REVIEW ARTICLE

Ethical Cognition and Attitudes of Medical Students: A Bibliometric Analysis from 2000 to 2025

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Abstract

This study conducts a bibliometric and scientometric analysis of global research trends in medical ethics education from 2000 to 2025. Drawing on 443 English-language articles retrieved from the Scopus database, the analysis employs VOSviewer to map knowledge structures, identify thematic clusters, and reveal intellectual trajectories. Results show a sustained growth in publication volume and increasing scholarly attention to ethics education across multiple dimensions. Keyword co-occurrence and clustering analysis identify five core thematic areas: ethical identity formation, student engagement with bioethical dilemmas, moral development in early education, public health ethics in policy contexts, and research ethics awareness. The field has evolved from a focus on normative instruction to a more integrated, contextual, and experiential model of ethics education, emphasizing identity, affect, and systemic accountability. Highly cited works highlight the importance of the hidden curriculum, reflective practice, and simulation-based learning. This study provides a comprehensive knowledge map of the field and offers insights for future pedagogical design and policy formation. By clarifying conceptual foci and research frontiers, it contributes to the strategic development of ethics education within increasingly complex medical and societal environments.

Keywords: ethical cognition, attitudes, medical students, bibliometric.

1 Introduction

Medical ethics has long served as a critical foundation of professional identity and moral reasoning in medical education [1, 2]. Medical students, as future practitioners, are expected not only to acquire clinical competencies but also to internalize core ethical principles such as autonomy, beneficence, non-maleficence, and justice. The development of ethical cognition and attitudes during medical training is essential for ensuring responsible clinical decision-making, maintaining trust with patients, and upholding the integrity of the profession [3, 4].

In recent years, transformative changes in healthcare systems and medical education have introduced new challenges and imperatives for ethics education. The rapid integration of artificial intelligence (AI) in diagnostics, treatment planning, and even medical instruction has expanded the boundaries of clinical

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decision-making, often raising complex ethical concerns [5]. These include issues of algorithmic transparency, bias in training data, accountability in AI-supported decisions, and the potential erosion of humanistic care [6]. Medical students are now required to grapple with dilemmas where traditional bioethical frameworks may no longer suffice. Concurrently, the post-pandemic shift in healthcare delivery, including the accelerated adoption of telemedicine and remote diagnostics, has introduced further ethical tensions related to access, confidentiality, and equity [7, 8]. The increasing global emphasis on cultural competence and health equity has also drawn attention to the importance of sociocultural contexts in ethical decision-making [9]. Moreover, empirical studies have highlighted a concerning association between medical student burnout and diminished ethical sensitivity, raising questions about the resilience of ethical training amidst high-pressure learning environments [10]. These multifaceted developments signal a pressing need to reevaluate how ethical cognition is cultivated and sustained in medical students [11].

While numerous qualitative and survey-based studies have examined medical students' ethical awareness, values, and decision-making, a comprehensive mapping of the academic discourse over time remains limited. This study employs a bibliometric approach to analyze global literature on the ethical cognition, attitudes, and perceptions of medical students. The objective is to elucidate the research trajectory, identify influential scholars and institutions, and uncover emerging thematic foci—particularly those shaped by recent technological and global health developments. In doing so, the study aims to contribute a structured understanding of how ethics education for medical students has evolved, and to provide an evidence-based foundation for future curriculum reform and policy development. To ensure relevance to current ethical, pedagogical, and technological contexts, this study includes literature published from 2000 to 2025. The turn of the 21st century marked significant shifts in medical education paradigms, the rise of bioethics as a structured discipline, and the emergence of new ethical challenges driven by digital health technologies. Furthermore, indexing quality and bibliographic completeness in major databases significantly improved after 2000, making this period methodologically appropriate for bibliometric analysis.

2 Materials and Methods

We use Scopus databases as the source of literature to ensure that a sufficient number of studies in this field are covered. The key contents of concern include: (1) Terms related to medical students or medical education (search terms include medical ethics, bioethics, health ethics, clinic ethics); (2) Ethics-related terms (Search terms include medical ethics, bioethics, health ethics, ethical attitude, ethical awareness, ethical knowledge) "ethical perception, moral cognition." We search in the "Title, Abstract or Keywords" section. The publication time of the paper is from 2000, and the retrieval cut-off date is April 30, 2025. The article types are limited to Article, and the language is restricted to English. This stage of the search resulted in 3421 articles.

To ensure the validity of the included literature, we employed a manual screening process with two individuals. This step is crucial, some literature is about patients' attitudes towards medical students' participation in diagnosis and treatment, or teachers' viewpoints on the curriculum design of medical ethics, which has caused confusion in the retrieval, which has caused confusion in retrieval. These cases were resolved through manual review. After a double-blind screening process, the two researchers discussed and ultimately determined the list of papers to be included. The Kappa value of 0.816 in the screening results indicates that the codes are reliable. The Kappa value is used to measure consistency among reviewers and to evaluate the accuracy of screening. This value represents the percentage of agreement between two reviewers, with 1 point indicating complete agreement on whether an article should be included and 0 point indicating complete disagreement. The Kappa value of 0.816 for this process indicates a high degree of consistency between the two screening personnel regarding the inclusion and exclusion criteria of the article. Finally, 443 articles were included in the final analysis.

