

Research Hotspots and Development Trends of Medical Ethics and Bioethics

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Abstract

Introduction: The objective is to examine the conceptual structure of research related to medical ethics and bioethics in the Web of Science database and to identify the sub-domains and important dimensions of these concepts.

Material and Methods: This research is conducted using bibliometric techniques and co-occurrence analysis of keywords. To identify trends in medical ethics and bioethics research (1974–2024), 10,761 documents were examined. Cluster analysis and a strategic diagram were used to depict the conceptual structure of the research.

Conclusion: Nine clusters in medical ethics and bioethics were identified: 1) Moral values, 2) Philosophy of bioethics, 3) Ethics and human dignity, 4) Medical ethics and education, 5) Bioethics and human rights, 6) Clinical ethics, 7) Ethics and bioethics committee research, 8) Research ethics, 9) Principles of bioethics in Islam. Additionally, by analyzing the content of the articles, emerging topics, subject areas, and prominent publications in medical ethics and bioethics were identified. The results will help researchers gain a comprehensive understanding of the concepts of medical ethics and bioethics and identify potential areas for future research.

Keywords: *Medical Ethics, Bioethics, Research ethics, Co-occurrence analysis, Web of Science.*

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INTRODUCTION

Medical ethics and bioethics are fundamental to the proper practice of the medical profession. Medicine, a field with profound responsibilities in safeguarding human physical and mental health, has always been held in high esteem. As a branch of applied ethics, medical ethics examines ethical issues related to medicine and healthcare. Hippocratic or traditional medical ethics have guided physicians for 2,500 years. Recently, it has been replaced by bioethics. Traditional medical ethics represent a covenant between a skilled

physician and a patient aimed at healing. Bioethics, in contrast, is a consensual civil ethics that regulates healthcare delivery and is inherently impersonal. Traditional medical ethics are deontological and virtue-based, while bioethics is a liberal utilitarian ethics emphasizing individual autonomy. Both bioethics and Principlism play roles in guiding healthcare delivery in pluralistic societies. However, traditional medical ethics-not bioethics-provides the most appropriate response to ethical dilemmas arising from the personal relationship

between a caring physician and a suffering patient [1]. Medicine and philosophy are not strangers. Traditional medical philosophy addresses metaphysical concepts such as humanity's place in the world, the relationship with divinity, health and disease, and epistemological and methodological concepts of diagnosis, classification, risk assessment, and treatment. Traditional medical ethics also involve judgments about the patient-physician relationship, the patient's best interest, and the virtues expected of a good physician [2]. The physician-patient relationship must uphold four principles: patient autonomy in decision-making, beneficence of medical actions, non-maleficence, and justice in all related contexts [3].

As science and technology advance and become more integrated into our daily lives, ethical considerations become increasingly important [4]. Ethics is the science of considering values in human behaviors [5]. Advances in medical science and modern biological research methods have created diverse ethical conflicts, causing greater attention to medical ethics [6]. Medical ethics is considered a core component of medical education [7]. Research in medical ethics has shifted significantly in recent decades, moving from philosophical-normative analyses toward empirical methodologies [8].

Rapid advancements in biotechnology and medicine have introduced unprecedented ethical challenges. Meanwhile, shifts in medical ethics research methodologies—from philosophical-normative analyses to empirical approaches—highlight the need to critique past and current trends. These changes, alongside increasingly complex ethical issues, underscore the urgency of developing new policies and guidelines to address such challenges. Analyzing the conceptual structure of medical ethics and bioethics research by identifying current trends and predicting future directions can enhance understanding of

this field and provide a framework for guiding future studies.

Co-word analysis has been applied in many domains, such as knowledge discovery [9], information literacy [10], financial literacy [11], health literacy [12], general literacy [13], pulsatile headaches [14], and Iranian higher education studies [15].

Research shows that Islamic medical ethics, emphasizing piety and human dignity, can prevent crises in medical decision-making [16]. Medical ethics in Iran have been a focus from the early Islamic centuries to the modern era [17]. Cluster analysis in medical ethics identified nine main clusters, with informed consent and ethics-oriented medical education at the core, while topics like physician-patient relationships and euthanasia are emerging or declining [18]. Communication skills, professional behavior, and professionalism training are essential needs for physicians [19]. Examining the foundations of medical ethics through the perspectives of Zakariya Razi and Qutb al-Din Shirazi revealed that ethical principles are vital for the physician-patient relationship and physicians' behavioral and professional competencies [6].

