

# Joint latent profile analysis of artificial intelligence literacy and critical thinking among clinical nurses and their association with evidence-based decision-making capacity: A cross-sectional study

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## Research Article

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# Abstract

## Background

To identify joint latent profiles of AI literacy and critical thinking among clinical nurses and to examine the differential associations of these two competencies with evidence-informed decision-making (EDM) competence across profiles.

## Methods

A multicenter cross-sectional survey was conducted from March to June 2026 among 2,306 registered nurses recruited from eight hospitals across four Chinese provinces using stratified convenience sampling. Data were collected using the AI Literacy Scale, the Clinical Nurses' Critical Thinking Assessment Scale, and the EDM Competence Scale. Latent profile analysis was used to identify joint profiles, subgroup-specific regression to examine the associations of the two competencies with EDM across profiles, and multinomial logistic regression to identify factors associated with profile membership, all adjusted for covariates.

## Results

Four profiles were identified: low literacy–low critical thinking (22.38%), low literacy–high critical thinking (35.78%), high literacy–moderate critical thinking (20.56%), and high literacy–high critical thinking (21.29%). EDM competence followed a clear gradient: high–high > high–moderate > low–high > low–low ( $P < 0.001$ ). Profile membership independently explained 29.6% of the variance in EDM ( $\Delta R^2 = 0.296$ ,  $P < 0.001$ ). Subgroup-specific regression revealed that in the high–high group, both AI literacy ( $\beta = 0.432$ ) and critical thinking ( $\beta = 0.351$ ) demonstrated strong independent effects on EDM, whereas in the high–moderate group, the effect size of AI literacy ( $\beta = 0.296$ ) was markedly attenuated. AI-specific training (OR = 1.813) and routine AI use (OR = 1.465) positively predicted high–high membership; notably, routine AI use showed the strongest predictive effect for the high–moderate profile (OR = 1.991).

## Conclusion

Clinical nurses exhibit four heterogeneous joint profiles of AI literacy and critical thinking. The high literacy–moderate critical thinking group (20.56%) represents a hidden-risk population—proficient in technical operation but deficient in critical appraisal, in whom AI use behaviors may exert a double-edged sword effect. This stratified framework can inform targeted training, competency-based job allocation, and quality control of AI-assisted decision-making.

## Introduction

Artificial intelligence (AI) has comprehensively reshaped the full spectrum of clinical nursing practice. Generative artificial intelligence (GenAI), equipped with functions including automated retrieval of evidence-based literature, standardized generation of nursing documentation, and risk stratification alerts for hospitalized patients, effectively alleviates nurses' repetitive administrative workload and delivers novel technical support for evidence-based nursing across multiple scenarios such as perioperative care, long-term chronic disease management, and dynamic monitoring of critically ill patients<sup>[1–4]</sup>. Nevertheless, constrained by inherent limitations including time-lagged training datasets, opaque algorithmic black boxes, and insufficient capacity to perceive patients' individualized clinical contexts, GenAI tends to produce outputs with factual inaccuracies, biased clinical evidence, and recommendations mismatched to patients' actual conditions<sup>[5,6]</sup>. If clinical nurses directly adopt AI-generated nursing protocols without systematic verification combined with specialized clinical experience and individual patient preferences, the risks of biased nursing decisions and in-hospital adverse events will rise substantially. Meanwhile, ethical and safety hazards such as patient privacy breaches and ambiguous accountability in human-AI collaborative decision-making will emerge, posing direct threats to patient care safety<sup>[7–9]</sup>. Against this backdrop, identifying

the core competencies enabling nurses to translate AI into clinical decision-making advantages safely and efficiently has become an urgent practical issue for the clinical implementation of intelligent nursing.

Evidence-informed decision-making (EDM), the core medium bridging evidence-based nursing theory and bedside practice, refers to nurses' integrated competence to synthesize high-quality research evidence, specialized clinical expertise, patients' value preferences, and institutional healthcare resources to develop tiered nursing plans tailored to individual patients<sup>[10,11]</sup>. Multiple studies have verified that consistent, standardized EDM competence continuously improves nursing service quality, reduces the incidence of patient complications, and optimizes long-term rehabilitation outcomes<sup>[12–14]</sup>. Although over 60% of clinical nurses have received theoretical training in evidence-based nursing, merely 7.7% can complete the entire standardized EDM workflow thoroughly and appropriately. Among all practice links, critically appraising AI-generated evidence and translating universal evidence-based guidelines into individualized clinical interventions represent the most prominent competency gaps among frontline nurses<sup>[13]</sup>. Scholars initially anticipated that GenAI could compensate for nurses' low efficiency in evidence acquisition, streamline literature searching via intelligent tools, and accelerate the popularization of evidence-based nursing on general wards<sup>[15]</sup>. However, existing clinical empirical evidence indicates that GenAI only performs standardized information aggregation; it fails to accommodate individualized patient characteristics such as age, underlying comorbidities, and family caregiving circumstances, and cannot conduct multi-layered comprehensive decision-making that balances clinical realities, ethical restrictions, and patient demands<sup>[16]</sup>. Reliance on AI tools alone cannot fundamentally improve the quality of evidence-based clinical decision-making. This implies that, amid the deep integration of AI into clinical nursing, it is necessary to explore core intrinsic determinants of bedside evidence-based care quality from the perspective of nurses' combined individual cognitive competencies.

AI literacy refers to nurses' comprehensive professional competency in clinical settings to comprehend the operational logic of AI, proactively identify inherent algorithmic limitations, objectively evaluate the clinical reliability of AI-generated outputs, and rationally deploy intelligent nursing systems within the framework of clinical ethics. It serves as a fundamental prerequisite for safe evidence-based practice in digital wards<sup>[17,18]</sup>. Cross-sectional surveys of clinical nurses across numerous countries worldwide have revealed that the overall level of AI literacy among nurses is moderately low with prominent individual heterogeneity. The identification of algorithmic risks and assessment of clinical compatibility of AI outputs represent universal weak dimensions across the workforce<sup>[19]</sup>. Existing clinical studies have confirmed that higher AI literacy can boost nurses' efficiency in evidence retrieval, reduce anxiety regarding digital tool utilization, and enhance their willingness to adopt intelligent evidence-based systems<sup>[20]</sup>. Nevertheless, AI literacy alone cannot guarantee safe, high-quality evidence-informed decision-making (EDM). GenAI inherently lacks capabilities in clinical contextual reasoning and humanistic value weighing; proficiency in operating AI tools for literature retrieval and documentation generation does not equate to nurses possessing high-order critical reasoning skills to screen out and revise erroneous AI nursing recommendations<sup>[16]</sup>. If nurses only master digital operational skills without high-level cognitive capabilities to verify AI outputs, the convenience of streamlined information access enabled by AI will instead amplify the likelihood of misapplying low-quality, clinically mismatched evidence-based data, raising risks of clinical nursing errors.