This study conducted a bibliometric analysis of literature on the introduction of artificial intelligence in medical education, supplemented by cluster based content analysis. Bibliometrics is a methodology used to study scientific activities, knowledge dissemination, and academic impact through quantitative analysis of literature and its related features. Many scholars from different disciplines such as ethics, education, and medicine have applied bibliometric techniques to describe the knowledge structure of a field, thereby identifying the most important and influential research elements in these fields [12–14].

For the bibliometric analysis in this study, we used VOSviewer software for quantitative analysis, including keyword co-occurrence and citation coupling [15]. In terms of network visualization, the network consists of nodes and edges. Nodes can represent entities such as countries, authors, or keywords, indicating the relationships between these entities. The distance between nodes represents the strength of their connections; The shorter the distance, the stronger the association [16]. In this study, we focus on networks based on Total Link Strength (TLS). The link and TLS properties both display the number of connections between a project and other projects, as well as the total strength of these connections. To supplement quantitative analysis, we conducted content analysis on the four clusters identified in the co-occurrence keyword analysis.

3 Results

3.1 Study the main distribution characteristics

3.1.1 Research time distribution characteristics

The temporal distribution of publications related to medical students' ethical cognition, attitudes, and education from 2000 to 2025 reveals a clear upward trajectory with distinguishable developmental phases. Between 2000 and 2009, publication output remained relatively low and stable, reflecting the early developmental stage of this research domain, during which bioethics and professionalism were only beginning to receive structured attention in medical curricula.

From approximately 2010 onwards, a moderate and steady increase in scholarly output became evident, aligning with global shifts toward competency-based medical education and growing institutional emphasis on professional identity formation, empathy, and moral reasoning. This period marked a broader recognition of ethics education as an integral part of undergraduate medical training.

A more pronounced acceleration occurred after 2018, with annual publications consistently exceeding 20 per year and peaking in 2024. As shown in Figure 1, this surge likely reflects the compounding impact of several factors, including the COVID-19 pandemic, which brought ethical dilemmas in healthcare to the forefront, and the rapid integration of digital technologies (e.g., artificial intelligence, telemedicine) into medical education and clinical practice. These developments introduced novel ethical challenges, thereby intensifying academic interest in related pedagogical approaches and student attitudes [17, 18]. Although the number for 2025 appears lower, it is important to note that data collection for the current year remains incomplete.

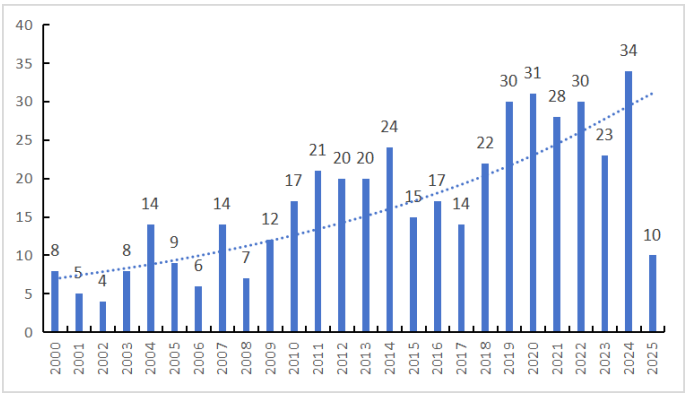


Figure 1. Number of publications over 2000–2025.

3.1.2 Distribution characteristics of authors

The international collaboration network in the examined literature reveals a multi-polar structure centered around several influential countries, with the United States, the United Kingdom, and Canada forming the core hubs (Figure 2). These countries are distinguished not only by their high volume of publications but also by extensive international linkages and citation impact. The United States leads by a significant margin, with collaborations spanning 23 countries, a total of 114 documents, and 1,960 citations, resulting in an average of 17.19 citations per document and a normalized citation score of 1.064. The United Kingdom similarly exhibits a strong presence, with 31 publications and the highest average citation count (28.10) among major contributors, along with a robust normalized impact of 1.14.

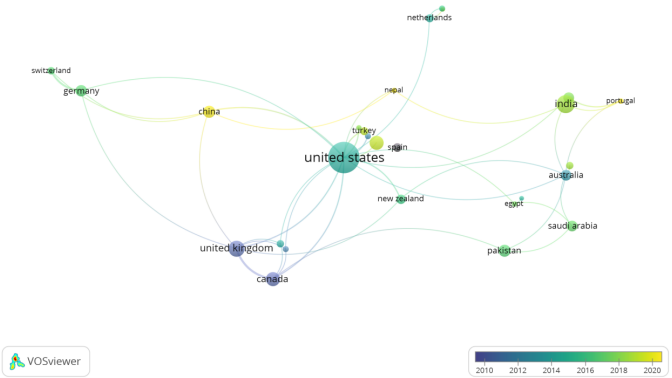


Figure 2. Overlay visualization of co-authorship countries.

Peripheral countries such as Brazil, Egypt, and

Iran participate in the network with moderate publication numbers but are generally involved in fewer collaborative ties and demonstrate variable citation impacts. Notably, countries like Saudi Arabia and Portugal, although smaller in terms of overall output, display relatively high average and normalized citations, suggesting a concentration of quality or niche expertise. For example, Portugal has a normalized citation score of 2.31, the highest among all countries analyzed, while Saudi Arabia achieves an impressive 1.49. These cases point to a decoupling of quantity and influence in certain contexts, where focused high-impact contributions may outweigh sheer volume.