Studies in medical ethics and bioethics suggest that robust philosophical foundations can resolve conflicts between altruism and self-interest, safeguarding professional ethics from socio-political changes [20]. Inadequate training and lack of strategic planning in medical ethics education remain significant challenges globally [21]. Physicians' adherence to justice is critical in reducing patient noncompliance [5]. Ethical principles should be formally integrated into medical curricula rather than conveyed through informal interactions alone [22]. Emphasizing care as a key principle could improve contemporary medical ethics [23]. Empirical research in medical ethics requires normative analysis to strengthen the link between data and ethical principles [8]. In pharmacy, many ethical

challenges cause practical guidelines [24]. Bibliometric findings indicate that newer publications on ethics and technology rank higher in search results despite having fewer citations, revealing an inverse relationship between publication year and citation count [25]. Bibliometric analyses show growing attention to topics like clinical competency assessment in medical ethics [26]. Ethics education, particularly through practical and clinical methods, is highly effective and widely supported by students and faculty [7, 27].

MATERIAL AND METHODS

Co-word analysis reveals the patterns and trends of a specific field by measuring the association strength of representative terms in its publications. The key feature of co-word analysis is that it visualizes the intellectual structure of a discipline through conceptual space maps and creates a timeline of such maps to trace changes in this conceptual space [28]. This study employs bibliometric analysis. Data were processed using VOSviewer, UCINet, and BibExcel software. The data were extracted from the Web of Science database using the keywords "Medical ethics" and "Bioethics." The extracted data spanned 51 years

(1971–2024) and included 10,761 documents. These documents contained 16,030 author-provided keywords. After extracting the keywords, standardization, and normalization were performed. For example, singular and plural forms were unified, acronyms were expanded to whole phrases, and synonyms were merged. Following standardization, 6,750 unique keywords remained. A VOSviewer was used to map co-occurrence. First, a symmetric matrix was created in BibExcel, and the raw matrix was converted into a correlation matrix. A threshold value of 11 applies to generate an 181x181 matrix. Diagonal cells in the matrix would have zero. For clustering, the k-means method in VOSviewer was employed to create the co-occurrence map.

DISCUSSION

The results of the data analysis related to medical ethics and bioethics reveal that 10,761 documents containing the keywords "medical ethics" and "bioethics" in their titles were published between 1974 and 2024.

Publication Trends in Medical Ethics (1974–2024)

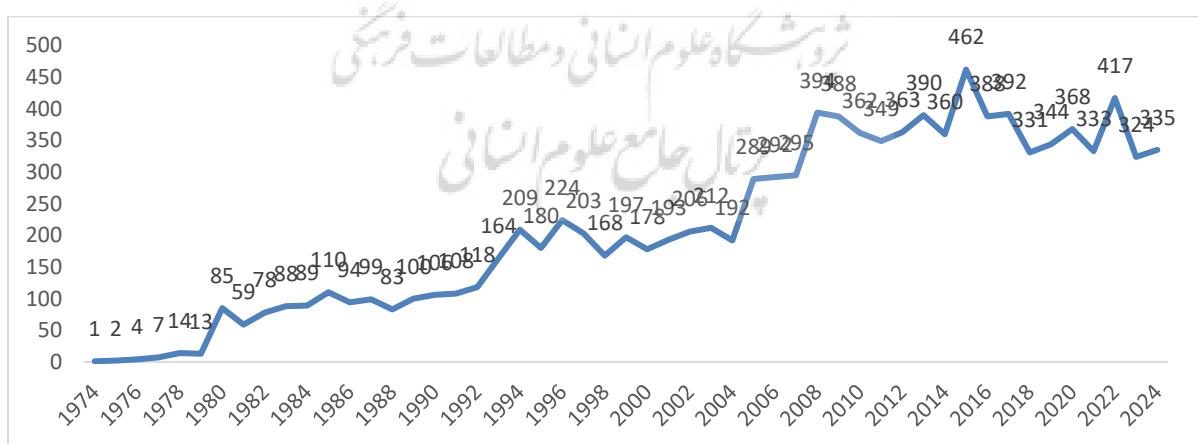


Figure 1. Publication trends (1974–2024)

As shown in Figure 1, medical ethics publications have followed a mild growth trend over the years. The highest number of publications was recorded

in 2015, with 462 documents. However, in recent years, the growth rate has declined gradually.

The frequency distribution based on the co-occurrence.