Critical thinking denotes a high-order clinical cognitive competency centered on clinical problem identification, logical reasoning, intervention reflection, and ethical deliberation. It also acts as a core cognitive barrier for nurses to screen algorithmic bias and verify the alignment between AI-generated nursing plans and patients' actual clinical conditions<sup>[21]</sup>. A wealth of evidence-based nursing studies has demonstrated that critical thinking capacity maintains a stable positive correlation with nurses' reserves of evidence-based knowledge, attitudes toward implementing evidence-based practice, and bedside evidence-based intervention behaviors, rendering it a pivotal cognitive indicator for predicting the implementation efficacy of EDM<sup>[22,23]</sup>. Under scenarios of GenAI-assisted clinical decision-making, AI systems merely produce templated, standardized evidence-based recommendations and fail to capture patients' unique clinical conditions, psychological demands, and underlying dataset biases embedded within algorithms. Nurses must rely on critical thinking to cross-validate the compatibility of AI outputs with real clinical contexts, break blind overreliance on intelligent tools, and avert nursing decision errors induced by algorithmic prejudice<sup>[24]</sup>. Recent surveys targeting registered clinical nurses further indicate that AI

literacy and critical thinking are not two entirely independent cognitive capacities; they exhibit a moderate, stable positive correlation and mutually reinforce and develop synergistically within digital clinical care environments<sup>[23,24]</sup>. However, most extant studies in this field adopt a variable-centered analytical paradigm that separately examines the independent effects of AI literacy and critical thinking on evidence-based practice, presuming that the two competencies exert uniform impacts on all nurses. Such approaches overlook the objective reality of uneven development of these two capabilities within the nursing workforce and fail to distinguish differentiated performance in EDM and clinical risk management across varied competency combinations, rendering them insufficient to guide targeted ward-based risk interventions.

Guided by Cognitive Load Theory (CLT) and Automation Bias Theory, this study constructs a theoretical explanatory model to elaborate the intrinsic cognitive mechanisms through which combined configurations of AI literacy and critical thinking shape nurses' EDM. As proposed by Sweller, human working memory has a fixed capacity constraint; extraneous, germane, and intrinsic cognitive loads generated by complex clinical tasks compete for limited cognitive resources, and the pattern of resource allocation directly determines task performance quality<sup>[25]</sup>. Translating this framework to AI-assisted evidence-based nursing, AI literacy streamlines mechanical workflows such as evidence retrieval and standardized documentation generation, alleviates extraneous cognitive loads stemming from repetitive work, and frees working memory to support in-depth clinical reasoning. Meanwhile, critical thinking optimizes germane cognitive loads by identifying AI hallucinations and correcting dataset biases, enabling multi-dimensional integration of research evidence, clinical expertise, and patient preferences. Accordingly, the quality of nurses' EDM is not determined by AI literacy or critical thinking in isolation. Distinctive patterns of cognitive resource allocation formed by varied combinations of the two capabilities produce stratified levels of EDM performance. Automation Bias Theory further elucidates latent safety risks associated with imbalanced competency subtypes: long-term frequent use of AI tools easily induces cognitive inertia, leading individuals to place unconditional trust in algorithmic outputs and voluntarily weaken independent verification and clinical critical reflection<sup>[26]</sup>. This mechanism explains why nurses with robust digital operational proficiency tend to follow AI recommendations uncritically due to insufficient activation of critical thinking, creating latent clinical hazards that conventional quality control systems struggle to detect. Collectively, Cognitive Load Theory establishes the underlying cognitive logic linking balanced or imbalanced competency configurations to EDM outcomes, while Automation Bias Theory focuses on the risk formation pathway for nurses with high AI literacy but inadequate critical thinking. The dual theories jointly provide a complete theoretical foundation for this study to categorize latent competency profiles and interpret intergroup disparities in EDM.

Most contemporary relevant research adopts a variable-centered paradigm that separately tests the independent net effects of AI literacy or critical thinking on EDM, assuming that the two competencies exert homogeneous linear effects across all nurses. This methodological orientation not only ignores the inherent uneven distribution of competency development within populations but also fails to address a clinically meaningful question: under the dual modulation of cognitive load allocation and susceptibility to automation bias, which competency configurations constitute sufficient and necessary conditions for high-performance EDM, and which configurations create a trap marked by high cognitive resource consumption yet low decision-making quality? The lack of insights into this issue has confined existing intervention strategies to crude modes of either remedying deficient skills or strengthening dominant capabilities, making precise, stratified clinical risk management unattainable. Therefore, this study intends to employ latent profile analysis to identify joint latent profiles of clinical nurses' AI literacy and critical thinking, compare intergroup disparities in EDM capacity across distinct subtypes, and verify the independent predictive effect of composite competency configurations on EDM after adjusting for confounding variables. The findings of this study aim to provide localized multi-center evidence for implementing stratified risk control of nurses' AI utilization and optimizing bedside human-AI collaborative evidence-based care workflows. Meanwhile, the results offer practical references for nursing administrators to design precise stratified on-the-job training systems that simultaneously cultivate nurses' digital operational proficiency and clinical critical thinking skills.

Based on the foregoing theoretical analyses and identified research gaps, this study proposes the following hypotheses:

H1: Heterogeneous joint latent profiles exist with respect to clinical nurses' AI literacy and critical thinking.

H2: Significant disparities in evidence-informed decision-making capacity are observed across distinct joint latent profiles.

H3: After controlling for relevant covariates, membership in joint latent profiles exerts a significant independent predictive effect on nurses' evidence-informed decision-making capacity.