Overall, the network reflects both hierarchical and regional dimensions of collaboration. Central actors not only drive publication volume but also amplify the impact and visibility of joint research. For peripheral participants, strategic partnerships with core countries may offer a pathway to greater academic influence. These patterns underscore the critical role of international collaboration in shaping research productivity and impact, especially in a globalized knowledge economy.

3.2 Thematic analysis

3.2.1 Keywords co-occurrence network

This study analyzed 795 author keywords extracted from collected papers, with a focus on keywords that appear more frequently than 3. In order to improve the clarity of clustering and emphasize the main research topics, five minimum cluster sizes were adopted. This process generated 81 keywords that appeared more than 3 times, forming 5 different clusters with a total link strength of 903.

3.2.2 Keywords frequency analysis

The analysis of author-provided keywords reveals a concentrated thematic focus within the literature, with only 14 keywords appearing more than 10 times (Figure 3). This limited but highly recurrent set indicates a well-defined research landscape centered on medical ethics education and its components. The predominance of terms related to ethics—such as "medical ethics," "ethics," "bioethics," and "ethics education"—highlights the foundational role of ethical inquiry within medical training. Concurrently, keywords emphasizing the learner and educational context, including "medical students," "medical education," "education," "curriculum," and "medical education & training," underscore the pedagogical orientation of the field, reflecting ongoing efforts to structure and deliver ethics education effectively.

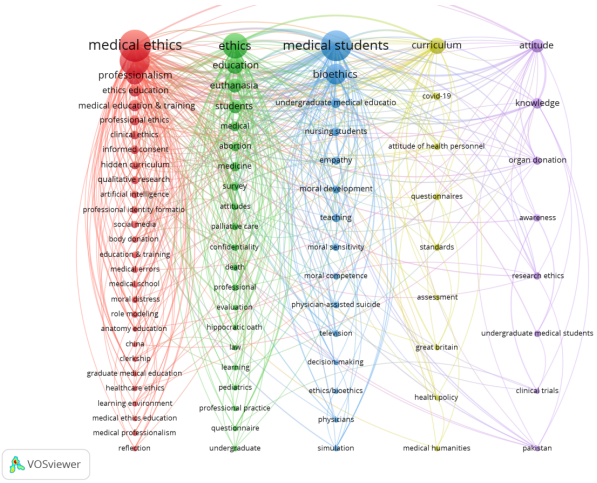


Figure 3. The network visualization of Co-occurrence-Author keywords.

Moreover, the presence of terms like "professionalism" and "attitude" points to an interest not only in imparting ethical knowledge but also in shaping professional identity and moral dispositions among medical students. The inclusion of ethically complex topics such as "euthanasia" illustrates the engagement of the literature with practical, real-world dilemmas that challenge both students and educators. Overall, the frequency distribution of keywords suggests that the literature is tightly clustered around the intersection of ethics content, learner development, and curricular implementation. This focus reflects an integrated approach aiming to combine theoretical foundations, educational strategies, and attitudinal outcomes within medical ethics education. The limited diversity yet high recurrence of keywords indicates a mature research domain with clearly articulated priorities, emphasizing the continuous refinement of ethical training as a critical component of medical education.

3.2.3 Average year of keyword co-occurrence

The average publication year of keyword co-occurrence offers a valuable temporal dimension for understanding the evolution of research themes within medical ethics education. Keywords with relatively recent average years, such as "artificial intelligence" (2023.6), "professional identity formation" (2021.2), and "moral distress" (2022.5), indicate emerging areas of scholarly interest that reflect ongoing advancements and contemporary challenges in medical education. The prominence of terms related to cutting-edge technologies and psychosocial aspects suggests an

expanding research focus beyond traditional ethical topics.

In contrast, keywords such as "medical ethics" (2017.96), "medical education" (2018.7), and "professionalism" (2018.1) represent enduring core topics that continue to be central to academic discourse. These foundational themes maintain relevance as medical ethics education evolves to address changing curricular needs and professional expectations. Additionally, keywords like "hidden curriculum" (2018.16) and "qualitative research" (2020.67) point to increased attention on the implicit aspects of medical training and methodological diversification in ethics research.

Some keywords exhibit earlier average publication years, such as "medical errors" (2014.75) and "role modeling" (2014), indicating established research domains that remain influential. The clustering of keywords into thematic groups with varying average publication years (Table 1) highlights the dynamic and multifaceted nature of the field, encompassing both longstanding bioethical concerns and newly arising issues such as "social media" (2018.8) and "covid-19" (2022.4).

Overall, the temporal analysis of keyword co-occurrence underscores the balance between continuity and innovation in medical ethics education research, providing insights into both the historical development and current trajectories within this scholarly domain.

