

ETHICAL INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI) IN THE USE OF HERBAL MEDICINE: THE CASE OF A CHINESE NURSING VOCATIONAL COLLEGE

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Abstract

Introduction: Artificial Intelligence (AI) is increasingly transforming healthcare education and clinical practice, offering new possibilities for efficiency, accuracy, and innovation. In the context of herbal medicine and Traditional Chinese Medicine (TCM), AI integration presents unique ethical challenges related to cultural integrity, data privacy, accountability, and human-centered care.

Methods: This study employed a mixed-method embedded design involving teacher-doctors and nursing students from a Chinese nursing vocational college. Quantitative data were collected through a structured questionnaire assessing six ethical integration domains, while qualitative insights were obtained through semi-structured interviews. Descriptive statistical analysis and thematic analysis were used to interpret the data.

Results: Findings revealed moderate to high acceptance of AI-driven innovation and efficiency in herbal medicine education and practice. However, lower levels of agreement were observed in ethical governance, data privacy, and modernized pedagogy. Qualitative findings highlighted concerns regarding over-reliance on AI, unclear accountability, and potential dilution of traditional TCM principles.

Conclusion: While AI offers substantial benefits for advancing herbal medicine education, ethical integration remains insufficiently developed. Strengthening institutional policies, data governance frameworks, ethical training, and culturally sensitive implementation strategies is essential to ensure responsible and sustainable AI adoption.

Keywords: Artificial Intelligence (AI), Ethical Integration, Herbal Medicine, Traditional Chinese Medicine (TCM), Nursing Vocational Education.

Introduction

Artificial Intelligence (AI) has emerged as a transformative force in global healthcare, reshaping clinical decision-making, medical education, and health information systems. AI-driven technologies - such as machine learning, predictive analytics, and decision-support systems - have demonstrated significant potential to enhance diagnostic accuracy, optimize workflows, and improve patient outcomes (World Health Organization [WHO], 2021; Mu & Xu, 2025). As a result, healthcare education institutions are increasingly incorporating AI into curricula to prepare future practitioners for technologically augmented practice environments.

Despite these advancements, the rapid adoption of AI has raised critical ethical concerns, particularly related to data privacy, algorithmic bias, transparency, accountability, and the preservation of human-centered care (Xu et al., 2025). These concerns are amplified in traditional and complementary medicine systems, where knowledge is deeply rooted in cultural philosophy, experiential learning, and practitioner intuition rather than purely standardized biomedical metrics. Traditional Chinese Medicine (TCM) and herbal medicine represent holistic healthcare systems emphasizing balance, individualized diagnosis, and long-established theoretical frameworks. Integrating AI into these systems challenges conventional ethical paradigms, as algorithmic standardization may conflict with the contextual and interpretive nature of TCM practice (Hou et al., 2025). Scholars have cautioned that without culturally sensitive ethical frameworks, the integration of AI risks marginalizing traditional knowledge and undermining practitioner autonomy (Lu et al., 2025).

In China, nursing vocational colleges play a critical role in safeguarding TCM heritage while simultaneously responding to national and global calls for digital innovation in healthcare education. These institutions are positioned at the intersection of tradition and technology, making them ideal settings for examining ethical AI integration. Understanding stakeholder perceptions within these institutions is essential for developing responsible

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policies that balance innovation with ethical stewardship (WHO, 2021).

This study therefore aims to examine the ethical integration of AI in the use of herbal medicine within a Chinese nursing vocational college. Specifically, it seeks to assess perceptions related to innovation, efficiency, pedagogy, ethical practices, and data privacy, thereby contributing empirical evidence to inform ethically grounded AI adoption in traditional healthcare education.

Methods

Research Design

This study employed a mixed-method embedded research design, wherein quantitative data served as the primary method and qualitative data provided supportive contextual insights. This design enabled a comprehensive examination of ethical integration by combining measurable trends with lived experiences and perceptions.

Participants

Participants included teacher-doctors and nursing students from a Chinese nursing vocational college specializing in Traditional Chinese Medicine and herbal studies. A total of 300 respondents participated in the quantitative phase, while 20 participants (10 teacher-doctors and 10 students) were purposively selected for semi-structured interviews.