## Methods

### Participants

A multicenter cross-sectional survey was conducted from March to June 2026. A stratified convenience sampling strategy was adopted. Four provinces covering distinct geographical zones and varying levels of economic and medical resource allocation were recruited, including Guangxi (Southwest China), Hunan (Central China), Zhejiang (Eastern Coastal China), and Anhui (Inland East China). One tertiary Grade A hospital and one secondary Grade A hospital were selected within each province, resulting in a total of eight participating medical institutions to mitigate systematic disparities in nurses' digital competency across hospital tiers. The inclusion criteria were as follows: (1) registered nurses with valid professional practice certificates; (2) a minimum of 1 year of clinical nursing experience; (3) voluntary participation with signed informed consent forms. The exclusion criteria included: (1) nursing students and nurses undergoing standardized residency training; (2) on-duty nurses unavailable for participation due to further education, long-term leave, or external research commitments. Sample size calculation was performed in accordance with the latent profile analysis (LPA) methodological criteria proposed by Nylund et al.<sup>[27]</sup> We comprehensively accounted for model complexity and the anticipated number of latent classes to ensure each subgroup contained no fewer than 50 participants for stable parameter estimation. Pilot data suggested that 3 to 4 latent profiles would be extracted. Accounting for an approximate 10% rate of invalid questionnaires, the minimum required sample size was set at 250. Ultimately, a total of 2,306 participants were enrolled, far exceeding the minimum sample threshold for LPA and ensuring adequate statistical power.

### Study Instruments

#### General Information Questionnaire

A structured self-designed questionnaire was used to collect demographic and occupational data. Demographic variables encompassed gender, age, marital status, and highest educational attainment. Occupational variables included years of clinical practice, professional title, hospital grade, clinical department, managerial position, specialist nurse qualification, experience of further education, receipt of special AI training, regular AI usage, research project approval, participation in evidence-based practice programs, perceived occupational stress, and family support for nursing work. Regular AI usage was defined as actively employing AI-assisted nursing tools at least once weekly for tasks such as automated medical documentation, patient risk scoring, and evidence retrieval.

#### Artificial Intelligence Literacy Scale

The Artificial Intelligence Literacy Scale developed by Wang et al. in 2023<sup>[28]</sup> was utilized to assess nurses' AI literacy. The scale consisted of 12 items distributed across four dimensions: AI awareness, AI utilization, AI evaluation, and AI ethics. Items were scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), with total scores ranging from 12 to 84. Items 2, 5, and 11 were reverse-coded, and higher total scores indicated superior AI literacy. The Cronbach's  $\alpha$  coefficient of the scale in the present sample was 0.808.

#### Chinese Version of the Clinical Nurses' Critical Thinking Assessment Scale

The Chinese version of the Clinical Nurses' Critical Thinking Assessment Scale, originally developed by Berkow et al. (2011)<sup>[29]</sup> and cross-culturally adapted and validated by Zhang et al. (2024)<sup>[30]</sup>, was adopted to measure nurses' critical thinking competency. The 16-item scale covered five dimensions: clinical problem identification, clinical decision-making, nursing

priority setting, nursing planning, and nursing plan implementation and optimization. Responses were rated on a 6-point Likert scale from 1 (completely disagree) to 6 (completely agree), with total scores ranging from 16 to 96. Higher scores represented stronger critical thinking ability. The Cronbach's  $\alpha$  of the scale in this study was 0.954.

## Chinese Version of the Nurses' Evidence-Informed Decision-Making Scale

The Chinese translation of the Nurses' Evidence-Informed Decision-Making Scale, originally developed by Belita et al. (2022)<sup>[31]</sup> and culturally revised by Wei et al. (2025)<sup>[32]</sup>, was employed to evaluate nurses' evidence-informed decision-making (EDM) competency. The scale contained 25 items grouped into three dimensions: knowledge and skills, beliefs, and behavioral practice. A 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) was applied, with total scores ranging from 25 to 175. Higher scores reflected greater proficiency in EDM. The Cronbach's  $\alpha$  coefficient of the scale in the current sample reached 0.984.

## Ethical Considerations

This research protocol obtained ethical approval from the Ethics Committee of Nanxishan Hospital of Guangxi Zhuang Autonomous Region (Approval No.: NXSYY-2026-076 (Y)). All survey procedures strictly complied with the ethical principles laid out in the 1964 Declaration of Helsinki and all subsequent amendments. The ethics committee thoroughly reviewed the written informed consent procedure, full anonymity of all participants, de-identification of questionnaire data, encrypted cloud storage of survey materials, and restricted data access exclusively for the research team. All participating nurses were informed that their involvement was entirely voluntary and they retained the right to withdraw from the survey without any penalty at any time.

## Data Collection and Quality Control

Electronic questionnaires were distributed via the Wenjuanxing online platform with coordination from the nursing departments of all collaborating hospitals. Mandatory item responses and logical validation functions were enabled to reduce missing values and illogical responses. Each internet protocol (IP) address was limited to a single submission to avoid duplicate questionnaires. Questionnaires completed in less than 180 seconds were classified as careless responses and excluded from analysis. A total of 2,482 questionnaires were distributed, among which 2,306 valid responses were retrieved, corresponding to an effective response rate of 92.9%.

## Statistical Analysis

Mplus 8.3 software was used to conduct latent profile analysis (LPA). Standardized Z-scores of the four AI literacy dimensions and five critical thinking dimensions were set as exogenous manifest indicators. Models with one to six latent profiles were sequentially fitted using the robust maximum likelihood (MLR) estimator. The optimal number of latent profiles was determined through a comprehensive set of criteria: Goodness-of-fit indices: Lower values of the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and adjusted BIC (aBIC) indicated better model fit; Classification accuracy: The Entropy value ranged from 0 to 1, with Entropy  $\geq 0.8$  suggesting satisfactory classification precision;

Likelihood ratio tests: Statistically significant Lo–Mendell–Rubin LRT and Bootstrap LRT results ( $P < 0.05$ ) indicated that the  $k$ -class model fitted the data significantly better than the  $(k - 1)$ -class model; Subgroup rationality: Each latent subgroup accounted for no less than 10% of the total sample, and each profile yielded interpretable clinical implications consistent with existing theories. SPSS 26.0 was applied for all remaining statistical analyses. Normally distributed continuous variables were presented as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ), while non-normal continuous variables were described as median (interquartile range) [ $M(P25, P75)$ ]. Categorical variables were summarized as frequency and percentage ( $n, \%$ ). Chi-square

tests were used for intergroup comparisons of categorical demographic variables. The Kruskal–Wallis H test was adopted for overall between-group comparisons of non-normally distributed total and subdimension EDM scores, followed by Bonferroni-corrected pairwise post-hoc tests to control Type I error. Multinomial logistic regression was performed with the low AI literacy & low critical thinking group (C1) designated as the reference category. All demographic and occupational covariates with  $P < 0.05$  in univariate analyses were entered into the regression model. Hierarchical linear regression was further conducted to examine the independent predictive effect of latent profile membership on EDM competency, with predictors entered hierarchically after adjusting for demographic and clinical confounding variables. The change in R-squared ( $\Delta R^2$ ) and corresponding significance values were reported for each layer of the model. All statistical tests were two-tailed, and the significance level was set at  $\alpha = 0.05$ .