3.2.4 Content analysis based on keyword clustering

The keyword co-occurrence analysis identified five major thematic clusters, reflecting the evolving landscape of ethics education in medical training (Table 1). These clusters represent distinct yet interrelated domains, ranging from the development of ethical identity to the integration of ethics into broader health policy and research contexts. Rather than existing in isolation, the clusters collectively map a complex, multidimensional field shaped by pedagogical innovation, social values, and institutional responses to contemporary challenges. The analysis reveals how medical ethics education has expanded from traditional bioethical instruction to encompass experiential learning, affective development, policy responsiveness, and research integrity.

Cluster 1: Ethical Identity Formation in Medical Training

Table 1. Keywords content analysis based on clustering.

Cluster	Topics	Keywords
1	Ethical Identity Formation in Medical Training	medical ethics, medical education, professionalism, ethics education, medical education & training, professional ethics, clinical ethics, informed consent, hidden curriculum, qualitative research, artificial intelligence, professional identity formation, social media, body donation, education & training, medical errors, medical school, moral distress, role modeling, anatomy education, china, clerkship, graduate medical education, healthcare ethics, learning environment, medical ethics education, medical professionalism, reflection
2	Student Perspectives on Bioethical Dilemmas	ethics, education, euthanasia, students, medical, abortion, medicine, survey, attitudes, palliative care, confidentiality, death, professional, evaluation, hippocratic oath, law, learning, pediatrics, professional practice, questionnaire, undergraduate
3	Moral Development in Early Medical Education	medical students, bioethics, undergraduate medical education, nursing students, empathy, moral development, teaching, moral sensitivity, moral competence, physician-assisted suicide, television, decision-making, ethics/bioethics, physicians, simulation
4	Ethics Integration in Health Policy and Humanities	curriculum, covid-19, attitude of health personnel, questionnaires, standards, assessment, great britain, health policy, medical humanities
5	Research Ethics Awareness and Biomedical Practice	attitude, knowledge, organ donation, awareness, research ethics, undergraduate medical students, clinical trials, pakistan

This cluster reflects a paradigmatic shift in medical ethics education, moving away from traditional, principle-based instruction toward more situated and context-sensitive approaches. Central to this cluster is the formation of professional identity through experiential and social learning mechanisms [2, 19]. Research highlights that ethical competence among medical students is shaped not only by formal curricula but also significantly influenced by the hidden curriculum, role modeling, and clinical exposure [20, 21]. Ethical awareness emerges from complex interactions involving mentors, institutional culture, and increasingly, digital environments such as social media [22, 23]. The integration of artificial intelligence and the concept of moral distress within this cluster further underscores an evolving landscape where ethics is negotiated amid emerging technological and emotional contexts [18, 24]. This cluster dominates not only in quantity but also serves as a bridge and cohesion center within the network structure. It captures the complexity of medical students' ethical socialization, emphasizing that ethics education transcends mere classroom knowledge transmission. Instead, it highlights the roles of the hidden curriculum, reflective learning, and role modeling in shaping professional ethical identity. Ethics education here is conceptualized as a composite system crossing cognitive and emotional dimensions, institutional and individual levels, with modern elements such as AI and social media further illustrating the evolution of ethics teaching to meet contemporary challenges. This underscores a broader pedagogical transition from didactic ethics teaching to an integrative, identity-driven, and reflective formation process.

Cluster 2: Student Perspectives on Bioethical Dilemmas

This cluster centers on students' engagement with ethically contentious issues including euthanasia, abortion, confidentiality, and palliative care [25–28]. The thematic focus is on moral reasoning and value orientation in ethically complex scenarios. Frequently employing surveys and questionnaires, these studies investigate how students interpret, rationalize, and position themselves within bioethical debates [26]. Importantly, this cluster bridges ethical theory and real-world application by situating student attitudes within broader discourses on human rights, legal frameworks, and sociocultural norms. Recurring references to concepts such as the Hippocratic Oath and professional conduct reflect normative concerns regarding how traditional medical ethics interacts with contemporary societal values [29]. This cluster illustrates how medical students position their attitudes and values amid ethical dilemmas, revealing the formation of individual moral judgments and social ethical awareness beyond formal education. Students' responses to real or hypothetical ethical choices are shaped not only by personal beliefs and cultural contexts but also reflect "grey areas" in ethics education not fully addressed by curricula.

Cluster 3: Moral Development in Early Medical Education

This cluster emphasizes the cognitive and affective foundations of ethical capacity during the early stages of medical education. The core theme is the development of moral sensitivity, empathy, and competence as fundamental components of ethical professionalism [30–32]. Research commonly addresses the role of bioethics and undergraduate curricula in nurturing these foundational ethical skills [33]. There is a pronounced focus on simulation-based learning, reflective teaching strategies, and interdisciplinary exposure—such as the use of television portrayals of medicine—to enhance ethical receptivity [34, 35]. These studies argue that moral development extends beyond cognition to encompass profound emotional engagement, requiring pedagogical approaches that foster critical reflection, affective involvement, and narrative understanding. Compared to Cluster 1's focus on professional identity formation, this cluster concentrates more on the initial moral cognition and awakening of individual ethical intuitions [36]. Educational modalities like simulation, media-based teaching, and case discussions serve as pivotal means to cultivate moral sensitivity and judgment, illustrating the "forward shift" in ethics education that advocates for early integration of ethical development preceding clinical skills training.