Instruments

A researcher-developed survey questionnaire was utilized to assess perceptions of ethical AI integration across six domains: modernized pedagogy, bridging gaps between tradition and technology, efficiency and support, innovation, ethical practices, and data privacy and security. Responses were measured using a four-point Likert scale. Semi-structured interview guides were developed to explore ethical concerns, institutional readiness, and perceived risks and benefits of AI adoption.

Data Collection

Survey questionnaires were distributed electronically, while interviews were conducted through guided discussions. Participation was voluntary, and informed consent was obtained from all respondents.

Data Analysis

Quantitative data were analyzed using descriptive statistics, including means and standard deviations. Qualitative data were thematically analyzed to identify recurring ethical concerns and contextualize survey findings.

Ethical Considerations

The study adhered to ethical research standards, ensuring confidentiality, anonymity, and voluntary participation. No personal identifiers were collected, and all data were securely stored and used solely for academic purposes.

Result

The quantitative results demonstrate a generally positive but cautious perception toward the ethical integration of Artificial Intelligence (AI) in the use of herbal medicine within a Chinese nursing vocational college. Across all measured domains - modernized pedagogy, bridging gaps between traditional and modern medicine, efficiency and support, innovation, ethical practices, and data privacy and security - respondents exhibited varying degrees of agreement, indicating uneven readiness for ethical AI adoption.

Consistent with previous studies highlighting the uneven pace of ethical preparedness in AI-driven healthcare systems (Creswell & Plano Clark, 2007; Hou et al., 2025), respondents showed the strongest agreement in the domain of innovation. Teacher-doctors and nursing students acknowledged AI's potential to enhance quality control, drug-herb interaction analysis, efficacy modeling, and research acceleration. This finding aligns with Lu et al. (2025), who emphasize AI's growing role in supporting traditional medicine through computational validation and safety monitoring.

Innovation and Efficiency

High mean scores in innovation and efficiency-related indicators suggest that respondents view AI as a valuable support tool for improving diagnostic accuracy and standardizing herbal medicine practices. Participants strongly agreed that AI-assisted systems can improve accuracy while respecting the inherent limitations of combining algorithmic analysis with traditional clinical judgment. This supports prior literature indicating that AI, when used as an assistive technology, can enhance but not replace practitioner expertise (Xu et al., 2025).

However, despite high confidence in technical benefits, qualitative feedback revealed concerns about over-reliance on AI, echoing ethical warnings raised by the World Health Organization (2021) regarding automation bias in healthcare. Respondents emphasized that AI should function as a decision-support mechanism rather than an autonomous authority.

Modernized Pedagogy and Bridging Gaps

In contrast, modernized pedagogy yielded lower agreement scores, suggesting uncertainty about how

AI can be ethically integrated into teaching and learning without compromising the philosophical foundations of Traditional Chinese Medicine (TCM). While respondents recognized AI's ability to bridge gaps between ancient practices and modern scientific validation, they expressed reservations about pedagogical over-standardization. This finding resonates with Hou et al. (2025), who caution that excessive technologization may dilute holistic and experiential learning central to TCM education.

Ethical Practices and Data Privacy

The weakest domain across both respondent groups was data privacy and security. Many participants reported only slight agreement regarding the adequacy of current safeguards protecting sensitive patient and student data. This concern mirrors broader global challenges in health information management, where rapid AI adoption often outpaces regulatory and ethical infrastructure (Mu & Xu, 2025).

Interview participants highlighted ambiguity around accountability when AI-informed decisions result in adverse outcomes. The absence of clear institutional guidelines on responsibility and ethical governance raises risks related to patient autonomy, informed consent, and trust - core principles emphasized in international AI ethics frameworks (WHO, 2021).

Qualitative Results

The qualitative findings were derived from semi-structured interviews conducted with ten (10) teacher-doctors and ten (10) nursing students at Shandong Weifang Nursing Vocational College. The interviews aimed to explore issues in the ethical integration of Artificial Intelligence (AI) in the use of herbal medicine, thereby providing deeper explanations and contextual meaning to the quantitative results. Thematic analysis revealed six major themes, which are discussed below.