Table 1. Top 20 most frequent concepts in medical ethics and bioethics

No.	Concept	Frequency	No.	Concept	Frequency
1	Bioethics	1279	11	Euthanasia	60
2	Ethics	466	12	Public Health	59
3	Medical ethics	385	13	Clinical ethics	54
4	Autonomy	122	14	Justice	53
5	Medical education	118	15	Medicare	51
6	Human Rights	105	16	Abortion	50
7	Education	98	17	Human dignity	48
8	informed consent	78	18	Decision making	48
9	Research ethics	73	19	Global bioethics	48
10	COVID-19	67	20	Research	46

Table 1 displays concepts with a frequency of 46 or higher. The top three concepts are Bioethics (frequency = 1,279), Ethics (frequency = 466), and Medical Ethics (frequency = 385). The keyword Bioethics has the highest frequency (359), showing its centrality as a core concept in the medical ethics literature. Besides the high-

The frequency distribution of the most frequently used concepts during the study period is presented in Table 1.

Table 2. Top 20 co-occurring pair words in medical ethics and bioethics

No.	Co-occurrence	Frequency	No.	Co-occurrence	Frequency		
1	Bioethics	Ethics	109	11	Bioethics	Medical education	30
2	Bioethics	Human Rights	61	12	Bioethics	Teaching	27
3	Bioethics	Medical ethics	59	13	Bioethics	informed consent	26
4	Autonomy	Bioethics	56	14	Ethics	Medical education	26
5	Bioethics	Education	41	15	Bioethics	Biotechnology	25
6	Medical education	Medical ethics	41	16	Bioethics	Vulnerability	24
7	Education	Ethics	37	17	Bioethics	Dignity	23
8	Bioethics	Public Health	35	18	Bioethics	Medicare	23
9	Bioethics	Justice	31	19	Bioethics	Religion	22
10	Bioethics	COVID-19	30	20	Bioethics	Human dignity	22

Table 2 shows that the co-occurring pairs Bioethics–Ethics, Bioethics–Human Rights, and Bioethics–Medical Ethics have the highest co-occurrence in this timeframe. Overall, it can be concluded that bioethics is frequently combined with other concepts in the literature.

frequency concepts mentioned above, Table 2 presents the top 20 co-occurring keyword pairs in the studied timeframe.

Table 2 shows the concepts with the highest co-occurrence. These concepts appeared simultaneously in two documents.

Cluster analysis of concepts

The cluster analysis module in the VOSviewer was used to determine the number of clusters. The results are illustrated in Figure 2 and summarized in Table 3. As shown in the figure, the concepts in medical ethics and bioethics over

the studied timeframe are organized into nine clusters.