Cluster 4: Ethics Education in Public Health and Policy Contexts

This cluster highlights the intersection of ethics education with health policy, public health, and societal crises, notably the COVID-19 pandemic [37, 38]. The dominant theme concerns the adaptation and evaluation of ethics curricula in response to systemic and structural challenges. Studies explore how institutions reassess ethical training in light of evolving professional standards, societal expectations, and global health emergencies [39]. The prominence

of health policy and medical humanities indicates an expanded ethical lens that encompasses not only interpersonal conduct but also systemic justice and cultural competence [40, 41]. This cluster places strong emphasis on empirical evaluation, utilizing questionnaires and assessment tools to measure curricular effectiveness [42, 43]. It reflects an institutional shift toward accountability in ethics education, aiming to align pedagogical outcomes with practical competencies. Especially within the context of global health crises like COVID-19, ethical concerns have extended beyond doctor-patient relationships to issues of public resource allocation, balancing collective interests, and justifying governmental interventions [37]. Additionally, this cluster addresses curriculum evaluation standards and the integration of humanities, underscoring the necessity of systemic curricular reforms grounded in policy frameworks.

Cluster 5: Research Ethics Awareness and Biomedical Practice

This cluster focuses on medical students' knowledge and awareness of research ethics and clinical practice standards, particularly regarding organ donation and clinical trials [44, 45]. Its thematic core centers on ethical literacy within biomedical research and public health practice. Research often identifies gaps in students' understanding of informed consent, trial protocols, and ethical approval processes, pointing to a need for more robust integration of research ethics in undergraduate education [46, 47]. Studies emphasize fostering not only declarative knowledge but also critical awareness and attitudinal alignment with international ethical standards [44]. This cluster underscores the foundational role of ethics education in biomedical research and public health, advocating that students develop critical ethical understanding alongside moral responsibility. The research suggests that cultural and resource differences necessitate localized adaptations of global ethics standards [48]. Furthermore, this cluster highlights the importance of strengthening ethics training to address gaps in knowledge regarding research oversight and clinical compliance, thereby promoting the unification of ethical adherence and social responsibility in medical research activities and enhancing the overall ethical governance of healthcare systems [49, 50].

Together, these clusters offer a comprehensive overview of current priorities and emerging trends in the field. They underscore a pedagogical transition from static, rule-based instruction to dynamic, integrative approaches that engage students cognitively, emotionally, and contextually. The interplay among identity formation, moral reasoning, systemic ethics, and research responsibility suggests a shifting paradigm in which ethical competence is increasingly understood as a lifelong, interdisciplinary construct. This networked view not only enriches our understanding of how medical students internalize ethical values but also points to areas where future curricular efforts and institutional reforms can be strategically directed.

4 Knowledge base for medical education and artificial intelligence research

A citation analysis was conducted on 443 papers, of which 193 were cited more than 10 times. Among them, only 24 articles have been cited more than 50 times, and only 6 articles have been cited more than 100 times. We analyzed the three most frequently cited papers and the three papers with the highest total link strength (TLS) to determine the knowledge base for this research field.

4.1 Highly cited literature

The study by Patil et al. [51] titled "Health professional student attitudes towards people with disability" offers valuable insights into medical students' ethical cognition and attitudes, particularly concerning the principles of respect, equality, and non-discrimination that underpin medical ethics. The attitudes of medical students toward individuals with disabilities serve as a critical indicator of their ethical preparedness to provide equitable care and uphold patient dignity. This study reveals that while many students demonstrate empathy and respect, indicative of a foundational understanding of medical ethics, there remain significant gaps marked by implicit biases and stereotypical beliefs about disability. Such attitudes highlight deficiencies in ethical cognition, as these biases conflict with the core ethical principles of justice and respect for persons. The findings suggest that despite exposure to medical education, students may not fully internalize the ethical imperatives of inclusivity and respect for diversity, pointing to a shortfall in current ethics curricula. Furthermore, the attitudes held by students have direct implications for their future clinical behavior, as negative perceptions of disability may lead to discriminatory practices and inequitable healthcare delivery. The study underscores the necessity of integrating comprehensive ethics education that explicitly addresses disability rights and challenges prevailing

stereotypes. Incorporating experiential learning methods such as patient interactions, role-playing, and reflective exercises could facilitate deeper ethical understanding and promote positive attitude change. Moreover, interdisciplinary approaches that combine insights from sociology, psychology, and law could enrich students' ethical framework, fostering a holistic appreciation of patient autonomy and social justice. In summary, this research highlights the critical role of ethics education in shaping medical students' perceptions and attitudes towards marginalized patient populations. To cultivate physicians who are both ethically aware and compassionate, medical training programs must prioritize the development of ethical cognition and the promotion of attitudes that reflect genuine respect for all patients, regardless of their physical abilities.

