schools

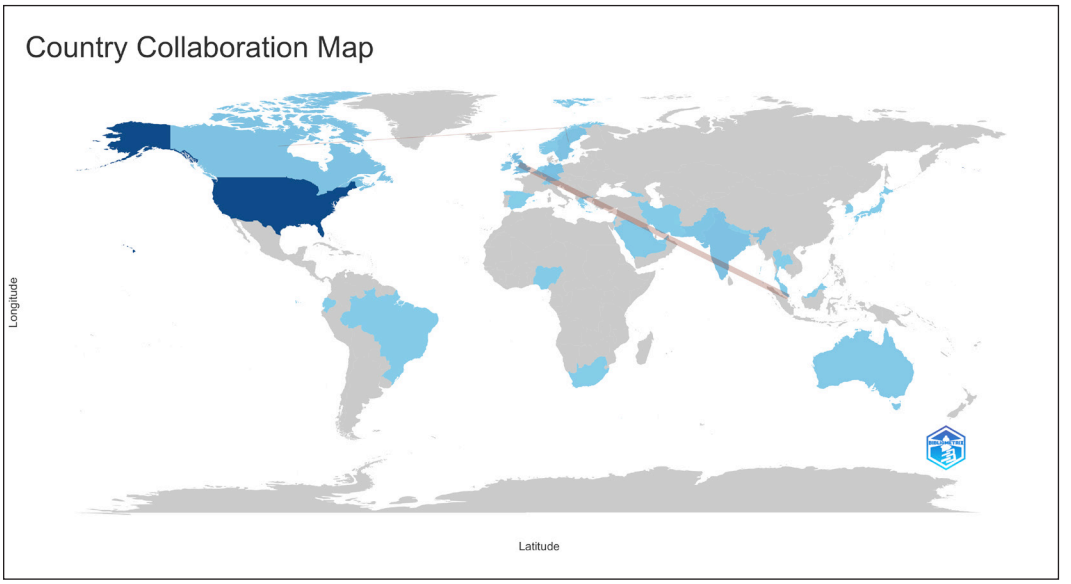
Reference	Search terms	Data source	No of documents	Focus
Osorio Meniz et al. (2022)	Tutorship, formative strategy, personal development, university students)	Scopus between 2003 and 2023	82	Mentoring as a formative strategy for the personal development of university students
Bataeineh and Haq (2020)	"Mentoring OR Mentorship or Coaching OR Leadership"	Web of Science from 1970 to 2014.	100	100 most cited articles of mentoring in education that indexed in the world-leading database, i.e., Web of Science
Masalimova et al. (2024)	(TITLE (mentoring) AND KEY ("science education") OR KEY ("biology education") OR KEY ("chemistry education") OR KEY ("physics education") OR KEY ("STEM education") OR KEY (stem)) AND (LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")) AND (EXCLUDE (PUBYEAR, 2023))	Scopus between 2000 to 2022	67	Research on mentoring in science education
Alonso-Muñoz et al. (2022)	"mentoring" AND (university OR "higher education")	Web of Sciences	232	Trends in Mentoring at Higher Education

Appendix C. Top 5 Countries, Institutes, and Sources that Contributed to Relevant Publications

Country/ Institution/Source		TP	NCP	TC	C/P	C/CP	h
Country	United States	97	85	2359	24.4	27.8	25
	United Kingdom	12	11	232	19.3	21.1	7
	Germany	10	9	169	16.9	18.8	6
	Sweden	8	8	228	28.5	28.5	6
	Canada	7	7	104	14.9	14.9	5
Institution	Karolinska Institutet	8	8	240	30.0	30.0	6
	Boston University Chobanian & Avedisian School of Medicine	6	6	268	44.7	44.7	6
	National University of Singapore	6	6	218	36.3	36.3	6
	NUS Yong Loo Lin School of Medicine	6	6	218	36.3	36.3	6
	University of California	6	5	222	37.0	44.4	4
Source	Medical teacher	12	12	680	56.7	56.7	11
	Academic Medicine	8	8	656	82.0	82.0	7
	BMC Medical Education	12	12	519	43.3	43.3	7
	Medical Science Educator	7	6	34	4.9	5.7	4
	Journal of Surgical Education	7	4	26	3.7	6.5	3

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index.

Appendix D. Country Scientific Production and Collaboration Map



Source: Image generated using Bibliometrix software

Appendix E. Top Author Keywords

Keywords	Total publication	%
mentoring	37	21.0
mentorship	30	17.0
medical students	25	14.2
medical education	24	13.6
medical student	14	8.0
mentor	14	8.0
undergraduate medical education	8	4.5
surgery	7	4.0
mentee	6	3.4
surgical education	6	3.4
medical school	5	2.8
mentors	5	2.8
diversity	4	2.3
professional development	4	2.3
residents	4	2.3
undergraduate medical students	4	2.3
career choice	3	1.7
covid-19	3	1.7
education	3	1.7
medical education & training	3	1.7
neurosurgery	3	1.7
perception	3	1.7
recruitment	3	1.7
research	3	1.7
residency	3	1.7
students	3	1.7
undergraduate	3	1.7