## Results

# Latent Profile Analysis of AI Literacy and Critical Thinking Among Clinical Nurses

Models with 1 to 6 latent profiles were fitted sequentially. The values of AIC, BIC, and adjusted BIC continuously decreased as the number of profiles increased, and the Entropy values of models with 2 to 6 profiles all exceeded 0.8. The Lo–Mendell–Rubin LRT (LMR-LRT) and Bootstrap LRT (BLRT) tests demonstrated that each model with 1 to 4 profiles exhibited significantly better data fit than its preceding model (all  $P < 0.001$ ). When the 5-profile model was estimated, two newly extracted subgroups only accounted for 11.83% and 10.28% of the total sample, respectively. Their standardized Z-scores across all dimensions overlapped substantially, failing to display distinct clinical competency characteristics; thus this grouping scheme offered limited interpretive value for nursing administration. For the 6-profile model, the LMR-LRT test yielded  $P = 0.116$ , indicating no statistically significant improvement in model fit after adding an extra profile, which implied severe overfitting. Accordingly, the 5-class and 6-class models were eliminated. Taken together with goodness-of-fit indicators, classification accuracy, subgroup sample proportions and clinical interpretability, the 4-profile model was identified as the optimal solution. The average posterior probabilities of the four subgroups were all greater than 0.85, suggesting reliable classification performance, detailed results are presented in Table 1.

Table 1  
Fit Indices of the Latent Profile Model for Clinical Nurses' AI Literacy and Critical Thinking ( $n = 2306$ ).

| Model                                                                                                                                             | AIC       | BIC       | aBIC      | Entropy | LMR p-value | BLRT p-value | Class probability (%)              |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|---------|-------------|--------------|------------------------------------|
| 1                                                                                                                                                 | 58924.299 | 59027.678 | 58970.488 | —       | —           | —            | —                                  |
| 2                                                                                                                                                 | 52096.326 | 52257.138 | 52168.177 | 0.869   | <0.001      | <0.001       | 54.08/45.92                        |
| 3                                                                                                                                                 | 48790.317 | 49008.561 | 48887.828 | 0.935   | <0.001      | <0.001       | 23.46/53.21/23.33                  |
| 4                                                                                                                                                 | 47412.107 | 47687.784 | 47535.279 | 0.898   | <0.0001     | <0.001       | 22.38/35.78/21.29/20.56            |
| 5                                                                                                                                                 | 46600.612 | 46933.722 | 46749.445 | 0.911   | <0.0001     | <0.001       | 21.90/34.78/21.12/11.83/10.28      |
| 6                                                                                                                                                 | 46018.743 | 46409.285 | 46193.237 | 0.899   | 0.1159      | 0.001        | 11.45/13.53/32.44/20.77/9.93/11.88 |
| Based on the distribution patterns of standardized Z-scores across all dimensions (Fig. 1), the four joint latent profiles were named as follows: |           |           |           |         |             |              |                                    |

Low AI Literacy & Low Critical Thinking Group (22.38%): Scores on all dimensions of both AI literacy and critical thinking were below the sample mean. This subgroup represented a high-risk population with the greatest barriers to implementing evidence-based nursing protocols.

Low AI Literacy & High Critical Thinking Group (35.78%): Scores for critical thinking were close to or above the sample mean, while AI literacy exhibited prominent deficits, corresponding to a moderate clinical-risk subgroup.

High AI Literacy & High Critical Thinking Group (21.29%): Scores for all dimensions of the two competencies were above average, indicating balanced development and a low clinical-risk profile.

High AI Literacy & Moderate Critical Thinking Group (20.56%): Participants achieved the highest overall AI literacy scores yet only attained average levels of critical thinking, constituting a moderately high-risk clinical subgroup.

## Comparison of Demographic and Occupational Characteristics Across Latent Profiles

A total of 2,306 frontline clinical nurses were enrolled in this study, and their baseline demographic data are presented in Table 2. Univariate analyses revealed statistically significant intergroup differences in age, educational attainment, hospital tier, clinical department, specialist nurse qualification, receipt of special AI training, and regular AI usage (all  $P < 0.05$ ). No significant between-group disparities were observed in gender or family support for work ( $P > 0.05$ ).

Table 2  
Comparison of General Demographic and Occupational Data of Nurses with Distinct Latent Profiles [*n* (%)]