An important longitudinal perspective on the evolution of medical students' ethical cognition and attitudes throughout their training is provided by the cohort study "Changes in students' moral development during medical school" [50]. The study systematically tracks shifts in moral reasoning and ethical awareness, shedding light on the dynamic nature of ethical development in medical education. From the standpoint of medical ethics, the findings emphasize the critical role that medical school plays in shaping students' moral frameworks, which directly influence their decision-making and patient care practices. Notably, the study reveals that while some students demonstrate progression in moral reasoning aligned with higher stages of ethical development, others exhibit stagnation or even regression, raising concerns about the adequacy of ethics instruction in fostering consistent ethical growth. This heterogeneity suggests that cognitive and affective components of ethics—such as understanding ethical principles and cultivating empathy and professional responsibility—may not be uniformly addressed in medical curricula. The study further highlights that external stressors, clinical experiences, and institutional culture can significantly impact students' ethical attitudes, sometimes engendering cynicism or moral distress that undermine ethical ideals. Consequently, the findings call for deliberate pedagogical strategies to support moral development, including reflective practice, mentorship, and ethics discussions embedded in clinical contexts. From a cognitive perspective, reinforcing moral reasoning skills alongside affective attitudes like compassion and respect is essential to developing ethically competent physicians. The research thus underscores the complexity of moral development in medical students and the imperative for comprehensive, longitudinal ethics education that nurtures both cognitive understanding and positive ethical attitudes. Ultimately, this study contributes to the ongoing discourse on how best to cultivate medical professionals who not only possess robust ethical knowledge but also consistently apply these principles in their clinical interactions.

In "Disclosing medical errors to patients: Attitudes and practices of physicians and trainees", Kaldjian et al. [35] present a critical examination of the attitudes and practices of physicians and medical trainees concerning the disclosure of medical errors to patients, a fundamental ethical issue in medical professionalism. This study offers valuable insights into how emerging medical professionals cognitively and affectively approach one of the most challenging aspects of clinical ethics: honesty and transparency in patient care. The findings reveal a complex interplay between ethical knowledge, personal and institutional barriers, and emotional responses that shape physicians' willingness to disclose errors. From the perspective of medical students' ethical cognition, this study highlights the necessity of embedding clear ethical principles, such as autonomy and beneficence, within clinical training, so that students develop not only an intellectual understanding but also the moral courage to confront errors openly. The research underscores that despite widespread endorsement of disclosure as an ethical imperative, many trainees experience conflict and anxiety due to fears of litigation, damage to reputation, and professional repercussions. These affective attitudes potentially hinder the consistent application of ethical principles in practice, pointing to gaps in medical education regarding the integration of ethics with real-world challenges. Furthermore, the study illuminates how institutional culture and mentorship significantly influence trainees' ethical attitudes and behaviors, suggesting that ethical cognition must be supported by a conducive learning environment that models transparency and accountability. Importantly, the research advocates for enhanced curricular efforts, including communication skills training and ethical deliberation exercises, to prepare students to navigate the moral complexities of error disclosure. Ultimately, Kaldjian et al. [35]'s work contributes to understanding how medical ethics education can evolve to better prepare students not only to recognize ethical duties but also to embody

them in difficult clinical situations, fostering a culture of trust and patient-centered care.

4.2 High link strength literature

The article by Patenaude et al. [50], titled "Changes in students' moral development during medical school: A cohort study" and published in the Canadian Medical Association Journal (CMAJ), stands out as a highly influential work in the field of medical education and ethics. It not only ranks as the second most cited paper in our dataset but also holds the highest number of links (Figure 4), indicating its extensive connectivity and relevance within academic networks. This dual distinction reflects the paper's significant impact on both the scholarly community and the broader discourse on moral development in medical students. Its prominence suggests that the study's findings on how moral reasoning evolves throughout medical training have been foundational for subsequent research and curricular reforms aiming to enhance ethical competence in future physicians.

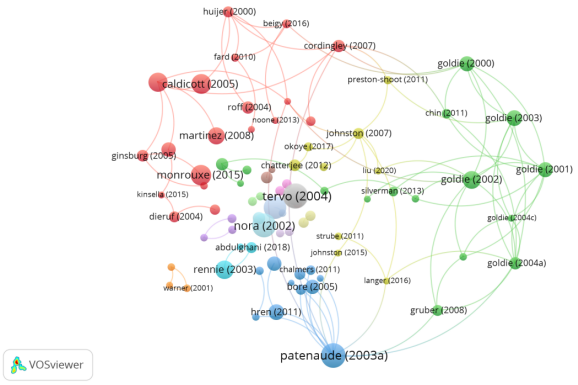


Figure 4. Network visualization of cited references.

The study by Goldie et al. [25], titled "The impact of three years' ethics teaching, in an integrated medical curriculum, on students' proposed behaviour on meeting ethical dilemmas" and published in *Medical Education*, represents a critical investigation into the long-term effects of ethics education on medical students' ethical decision-making. This article ranks second in link metrics within our dataset, underscoring its importance and broad engagement across academic networks concerned with medical ethics and education. A sustained, integrated ethics curriculum over three years is explored for its influence on students' responses to ethically challenging scenarios. The research methodology combines quantitative and qualitative analyses, offering a robust examination of whether formal ethics teaching translates into changes in students' proposed behaviors when confronted with real-world dilemmas. Their findings suggest that continuous ethics education fosters greater ethical sensitivity, better recognition of dilemmas, and more principled approaches to decision-making among medical students. From the perspective of medical students' cognition and attitudes toward medical ethics, this study reveals important shifts. Students exposed to integrated ethics teaching demonstrate heightened awareness of moral complexities inherent in clinical practice and express increased confidence in addressing ethical conflicts. The study also identifies areas where ethical reasoning remains underdeveloped, highlighting the ongoing need to refine curricular strategies to further enhance moral reasoning skills. The article's high number of academic links attests to its influence not only in shaping subsequent research but also in informing curriculum development in medical schools worldwide. It provides valuable evidence supporting the integration of ethics education throughout medical training, rather than isolated or superficial exposure. Ultimately, the understanding of how sustained ethics instruction shapes future physicians' professional identities and ethical conduct—a critical component of quality healthcare delivery—is significantly advanced.