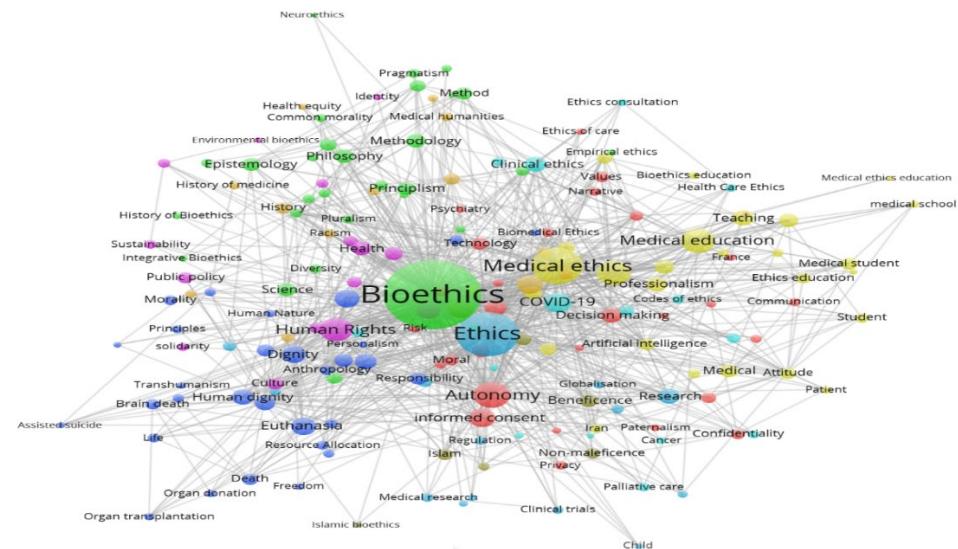


Figure 2. Co-word map of documents in medical ethics and bioethics

Table 3. Cluster distribution of medical ethics and bioethics concepts

Cluster Number	Cluster Name	Main Concepts	Weight	Cluster Number	Cluster Name	Main Concepts	Weight
1	Moral values	Autonomy	514	2	Philosophy of bioethics	Bioethics	3732
		informed consent	280			Philosophy	156
		Vulnerability	196			Methodology	150
		Decision making	178			Principlism	134
		Technology	112			Epistemology	128
		Values	96			Interdisciplinarity	126
		Moral	88			Method	114
		Consent	84			Empirical bioethics	98
		Confidentiality	80			Philosophy of medicine	76
		Virtue ethics	68			Hermeneutics	72
		Biomedical Ethics	64			Applied Ethics	68
		Privacy	60			Deliberation	68
		Communication	54			Pragmatism	68
		Advance directive	52			Pluralism	52
		Ethical dilemma	50			Social science	44
		Paternalism	48			theory	42
		Trust	44			Empirical ethics	34
		Social responsibility	40			History of Bioethics	32
		Ethics of care	34			Integrative Bioethics	32
		Feminist bioethics	24			Neuroethics	20
3	Ethics and human dignity	Euthanasia	250	4	Medical ethics and education	Medical ethics	1026
		Public Health	242			Education	460
		Dignity	236			Medical education	448
		Human dignity	184			Teaching	192
		Biotechnology	180			Professionalism	168
		Abortion	172			Curriculum	158
		Religion	130			Professional ethics	144
		Responsibility	120			Medical	136
		Biopolitics	118			Health care	134
		Death	104			Medical student	116
		Brain death	94			Ethics committee	112
		Virtue	78			Artificial intelligence	108

		Morality	76			Qualitative research	104
		Anthropology	72			Ethics education	88
		Biolaw	62			Student	82
		Christian bioethics	58			Nursing	64
		Principles	58			Empathy	54
		Personhood	54			Ethical principles	50
		Organ donation	48			medical school	44
		Human Nature	46			Bioethics education	42
		Ethical theory	44			Medical ethics education	20
5	Bioethics and human rights	Human Rights	444	6	Clinical ethics	COVID-19	296
		Medicare	222			Clinical ethics	186
		Health	144			Doctor-patient relationship	92
		Global bioethics	130			Public health ethics	74
		Culture	100			Pandemic	72
		Public policy	98			Codes of ethics	68
		UNESCO	96			Humanity	68
		Equity	94			Palliative care	62
		Social justice	88			Pediatrics	56
		Environmental Ethics	66			Health Care Ethics	54
		Cultural diversity	60			Ethics consultation	44
		solidarity	54			Cancer	42
		Environmental bioethics	30			Biomedical research	38
		Ethics	1506			Research ethics	282
		Research	186			Disability	110
7	Ethics and bioethics committee research	Genetics	86			History	104
		Research ethics committee	66			Conflict of interest	90
		Medical research	60			Human Experimentation	74
		Clinical trials	56			Discrimination	66
		politics	56			Racism	66
		Regulation	54			Medical humanities	60
		Globalisation	52			Eugenics	58
		Competence	46			History of medicine	50
		Bioethics committee	32			Narrative Ethics	46
		Cloning	32			Health equity	38
Cluster Number	Cluster Name	Main Concepts	Weight				
9	Principles of bioethics in Islam	Justice	298				
		Beneficence	132				
		Quality of life	112				
		Islam	100				
		Non-maleficence	96				
		Bioethical Principles	52				
		Islamic bioethics	28				

The clustering was performed using the K-means algorithm in the VOSviewer software. As illustrated in Figure 1 and Table 3, the clusters were assigned the following themes and their respective weights: Cluster 1: Moral value, Cluster 2: Philosophy of bioethics, Cluster 3: Ethics and human dignity, Cluster 4: Medical ethics and education, Cluster 5: Bioethics and human rights, Cluster 6: Clinical ethics, Cluster 7: Ethics and bioethics committee research, Cluster

8: Research ethics, Cluster 9: Principles of bioethics in Islam.

The conceptual structure of medical ethics and bioethics using a strategic diagram

After constructing the matrix for each cluster and importing it into the UCINET software, the clusters' centrality and density scores were determined, and a strategic diagram was plotted. Notably, the origin of the diagram was set based on the clusters' mean centrality and density values, adjusted to 15.81 and 0.936, respectively.

The cluster density and centrality scores are presented in Table 4.