Theme 1: AI as a Supportive Tool Rather Than a Replacement for Human Expertise

Both teacher-doctors and nursing students consistently emphasized that AI should function as a supportive or assistive tool rather than a substitute for human clinical judgment. Participants highlighted that Traditional Chinese Medicine (TCM) relies heavily on experiential knowledge, holistic diagnosis, and practitioner intuition, which cannot be fully replicated by algorithms.

Teacher-doctors expressed concern that excessive reliance on AI may weaken professional responsibility and clinical accountability. Nursing students echoed this view, stating that AI-generated recommendations should always be validated by licensed practitioners. This theme reflects a strong

preference for human oversight in AI-assisted herbal medicine practice.

Theme 2: Ethical Concerns on Data Privacy and Patient Confidentiality

Data privacy emerged as a major ethical concern across all interviews. Respondents expressed uncertainty about how patient data, diagnostic information, and herbal treatment records are collected, stored, and processed within AI systems. Several teacher-doctors raised concerns about the lack of transparency in AI algorithms and the potential for unauthorized access or misuse of sensitive health information.

Nursing students also voiced apprehension about whether they are adequately trained to handle AI-related data responsibly. Overall, participants perceived data privacy safeguards as insufficiently emphasized or inconsistently implemented, especially in educational and clinical settings involving AI.

Theme 3: Algorithmic Bias and Cultural Misrepresentation of TCM

Participants highlighted the risk of algorithmic bias, particularly when AI systems are trained using datasets that do not fully reflect the philosophical foundations and cultural context of Traditional Chinese Medicine. Teacher-doctors pointed out that TCM diagnosis is highly individualized and culturally embedded, making it difficult for AI to interpret without oversimplification.

Some respondents noted that AI tends to favor biomedical logic and quantifiable indicators, which may marginalize holistic TCM principles such as yin-yang balance, qi flow, and pattern differentiation. This concern suggests that AI systems may unintentionally distort or misrepresent traditional herbal practices.

Theme 4: Inadequate Ethical Guidelines and Regulatory Frameworks

Another dominant theme was the absence of clear, institution-specific ethical guidelines governing the use of AI in herbal medicine education and practice. Teacher-doctors expressed that while general AI ethics principles exist, they are often too broad and not tailored to TCM contexts.

Respondents stressed the need for formal policies that clearly define accountability, practitioner responsibility, and limits of AI decision-making. Nursing students added that clearer guidelines would help them feel more confident and ethically grounded when using AI tools in learning and clinical simulations.

Theme 5: Gaps in Training and Ethical Preparedness

Both groups acknowledged that while AI tools are increasingly present, ethical training related to AI use remains limited. Teacher-doctors expressed the need for continuous professional development programs focusing on ethical AI integration, while students indicated that ethical discussions are often theoretical and not sufficiently applied in real-world scenarios.

Participants suggested that ethics education should be embedded in both the curriculum and clinical training, emphasizing informed consent, patient autonomy, data protection, and responsible AI usage.

Theme 6: Opportunities for Innovation with Ethical Safeguards

Despite the concerns raised, respondents also recognized AI's potential to enhance innovation in herbal medicine - particularly in quality control, herb - drug interaction analysis, research efficiency, and personalized treatment planning. However, participants stressed that such innovation must be guided by strong ethical safeguards, transparency, and continuous human supervision.

This theme reflects a balanced perspective: AI is viewed as beneficial when ethically integrated, culturally sensitive, and properly regulated.

Synthesis of Quantitative and Qualitative Results

The integration of quantitative and qualitative findings reveals a convergent and complementary relationship between the two data sets, strengthening the overall conclusions of the study.

Quantitatively, respondents moderately agreed with the ethical integration of AI in the use of herbal medicine (overall mean = 2.91), with innovation receiving the highest rating, while modernized pedagogy and data privacy and security obtained lower mean scores. These numerical trends indicate cautious acceptance of AI, coupled with ethical reservations.

Qualitatively, the interview findings explain and contextualize these survey results. For instance, the high quantitative rating for innovation is supported by qualitative themes highlighting AI's usefulness in improving accuracy, quality control, and research efficiency. The lower quantitative scores on data privacy and modernized pedagogy are reinforced by qualitative concerns regarding insufficient data protection, lack of transparency, and limited ethical training. The moderate agreement on ethical practices aligns with interview findings that ethical awareness exists but is not consistently translated into practice due to weak institutional guidelines and regulatory structures.