| Variable                                                                                                                                                                                                                                                                                                                     | Category                   | C1( <i>n</i> = 516) | C2( <i>n</i> = 825) | C3( <i>n</i> = 491) | C4( <i>n</i> = 474) | $\chi^2$ /Hstatistic | Pvalue |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------|---------------------|---------------------|---------------------|----------------------|--------|
| Gender                                                                                                                                                                                                                                                                                                                       | Male                       | 36(7.0)             | 45(5.5)             | 17(3.5)             | 24(5.1)             | 6.296                | 0.098  |
|                                                                                                                                                                                                                                                                                                                              | Female                     | 480(93.0)           | 780(94.5)           | 474(96.5)           | 450(94.9)           |                      |        |
| Age                                                                                                                                                                                                                                                                                                                          | ≤ 30 years                 | 267(51.7)           | 342(41.5)           | 151(30.8)           | 188(39.7)           | 47.361               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | 31-40years                 | 188(36.4)           | 308(37.3)           | 234(47.7)           | 191(40.2)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | >40years                   | 61(11.8)            | 175(21.2)           | 106(21.6)           | 95(20.0)            |                      |        |
| Marital status                                                                                                                                                                                                                                                                                                               | Unmarried                  | 248(48.1)           | 290(35.2)           | 125(25.5)           | 156(32.9)           | 58.603               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | Married                    | 268(51.9)           | 535(64.8)           | 366(74.5)           | 318(67.1)           |                      |        |
| Educational attainment                                                                                                                                                                                                                                                                                                       | Below bachelor's degree    | 115(22.3)           | 168(20.4)           | 78(15.9)            | 61(12.9)            | 19.100               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | Bachelor's degree or above | 401(77.7)           | 657(79.6)           | 413(84.1)           | 413(87.1)           |                      |        |
| Hospital tier                                                                                                                                                                                                                                                                                                                | Secondary hospital         | 167(32.4)           | 286(34.7)           | 125(25.5)           | 104(21.9)           | 29.455               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | Tertiary hospital          | 349(67.6)           | 539(65.3)           | 366(74.5)           | 370(78.1)           |                      |        |
| Professional title                                                                                                                                                                                                                                                                                                           | Junior title               | 317(61.4)           | 427(51.8)           | 210(42.8)           | 226(47.7)           | 42.720               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | Intermediate title         | 165(32.0)           | 320(38.8)           | 215(43.8)           | 180(38.0)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | Senior title               | 34(6.6)             | 78(9.5)             | 66(13.4)            | 68(14.3)            |                      |        |
| Working years                                                                                                                                                                                                                                                                                                                | <5years                    | 196(38.0)           | 241(29.2)           | 89(18.1)            | 121(25.5)           | 70.411               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | 5-10years                  | 126(24.4)           | 178(21.6)           | 98(20.0)            | 109(23.0)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | 11-20years                 | 153(29.7)           | 280(33.9)           | 216(44.0)           | 176(37.1)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | >20years                   | 41(7.9)             | 126(15.3)           | 88(17.9)            | 68(14.3)            |                      |        |
|                                                                                                                                                                                                                                                                                                                              | Internal medicine          | 222(43.0)           | 323(39.2)           | 201(40.9)           | 199(42.0)           | 22.711               | 0.001  |
| Clinical department                                                                                                                                                                                                                                                                                                          | Surgery                    | 149(28.9)           | 256(31.0)           | 189(38.5)           | 166(35.0)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | Other departments          | 145(28.1)           | 246(29.8)           | 101(20.6)           | 109(23.0)           |                      |        |
| Management position                                                                                                                                                                                                                                                                                                          | Non-managerial             | 486(94.2)           | 737(89.3)           | 427(87.0)           | 417(88.0)           | 16.758               | 0.001  |
|                                                                                                                                                                                                                                                                                                                              | Managerial                 | 30(5.8)             | 88(10.7)            | 64(13.0)            | 57(12.0)            |                      |        |
| Specialist nurse qualification                                                                                                                                                                                                                                                                                               | No                         | 432(83.7)           | 638(77.3)           | 368(74.9)           | 361(76.2)           | 13.659               | 0.003  |
|                                                                                                                                                                                                                                                                                                                              | Yes                        | 84(16.3)            | 187(22.7)           | 123(25.1)           | 113(23.8)           |                      |        |
|                                                                                                                                                                                                                                                                                                                              | No                         | 398(77.1)           | 612(74.2)           | 360(73.3)           | 350(73.8)           | 4.928 <sup>1</sup>   | 0.177  |
| Notes: C1 = Low AI Literacy & Low Critical Thinking Group; C2 = Low AI Literacy & High Critical Thinking Group; C3 = High AI Literacy & High Critical Thinking Group; C4 = High AI Literacy & Moderate Critical Thinking Group. $\chi^2$ denotes the chi-square test statistic; H denotes the Kruskal-Wallis test statistic. |                            |                     |                     |                     |                     |                      |        |

| Variable                      | Category | C1(n = 516) | C2(n = 825) | C3(n = 491) | C4(n = 474) | $\chi^2$ /Hstatistic | Pvalue |
|-------------------------------|----------|-------------|-------------|-------------|-------------|----------------------|--------|
| Further education experience  | Yes      | 118(22.9)   | 213(25.8)   | 131(26.7)   | 124(26.2)   |                      |        |
| Special AI training           | No       | 464(89.9)   | 706(85.6)   | 382(77.8)   | 376(79.3)   | 35.771               | 0.001  |
|                               | Yes      | 52(10.1)    | 119(14.4)   | 109(22.2)   | 98(20.7)    |                      |        |
| Regular AI usage              | No       | 384(74.4)   | 599(72.6)   | 288(58.7)   | 249(52.5)   | 82.352               | 0.001  |
|                               | Yes      | 132(25.6)   | 226(27.4)   | 203(41.3)   | 225(47.5)   |                      |        |
| Research project approval     | No       | 487(94.4)   | 751(91.0)   | 413(84.1)   | 409(86.3)   | 34.934               | 0.001  |
|                               | Yes      | 29(5.6)     | 74(9.0)     | 78(15.9)    | 65(13.7)    |                      |        |
| Participation in EBP projects | No       | 481(93.2)   | 764(92.6)   | 425(86.6)   | 405(85.4)   | 29.513               | 0.001  |
|                               | Yes      | 35(6.8)     | 61(7.4)     | 66(13.4)    | 69(14.6)    |                      |        |
| Perceived occupational stress | No       | 132(25.6)   | 245(29.7)   | 188(38.3)   | 146(30.8)   | 19.972               | 0.002  |
|                               | Yes      | 384(74.4)   | 580(70.3)   | 303(61.7)   | 328(69.2)   |                      |        |
| Family support for work       | No       | 9(1.7)      | 14(1.7)     | 2(0.4)      | 3(0.6)      | 6.812                | 0.078  |
|                               | Yes      | 507(98.3)   | 811(98.3)   | 489(99.6)   | 471(99.4)   |                      |        |

Notes: C1 = Low AI Literacy & Low Critical Thinking Group; C2 = Low AI Literacy & High Critical Thinking Group; C3 = High AI Literacy & High Critical Thinking Group; C4 = High AI Literacy & Moderate Critical Thinking Group.  $\chi^2$  denotes the chi-square test statistic; H denotes the Kruskal-Wallis test statistic.

# Multinomial Logistic Regression Analysis of Predictors for Latent Profile Membership

With the Low AI Literacy & Low Critical Thinking Group (C1) set as the reference category, multinomial logistic regression revealed that age, marital status, hospital tier, clinical department, special AI training, regular AI usage, and perceived occupational stress were independent predictors of latent profile affiliation. Detailed regression outcomes are presented in Table 3.