The 2001 study by Goldie et al. [24], titled "Impact of a new course on students' potential behaviour on encountering ethical dilemmas" and published in *Medical Education*, investigates the immediate effects of a newly introduced ethics course on medical students' intended responses to ethical challenges. Ranking third in terms of academic links, this article has garnered considerable attention for its timely exploration of curriculum innovation in medical ethics education. This research focuses on how a targeted, structured ethics course influences students' attitudes and proposed behaviors when facing ethical dilemmas in clinical settings. Utilizing pre- and post-course evaluations, the study measures shifts in students' ethical awareness, decision-making confidence, and their hypothetical responses to complex moral situations. The findings indicate that even a single focused course can positively affect students' ethical reasoning and their readiness to engage with moral challenges during medical training. From the standpoint of medical students' cognition and attitudes toward medical ethics, well-designed ethics instruction has been shown to foster increased sensitivity to ethical issues and promote more thoughtful, principled decision-making. However, the study also notes

variability in how different students internalize ethical concepts, suggesting that ethics education must be tailored and reinforced throughout the medical curriculum to ensure lasting impact. The article's strong academic link ranking reflects its significant role in shaping ongoing debates about the best approaches to ethics teaching in medical schools. It underscores the importance of curriculum development that not only imparts theoretical knowledge but also cultivates practical ethical competencies. Ultimately, focused educational interventions have been shown to provide foundational insights into preparing medical students to navigate the complex moral landscape of modern healthcare effectively.

5 Discussion

The bibliometric landscape of research on medical students' ethical cognition, attitudes, and education reveals a field that is thematically concentrated yet dynamically evolving. The keyword co-occurrence analysis, along with high-link and highly cited publications, underscores a core intellectual structure centered on professional identity formation, ethics education methodologies, and bioethical decision-making. The five thematic clusters generated through co-occurrence mapping illustrate both the depth and diversification of the field, ranging from early-stage moral development to broader institutional and sociopolitical engagements with ethics.

Structurally, the research coalesces into several interconnected but distinct thematic currents, each reflecting different phases and layers of ethical development. At the foundational level, moral formation is emphasized during the early years of medical education. This strand stresses the affective and cognitive capacities—empathy, moral sensitivity, and reflective judgment—as critical preconditions for ethical competence [52–54]. Research in this area has consistently argued for early ethics education, often using simulation-based, media-assisted, or interdisciplinary pedagogies to embed ethical reflexivity before students face real clinical dilemmas [34, 39]. These pedagogies respond to concerns, raised in high-impact works such as Patenaude et al. [50] and Seed Ahmed et al. [55], that delayed moral engagement may lead to ethical desensitization or detachment once students enter hierarchical clinical settings .

Progressing along the developmental trajectory, the literature reflects a growing focus on ethical identity formation, particularly within clinical and institutional contexts [34, 56]. Here, ethics is no longer perceived solely as a set of principles but as a lived, relational, and socially negotiated experience. Studies highlight the profound influence of the hidden curriculum, informal norms, and role modeling on students' ethical reasoning [57–59]. The inclusion of emerging keywords such as "moral distress," "professional identity formation," and "social media" reflects new complexities introduced by digitalization and institutional cultures [2, 42]. This dimension is further reinforced by high-link publications like Smothers et al. [60], which argue for the cultivation of moral resilience through reflective practice and community-based learning. The thematic shift from abstract knowledge to contextualized ethical embodiment signifies a broader pedagogical transition—from didactic ethics to integrative, identity-driven learning processes.

Another prominent thematic focus addresses students' engagement with bioethical dilemmas—topics that provoke normative reasoning and personal reflection. Issues such as euthanasia, abortion, confidentiality, and palliative care dominate this strand, often explored through surveys that examine how students position themselves in morally ambiguous scenarios [25–28]. These studies bridge theoretical knowledge and practical judgment, revealing the friction between curricular content and students' lived moral experiences. Sociocultural factors, religious beliefs, and exposure to conflicting professional norms significantly shape students' ethical orientations. For instance, research from Jordan, Ukrainian , and China illustrates how localized contexts influence attitudes toward end-of-life care and reproductive ethics [61, 62]. The tension between universal bioethical principles and culturally situated interpretations highlights the need for ethics curricula that are both globally informed and locally responsive.

At a more systemic level, research has expanded to examine ethics education through the lens of public health, policy, and crisis management. Studies in this area gained particular traction during and after the COVID-19 pandemic, when ethical concerns over triage, resource allocation, and governmental authority surged to the forefront [17, 18]. This represents a shift from interpersonal ethics to macro-ethical considerations, addressing questions of justice, institutional responsibility, and collective moral accountability. The inclusion of keywords such as "health policy," "medical humanities," and "curriculum evaluation" indicates a broader redefinition of ethics education that integrates structural and societal

dimensions [59, 63]. These developments reflect a growing consensus on the need for ethics curricula that are not only pedagogically rigorous but also attuned to real-world disruptions, equity challenges, and the ethical demands of public health systems [64].