Moreover, both data sets converge on the importance of human oversight, the risks of algorithmic bias, and the necessity of context-sensitive ethical frameworks tailored to Traditional Chinese Medicine. While quantitative data illustrates patterns of perception and awareness, qualitative data provides depth by revealing the lived experiences, concerns, and expectations of teacher-doctors and nursing students.

The synthesis demonstrates that although AI is perceived as a valuable and innovative tool in herbal medicine, its ethical integration remains partial and evolving. Strengthening ethical guidelines, enhancing data privacy measures, and improving ethics-focused education are essential to achieving responsible and sustainable AI integration in Chinese nursing vocational colleges.

Discussion

Ethical Readiness Versus Technological Readiness

The expanded findings reveal a critical disconnect between technological readiness and ethical readiness in the integration of AI within herbal medicine education and practice. While respondents demonstrated strong confidence in AI's innovative and efficiency-enhancing capabilities, ethical governance structures appear underdeveloped. This imbalance reflects a recurring pattern identified in AI ethics literature, where technical advancement outpaces ethical implementation (Creswell & Plano Clark, 2007; Xu et al., 2025).

Cultural Integrity and Human-Centered Care

One of the most significant ethical implications emerging from this study is the potential tension between AI-driven standardization and the culturally grounded, individualized nature of TCM. Traditional Chinese Medicine relies heavily on practitioner intuition, contextual interpretation, and patient-practitioner relationships. Over-automation risks marginalizing these human-centered elements, thereby undermining cultural integrity (Hou et al., 2025).

Participants' insistence on maintaining human oversight aligns with ethical principles of beneficence and non-maleficence, emphasizing that AI must remain subordinate to professional judgment. This supports WHO (2021) recommendations advocating for "human-in-the-loop" systems in healthcare AI.

Data Privacy, Accountability, and Trust

Data privacy emerged as a critical ethical vulnerability. The moderate-to-low awareness of ethical data governance suggests an urgent need for institutional policies addressing consent, data ownership, algorithmic transparency, and

cybersecurity. Mu and Xu (2025) argue that without such safeguards, AI systems risk eroding public trust - particularly in culturally sensitive medical practices.

Accountability remains another unresolved issue. Respondents expressed uncertainty regarding liability when AI recommendations conflict with human decisions. This highlights the necessity of clearly defined responsibility frameworks that delineate the roles of practitioners, institutions, and technology developers (World Health Organization, 2021).

Implications for Nursing Education and Policy

For nursing vocational colleges, these findings underscore the importance of embedding AI ethics education into curricula. Ethical literacy should encompass not only technical knowledge but also cultural competence, legal awareness, and reflective practice. Interdisciplinary collaboration among educators, ethicists, technologists, and policymakers is essential to ensure responsible AI integration.

The expanded results and discussion affirm that AI holds significant promise for enhancing herbal medicine education and practice. However, without robust ethical frameworks, culturally sensitive pedagogy, and strong data governance, its integration may compromise trust, equity, and professional accountability. Ethical integration must therefore be intentional, systematic, and aligned with the holistic values that define Traditional Chinese Medicine.

Conclusion

This study demonstrates that the ethical integration of AI in herbal medicine within a Chinese nursing vocational college is both promising and challenging. While stakeholders acknowledge AI's capacity to enhance innovation and efficiency, significant gaps remain in ethical practices, data protection, and human-centered governance. Ethical integration requires more than technological capability; it demands culturally sensitive frameworks, robust policies, interdisciplinary collaboration, and continuous education. Addressing these needs will enable nursing institutions to harness AI responsibly while preserving the philosophical foundations of herbal medicine.

Conflicts of Interest

The author declares that there is no conflict of interest in this manuscript. Results have been deduced objectively; nothing influenced this result by any individual, monetary, or institutional interests. In effect, utmost endeavors were in order to conduct a bias-free operation of gathering and analyzing the data into interpretation and producing a study based on merit, away from research inconsistencies.

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