Table 3  
Multinomial Logistic Regression Analyses for Factors Predicting Nurses' Latent Profile Membership (*n* = 2306)

| Model         | Variable                                             | B      | SE    | Wald $\chi^2$ | P      | OR(95% CI)           |
|---------------|------------------------------------------------------|--------|-------|---------------|--------|----------------------|
| <b>C2VSC1</b> | Intercept                                            | 1.383  | 0.360 | 14.791        | <0.001 |                      |
|               | Age( $\leq$ 30years vs > 40 years)                   | -0.700 | 0.260 | 7.229         | 0.007  | 0.497(0.298 ~ 0.827) |
|               | Age (31–40 years vs > 40 years)                      | -0.661 | 0.214 | 9.513         | 0.002  | 0.516(0.339 ~ 0.786) |
|               | Marital status (unmarried vs married)                | -0.368 | 0.145 | 6.456         | 0.011  | 0.692(0.521 ~ 0.919) |
|               | Managerial position (yes vs no)                      | -0.544 | 0.236 | 5.296         | 0.021  | 0.581(0.366 ~ 0.923) |
|               | Specialist nurse qualification (yes vs no)           | 0.358  | 0.162 | 4.872         | 0.027  | 1.430(1.041 ~ 1.964) |
|               | Further education experience (yes vs no)             | 0.339  | 0.157 | 4.673         | 0.031  | 1.404(1.032 ~ 1.910) |
|               | Special AI training (yes vs no)                      | 0.391  | 0.194 | 4.047         | 0.044  | 1.478(1.010 ~ 2.163) |
| <b>C3VSC1</b> | Intercept                                            | -0.222 | 0.403 | 0.303         | 0.582  |                      |
|               | Age ( $\leq$ 30 years vs > 40 years)                 | -0.776 | 0.296 | 6.859         | 0.009  | 0.460(0.257 ~ 0.823) |
|               | Marital status (unmarried vs married)                | -0.696 | 0.173 | 16.163        | <0.001 | 0.499(0.355 ~ 0.700) |
|               | Hospital tier (tertiary vs secondary)                | 0.399  | 0.158 | 6.402         | 0.011  | 1.490(1.094 ~ 2.030) |
|               | Department (internal medicine vs other departments)  | 0.406  | 0.172 | 5.594         | 0.018  | 1.501(1.072 ~ 2.101) |
|               | Department (surgery vs other departments)            | 0.670  | 0.178 | 14.119        | <0.001 | 1.955(1.378 ~ 2.773) |
|               | Special AI training (yes vs no)                      | 0.595  | 0.204 | 8.515         | 0.004  | 1.813(1.216 ~ 2.704) |
|               | Regular AI usage (yes vs no)                         | 0.382  | 0.156 | 6.005         | 0.014  | 1.465(1.079 ~ 1.988) |
| <b>C4VSC1</b> | Perceived occupational stress (no vs yes)            | 0.701  | 0.143 | 23.993        | <0.001 | 2.015(1.523 ~ 2.668) |
|               | Intercept                                            | -0.251 | 0.411 | 0.373         | 0.541  |                      |
|               | Marital status (unmarried vs married)                | -0.523 | 0.170 | 9.470         | 0.002  | 0.593(0.425 ~ 0.827) |
|               | Education (below bachelor's vs bachelor's and above) | -0.369 | 0.188 | 3.861         | 0.049  | 0.692(0.479 ~ 0.999) |
|               | Hospital tier (tertiary vs secondary)                | 0.503  | 0.161 | 9.730         | 0.002  | 1.654(1.206 ~ 2.269) |

Notes: C1 = Low AI Literacy & Low Critical Thinking Group (reference group); C2 = Low AI Literacy & High Critical Thinking Group; C3 = High AI Literacy & High Critical Thinking Group; C4 = High AI Literacy & Moderate Critical Thinking Group. OR= odds ratio; CI= confidence interval.

| Model                                                                                                                                                                                                                                                                                      | Variable                                  | B     | SE    | Wald $\chi^2$ | P      | OR(95% CI)           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-------|-------|---------------|--------|----------------------|
|                                                                                                                                                                                                                                                                                            | Hospital tier (tertiary vs secondary)     | 0.388 | 0.177 | 4.786         | 0.029  | 1.474(1.041 ~ 2.087) |
|                                                                                                                                                                                                                                                                                            | Hospital tier (tertiary vs secondary)     | 0.689 | 0.153 | 20.295        | <0.001 | 1.991(1.476 ~ 2.687) |
|                                                                                                                                                                                                                                                                                            | Perceived occupational stress (no vs yes) | 0.380 | 0.147 | 6.726         | 0.010  | 1.463(1.097 ~ 1.949) |
| Notes: C1 = Low AI Literacy & Low Critical Thinking Group (reference group); C2 = Low AI Literacy & High Critical Thinking Group; C3 = High AI Literacy & High Critical Thinking Group; C4 = High AI Literacy & Moderate Critical Thinking Group. OR= odds ratio; CI= confidence interval. |                                           |       |       |               |        |                      |

## Comparison of Evidence-Informed Decision-Making Scores Among Different Latent Profiles

The results revealed statistically significant intergroup differences in the total evidence-informed decision-making (EDM) score as well as its three subdimensions (knowledge and skills, beliefs, behaviors) across the four latent profiles (all  $P < 0.001$ ), with significant pairwise differences remaining after Bonferroni correction. The hierarchical order of EDM scores was as follows: C3 (High AI Literacy & High Critical Thinking Group) > C4 (High AI Literacy & Moderate Critical Thinking Group) > C2 (Low AI Literacy & High Critical Thinking Group) > C1 (Low AI Literacy & Low Critical Thinking Group). This gradient indicated a positive graded association between the matching degree of AI literacy and critical thinking and nurses' EDM proficiency. Detailed data are presented in Table 4.

Table 4  
Comparison of Evidence-Informed Decision-Making Competence Scores Across Latent Profiles ( $n = 2306$ )

| Variable                                                                                                                                                                                                                                                                                                                                           | C1              | C2              | C3              | C4              | H statistic | Post-hoc pairwise comparison |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-------------|------------------------------|
| Mean total score of evidence-informed decision-making competence                                                                                                                                                                                                                                                                                   | 4.28(4.00,5.00) | 5.08(4.40,5.96) | 6.52(5.88,7.00) | 5.68(4.92,6.20) | 775.324*    | C3 > C4 > C2 > C1            |
| Knowledge and skills subdimension                                                                                                                                                                                                                                                                                                                  | 4.17(4.00,5.00) | 5.00(4.17,5.92) | 6.42(5.75,7.00) | 5.58(4.67,6.00) | 650.757*    | C3 > C4 > C2 > C1            |
| Belief subdimension                                                                                                                                                                                                                                                                                                                                | 4.50(4.00,5.00) | 5.00(4.50,6.00) | 6.75(6.00,7.00) | 6.00(5.00,6.25) | 759.233*    | C3 > C4 > C2 > C1            |
| Behavioral practice subdimension                                                                                                                                                                                                                                                                                                                   | 4.33(4.00,5.00) | 5.11(4.56,6.00) | 6.78(6.00,7.00) | 6.00(5.00,6.44) | 793.630*    | C3 > C4 > C2 > C1            |
| Notes: C1 = Low AI Literacy & Low Critical Thinking Group; C2 = Low AI Literacy & High Critical Thinking Group; C3 = High AI Literacy & High Critical Thinking Group; C4 = High AI Literacy & Moderate Critical Thinking Group. * $P < 0.001$ ; pairwise comparisons were corrected via the Bonferroni method with an adjusted $\alpha$ of 0.0083. |                 |                 |                 |                 |             |                              |