Table 4: density and centrality of clusters

Cluster	Cluster name	Centrality	Density
1	Moral values	12.323	0.411
2	Philosophy of bioethics	29.533	1.018
3	Ethics and human dignity	14.8	0.51
4	Medical ethics and education	32.148	1.236
5	Bioethics and human rights	12.533	0.895
6	Clinical ethics	7.2	0.514
7	Ethics and bioethics committee research	12.714	0.978
8	Research ethics	8.5	0.773
9	Principles of bioethics in Islam	12.571	2.095

Cluster 4, with a centrality score of 32.148, holds the highest centrality, while Cluster 9, with a density score of 2.095, exhibits the highest density. This shows strong interconnections within the co-occurrence networks of these two clusters. Cluster 4 demonstrates the most significant influence and connectivity with other topics in the network, while Cluster 9 shows the highest internal linkage strength among all clusters.

The strategic diagram describes the internal relationships and correlations between thematic clusters. Typically, the horizontal axis represents centrality (the cluster's interconnectedness with other clusters). The vertical axis represents density (the internal cohesion or strength of linkages within the cluster [29]. As Melcer et al.

explain, the strategic diagram is a visual tool to assess the maturity and coherence of thematic clusters within a research domain [30].

As shown in Figure 3, the strategic diagram is divided into four quadrants: Quadrant 1: Clusters here are well-developed and cohesive and occupy a central position in the research domain. These clusters represent major, well-established themes. Quadrant 2: Clusters remain cohesive but are less central, representing specialized or niche sub-themes within the domain. Quadrant 3: Clusters in this quadrant are declining; they may represent emerging or transient themes that lack stability. Quadrant 4: Clusters here are immature but hold the potential to evolve into central themes as the field develops [30, 31].

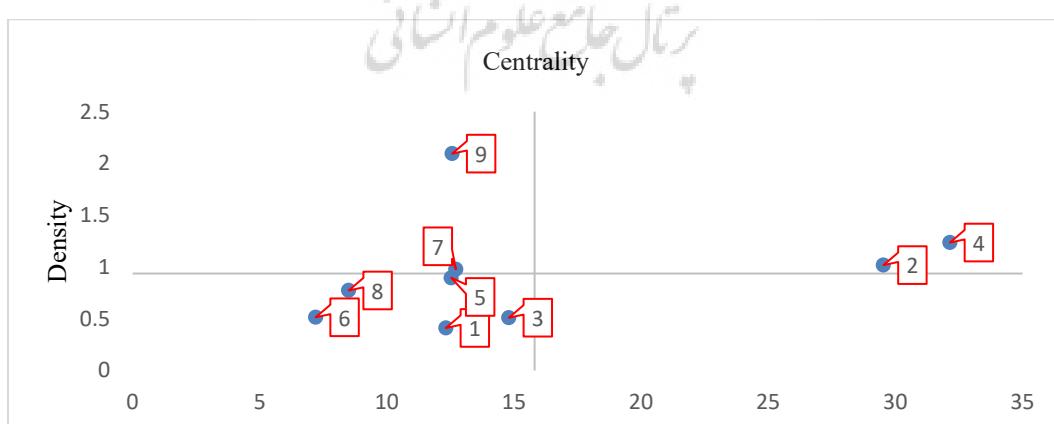


Figure 3: Strategic diagram of the medical ethics and bioethics

According to the strategic diagram, Quadrant 1 includes the Philosophy of Bioethics (Cluster 2) and Medical Ethics and Education (Cluster 4), which are the dominant themes of this period. These clusters are cohesive and central to the research domain, representing major themes that cover a significant portion of the network. Quadrant 2 contains the Ethics and bioethics committee research (Cluster 7) and Principles of Bioethics in Islam (Cluster 9). While these clusters remain cohesive, they hold lower centrality and influence than those in Quadrant 1, representing smaller, specialized sub-themes within the domain. Quadrant 3 includes five clusters in the medical ethics domain: Moral Values (Cluster 1), Ethics and Human Dignity (Cluster 3), Bioethics and Human Rights (Cluster 5), Clinical Ethics (Cluster 6), and Research Ethics (Cluster 8). These clusters represent emergent or transient themes gaining traction or declining relevance. Quadrant 4 is reserved for clusters with immature but high-potential themes that could evolve into core areas. In this study, no clusters were positioned in Quadrant 4.