A final but increasingly relevant trajectory in ethics education research concerns the cultivation of research ethics literacy and procedural integrity in biomedical contexts. Unlike clinical ethics, which often emphasizes relational judgment and professional comportment, research ethics demands a distinct set of competencies—including comprehension of consent procedures, regulatory protocols, and data governance [46, 47, 65]. Despite its foundational importance, this dimension remains insufficiently integrated into many undergraduate curricula, often treated as a peripheral or compliance-driven topic. The literature suggests that students commonly conflate biomedical professionalism with clinical practice, underestimating the unique ethical demands posed by research participation and oversight [44, 49]. This reveals a broader pedagogical blind spot: the assumption that ethical reasoning in clinical care seamlessly extends to research contexts [66]. Bridging this gap calls for rethinking ethics instruction not merely in terms of knowledge transmission, but as a means to cultivate procedural fluency, critical discernment, and anticipatory responsibility. In practical terms, embedding dedicated research ethics modules early in the preclinical curriculum—incorporating case-based discussions, simulated research scenarios, and interdisciplinary seminars—could ensure that students engage with these competencies before participating in formal research. Such integration would not only strengthen their ethical reasoning in research settings but also foster a durable culture of integrity that carries over into clinical practice. As biomedical innovation accelerates, so too does the urgency of preparing students to ethically navigate evolving research frontiers.

Taken together, the thematic structure of this research field reflects a pedagogical continuum—from foundational moral formation, through the socialization of professional identity, to systemic and institutional engagement with ethics. Each cluster not only represents a distinct focus but also complements the others, forming a multilayered approach to ethics education. Furthermore, the prominence of newer keywords such as "artificial intelligence," "hidden curriculum," and "moral distress" suggests an active reconfiguration of the field in response to technological advancements, emotional labor, and social complexity [67–69]. The evolution of publication trends—especially the post-2018 surge—corresponds with these thematic expansions, illustrating the field's responsiveness to external crises, emerging technologies, and shifting educational paradigms [69, 70].

In sum, the discourse on medical students' ethical cognition has matured into a complex, multidimensional field. Future research may benefit from more longitudinal and interventional studies to assess the lasting effects of ethics curricula, as well as from cross-cultural comparisons that explore how local values intersect with global bioethical standards. As medicine continues to evolve amid rapid technological, social, and ecological change, ethics education must remain adaptive, reflective, and globally conscious—equipping future professionals not only with moral knowledge, but with the ethical agility required for 21st-century practice.

6 Conclusion and Suggestion

This study reveals a progressively integrated landscape of research on medical students' ethical cognition, attitudes, and education. The field has evolved from imparting abstract ethical principles toward fostering a holistic formation of professional identity grounded in reflective, relational, and contextual learning. Across the literature, ethics education is portrayed not merely as a transmission of knowledge but as a dynamic process shaped by formal curricula, clinical experience, institutional culture, and emerging technologies. Ethical development begins early, with emphasis on moral sensitivity, empathy, and critical thinking—skills increasingly cultivated through innovative pedagogies such as simulation, narrative engagement, and interprofessional learning. Students' engagement with real-world ethical dilemmas—ranging from end-of-life decisions to data privacy—underscores the complexity of translating ethical ideals into practice. These challenges are compounded by systemic factors, including public health crises and shifting societal expectations, prompting a curricular turn toward justice, policy, and social accountability. At the same time, research ethics and biomedical compliance remain unevenly addressed, particularly in low-resource settings, revealing the need for more globally responsive and contextually adapted education frameworks.

In sum, medical ethics education is becoming a multidimensional endeavor that integrates personal

moral development, professional standards, and societal responsibilities. Future efforts should prioritize longitudinal evaluation, cultural inclusivity, and responsiveness to emerging ethical frontiers such as AI and digital health.

7 Limitation

This study has several limitations that warrant consideration. First, the analysis was confined to English-language publications, potentially excluding relevant studies in other languages and regional contexts. This exclusion may introduce selection bias by underrepresenting perspectives from non-Western contexts, where cultural norms, legal frameworks, and educational traditions may shape medical ethics differently. As a result, the global generalizability of the identified clusters may be constrained. Future studies could address this by incorporating multilingual databases and collaborating with international scholars to ensure a more comprehensive and culturally inclusive mapping of the field. Second, while the clustering and keyword analysis provide a structured overview of thematic trends, the dynamic evolution of terminology and overlap between themes may have led to minor classification ambiguities. Third, citation and link metrics, while useful indicators of influence, can be affected by factors such as publication age, journal policies, and citation practices, which are not fully controlled in this study. Additionally, although the study highlights emerging topics such as artificial intelligence and professional identity formation, it does not assess how these themes translate into practical educational reforms across different institutional settings. Finally, this bibliometric analysis focuses on structural patterns in the literature rather than evaluating pedagogical outcomes or ethical competencies directly, which limits conclusions about the actual effectiveness of ethics education on student behavior. These issues present directions for future, more integrative research approaches.

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Conflicts of Interest

The authors declare no conflicts of interest.

Ethical Approval and Consent to Participate

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