## Hierarchical Linear Regression Analysis of Factors Predicting Nurses' Evidence-Informed Decision-Making Competence

The variance inflation factor (VIF) values of all independent variables ranged from 1.08 to 2.31 (all  $< 5$ ), indicating no severe multicollinearity. The total score of evidence-informed decision-making (EDM) competence was set as the dependent variable. Model 1 only incorporated demographic and occupational covariates as control variables; Model 2 further added dummy variables representing latent profile groups (with C1 as the reference category) on the basis of Model 5. The regression results demonstrated that the control variables in Model 1 collectively explained 5.4% of the variance in EDM competence ( $F = 8.187$ ,

$P < 0.001$ ). After latent profile membership was entered into Model 2, the model explanatory power increased substantially, with  $\Delta R^2 = 0.296$  ( $\Delta F = 346.692$ ,  $P < 0.001$ ) and the total adjusted  $R^2$  reaching 0.345. After adjusting for all confounding covariates, nurses in groups C2, C3 and C4 achieved significantly higher overall EDM scores compared with those in C1 (all  $P < 0.001$ ). The standardized regression coefficient of C3 (High AI Literacy & High Critical Thinking Group) was the largest ( $\beta = 0.676$ ), followed by C4 (High AI Literacy & Moderate Critical Thinking Group,  $\beta = 0.432$ ). Full regression outputs are shown in Table 5.

Table 5  
Hierarchical Linear Regression Analysis of Predictors for Clinical Nurses' Evidence-Informed Decision-Making Competence

|                                                                                                                                                                                                                                                                                                        | Model 1  |           |         |          |          | Model 2  |           |         |          |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|---------|----------|----------|----------|-----------|---------|----------|----------|
|                                                                                                                                                                                                                                                                                                        | <i>B</i> | <i>SE</i> | $\beta$ | <i>t</i> | <i>P</i> | <i>B</i> | <i>SE</i> | $\beta$ | <i>t</i> | <i>P</i> |
| Constant                                                                                                                                                                                                                                                                                               | 171.755  | 5.607     | —       | 30.630   | <0.001   | 139.800  | 4.777     | —       | 29.267   | <0.001   |
| Control variables                                                                                                                                                                                                                                                                                      |          |           |         |          |          |          |           |         |          |          |
| Age (31–40 years)                                                                                                                                                                                                                                                                                      | 5.215    | 1.882     | 0.088   | 2.771    | 0.006    | 2.897    | 1.564     | 0.049   | 1.852    | 0.064    |
| Age (> 40 years)                                                                                                                                                                                                                                                                                       | 8.215    | 2.565     | 0.111   | 3.203    | 0.001    | 5.527    | 2.132     | 0.075   | 2.593    | 0.010    |
| Marital status (Married)                                                                                                                                                                                                                                                                               | 3.039    | 1.552     | 0.050   | 1.958    | 0.050    | -0.684   | 1.293     | -0.011  | -0.529   | 0.597    |
| Educational attainment (Bachelor's degree or above)                                                                                                                                                                                                                                                    | -0.837   | 1.631     | -0.011  | -0.513   | 0.608    | -1.699   | 1.354     | -0.023  | -1.254   | 0.210    |
| Hospital tier (Tertiary hospital)                                                                                                                                                                                                                                                                      | 0.175    | 1.398     | 0.003   | 0.125    | 0.900    | 3.036    | 1.165     | 0.048   | 2.605    | 0.009    |
| Clinical department                                                                                                                                                                                                                                                                                    | -0.801   | 0.747     | -0.022  | -1.072   | 0.284    | 0.099    | 0.621     | 0.003   | 0.160    | 0.873    |
| Management position (Yes)                                                                                                                                                                                                                                                                              | 2.398    | 2.130     | 0.025   | 1.126    | 0.260    | 3.854    | 1.769     | 0.041   | 2.179    | 0.029    |
| Specialist nurse qualification (Yes)                                                                                                                                                                                                                                                                   | 0.702    | 1.571     | 0.010   | 0.447    | 0.655    | 1.176    | 1.304     | 0.017   | 0.902    | 0.367    |
| Further education experience (Yes)                                                                                                                                                                                                                                                                     | 3.150    | 1.551     | 0.050   | 2.030    | 0.042    | 2.383    | 1.289     | 0.038   | 1.849    | 0.065    |
| Special AI training (Yes)                                                                                                                                                                                                                                                                              | 7.091    | 1.753     | 0.091   | 4.045    | <0.001   | 4.575    | 1.457     | 0.059   | 3.140    | 0.002    |
| Regular AI usage (Yes)                                                                                                                                                                                                                                                                                 | 0.811    | 1.398     | 0.013   | 0.580    | 0.562    | 2.268    | 1.170     | 0.037   | 1.938    | 0.053    |
| Research project approval (Yes)                                                                                                                                                                                                                                                                        | -4.988   | 2.158     | -0.053  | -2.311   | 0.021    | -2.626   | 1.792     | -0.028  | -1.465   | 0.143    |
| Participation in evidence-based practice projects (Yes)                                                                                                                                                                                                                                                | 10.679   | 2.086     | 0.111   | 5.120    | <0.001   | 8.953    | 1.733     | 0.093   | 5.167    | <0.001   |
| Professional title (Intermediate)                                                                                                                                                                                                                                                                      | 4.519    | 1.762     | 0.076   | 2.565    | 0.010    | 4.156    | 1.462     | 0.070   | 2.843    | 0.005    |
| Perceived occupational stress (Yes)                                                                                                                                                                                                                                                                    | 9.657    | 2.962     | 0.103   | 3.260    | 0.001    | 9.670    | 2.459     | 0.103   | 3.932    | <0.001   |
| Perceived occupational stress (Yes)                                                                                                                                                                                                                                                                    | -7.415   | 1.282     | -0.119  | -5.782   | <0.001   | -3.769   | 1.070     | -0.060  | -3.522   | <0.001   |
| Notes: The dependent variable is the total score of evidence-informed decision-making competence. Model 1: $R^2=0.054$ , adjusted $R^2=0.048$ , $F = 8.187$ , $P<0.001$ ; Model 2: $R^2=0.350$ , adjusted $R^2=0.345$ , $F = 64.759$ , $P<0.001$ $\Delta R^2=0.296$ , $\Delta F = 346.692$ , $P<0.001$ |          |           |         |          |          |          |           |         |          |          |