CONCLUSION

The first quadrant of the strategic diagram represents clusters with high cohesion and significant centrality in the research domain. In medical ethics and bioethics, the clusters Bioethics Philosophy [2] and Medical Ethics and Education [4] are identified as core topics during this period. These clusters dominate much of the network because of their broad impact and coverage of key concepts. The Bioethics Philosophy cluster emphasizes foundational concepts and interdisciplinary approaches, focusing on themes such as philosophy, methodology, and principlism to explore bioethics' theoretical foundations and guiding principles. Its emphasis on interdisciplinarity and integrating theory and practice has

established it as a central and influential topic in bioethics. The Medical Ethics and Education cluster highlights key concepts related to ethics education in medicine, addressing the role of education in fostering professionalism and ethical principles. Core themes in this cluster include medical ethics, pedagogy, and medical education, focusing on curriculum design and teaching methods to promote ethical principles among medical students.

Ethics and bioethics committee research [7] and Principles of Bioethics in Islam [9] fall into the second quadrant of the strategic diagram. Despite their high internal coherence and connectivity, these clusters have lower centrality within the research domain and represent smaller, specialized segments of the research network. The Ethics and bioethics committee research cluster focuses on ethical oversight and guidance in biomedical research, emphasizing the critical role of ethics committees. This cluster is vital in ensuring accountability in biomedical research by strengthening regulatory and ethical infrastructures. Meanwhile, the Principles of Bioethics in Islam cluster examines Islamic perspectives on bioethical frameworks, highlighting key ethical principles such as justice ('adl), benevolence (ihsān), and avoidance of harm (dar'-Masada). This cluster serves as a platform for advancing interdisciplinary knowledge in Islamic bioethics.

The third quadrant of the strategic diagram includes clusters such as Moral Values [1], Ethics and Human Dignity [3], Bioethics and Human Rights [5], Clinical Ethics [6], and Research Ethics [8]. These clusters represent emerging or declining areas of the network, currently exhibiting lower cohesion and centrality in research. The Moral Values [1] cluster focuses on foundational and applied concepts in bioethics, exploring ethical principles that influence medical and biological decision-making. It seeks

to create frameworks that balance patient and societal rights and needs. The Ethics and Human Dignity [3] cluster addresses the preservation of human dignity amid ethical challenges in biomedicine.

In contrast, the Bioethics and Human Rights [5] cluster emphasizes the link between bioethical principles and human rights, advocating for individual and social rights in medical contexts. The Clinical Ethics [6] cluster centers on ethical issues in clinical practice and physician-patient interactions, accentuating patient rights and dignity in treatment. Last, the Research Ethics [8] cluster analyzes ethical issues in biomedical research, prioritizing adherence to ethical principles in study design and execution to safeguard human dignity.

The fourth quadrant of the strategic diagram represents clusters with the potential to become central research themes. In this study, the absence of clusters in the fourth quadrant suggests that medical and bioethics research during this period has focused on established or evolving topics, with no significant identification of novel or emerging themes. This may reflect a research emphasis on expanding existing topics or a lack of significant new trends in the field.

Researchers and policymakers in medical and bioethics are encouraged to direct their attention toward the emerging clusters identified in this study-Moral Values, Ethics and Human Dignity, Bioethics and Human Rights, Clinical Ethics, and Research Ethics. Prioritizing these areas could foster innovation and address gaps in current ethical frameworks and practices.

Given the high centrality of the "Philosophy of Bioethics" cluster, future research should investigate ethical challenges posed by emerging technologies (e.g., artificial intelligence, gene editing, personalized medicine) through an interdisciplinary lens integrating philosophy, law, and empirical sciences. These studies could design ethical frameworks for the responsible use

of such technologies and analyze their impact on concepts like "human dignity" and "biogenetic justice" to reinforce this cluster's position as the field's core.

Comparative studies between ethics committee standards in Islamic countries and global benchmarks are critical considering the positioning of the "Research Ethics Committees" and "Principles of Bioethics in Islam" clusters. Such research could identify regulatory strengths and weaknesses and propose strategies to harmonize Islamic principles (justice, benevolence) with international standards. This would enhance the clusters' coherence and potential to evolve into key themes.

Given the placement of the "Clinical Ethics" and "Research Ethics" clusters in Quadrant III, research should focus on ethical dilemmas in crises (e.g., pandemics) or advanced technologies (e.g., artificial organ transplants). Examining conflicts between "individual rights" and "collective interests" in allocating scarce medical resources could redefine clinical ethics principles. Strengthening internal and external linkages would prevent these clusters' decline and foster their potential advancement.

ETHICAL CONSIDERATIONS

The writers have fully considered ethical issues (such as plagiarism, conscious satisfaction, misleading, making or forging data, publishing or sending to two places, redundancy, etc.)

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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