|                                                                                                                                                                                                                                                                                                          | Model 1  |           |         |          |          | Model 2  |           |         |          |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|---------|----------|----------|----------|-----------|---------|----------|----------|
|                                                                                                                                                                                                                                                                                                          | <i>B</i> | <i>SE</i> | $\beta$ | <i>t</i> | <i>P</i> | <i>B</i> | <i>SE</i> | $\beta$ | <i>t</i> | <i>P</i> |
| Latent profile membership                                                                                                                                                                                                                                                                                | —        | —         | —       | —        | —        |          |           |         |          |          |
| C2 Low AI Literacy & High Critical Thinking Group                                                                                                                                                                                                                                                        | —        | —         | —       | —        | —        | 18.877   | 1.328     | 0.313   | 14.214   | <0.001   |
| C3 High AI Literacy & High Critical Thinking Group                                                                                                                                                                                                                                                       | —        | —         | —       | —        | —        | 47.657   | 1.523     | 0.676   | 31.286   | <0.001   |
| C4 High AI Literacy & Moderate Critical Thinking Group                                                                                                                                                                                                                                                   | —        | —         | —       | —        | —        | 30.868   | 1.526     | 0.432   | 20.233   | <0.001   |
| Notes: The dependent variable is the total score of evidence-informed decision-making competence. Model 1: $R^2=0.054$ , adjusted $R^2=0.048$ , $F = 8.187$ , $P<0.001$ ; Model 2: $R^2=0.350$ , adjusted $R^2=0.345$ , $F = 64.759$ , $P<0.001$ ; $\Delta R^2=0.296$ , $\Delta F = 346.692$ , $P<0.001$ |          |           |         |          |          |          |           |         |          |          |

## Discussion

# Heterogeneous Profiles of AI Literacy and Critical Thinking Among Clinical Nurses

Through joint latent profile analysis, four distinct competency configurations of AI literacy and critical thinking were identified in the sample of clinical nurses: the Low AI Literacy & Low Critical Thinking Group (22.38%), Low AI Literacy & High Critical Thinking Group (35.78%), High AI Literacy & Moderate Critical Thinking Group (20.56%), and High AI Literacy & High Critical Thinking Group (21.29%). These findings validated Hypothesis H1. This result transcends the conventional analytical framework of prior studies, which only provided static descriptions of nurses' digital competency from a single dimension. It demonstrates that AI literacy and critical thinking do not develop synchronously among frontline nurses but exhibit markedly heterogeneous combinations, providing empirical evidence for the design of stratified, targeted training and intervention strategies.

Latent profile results indicated that the Low AI Literacy & Low Critical Thinking Group (22.38%) represented an overt high-risk subgroup. Nurses in this subgroup scored below the sample average across all dimensions of both competencies. They lacked proficiency in digital tools to reduce extraneous cognitive load generated by evidence retrieval, and also had insufficient critical reasoning capacity to identify AI hallucinations and dataset bias. As a result, they tended to adopt AI-generated standardized nursing plans without rigorous screening, substantially elevating the risk of clinical adverse events<sup>[33]</sup>. From the perspective of competency development, this group had not formed stable AI usage routines and retained high cognitive malleability, making them the priority population for hospital continuing education support.

The Low AI Literacy & High Critical Thinking Group (35.78%) constituted the largest proportion of participants and was categorized as a moderate overt-risk subgroup. Nurses in this subtype possessed sound logical frameworks for evaluating traditional evidence yet suffered structural deficiencies in AI operation and algorithm risk identification. They relied entirely on manual literature searching, which consumed massive working memory resources and left limited cognitive capacity for individualized clinical reasoning. This observation aligns with cross-sectional research on operating room nurses<sup>[34]</sup>. The root cause lies in the global nursing education system's overemphasis on case-based critical reasoning training, with a lack of hands-on courses focusing on the clinical validation of AI outputs, ultimately leading to an unbalanced profile featuring robust critical thinking but deficient digital competency.

The High AI Literacy & Moderate Critical Thinking Group (20.56%) represented the core finding of this study and constituted a moderately high covert-risk population easily overlooked by routine quality control (QC) systems. This subgroup achieved the highest total AI literacy score ( $73.45 \pm 0.23$ ) across all four profiles but only reached the population average in critical thinking, with prominent deficits in two core reasoning subdomains: clinical problem identification and nursing plan formulation. This reveals that advanced AI literacy cannot substitute nurses' independent critical judgment. Nurses proficient in AI tools tend to over-rely on algorithmic outputs and lose the initiative to identify clinical concerns and adjust nursing regimens autonomously, developing an AI-dependent decision-making pattern<sup>[19,23]</sup>. Accounting for 20.56% of all participants (approximately one in five nurses), this subgroup's individualized care deficits stemming from blind trust in algorithms cannot be captured by conventional QC systems centered on clinical outcomes and medical documentation. Interventions targeting this population should move beyond basic tool operation training, focusing on exercises such as comparative analysis of human versus AI decisions, counterfactual reasoning regarding AI recommendations, and debriefing of atypical clinical cases to actively stimulate clinical reflection and break automatic acceptance of AI-generated content.

The High AI Literacy & High Critical Thinking Group (21.29%) represented the optimal low-risk configuration for human-AI collaborative evidence-based nursing, with above-average scores across all subdimensions of both competencies. This cohort leveraged AI to streamline mechanical information processing and free up cognitive resources, while deploying high-order critical thinking to tailor AI-generated care plans to individual patient conditions. Nevertheless, this group obtained relatively low scores on the AI ethics dimension, revealing insufficient awareness of patient privacy protection and delineation of accountability in AI-assisted decision-making. Accordingly, training for this population should incorporate enhanced ethical awareness and clarification of responsibility boundaries alongside technical skill development.

This heterogeneous distribution illustrates that competency growth within human-AI collaborative clinical environments follows a non-linear, asymmetric trajectory rather than a synchronized linear process. Notably, no automatic conversion exists between high AI literacy and high critical thinking; improved technical proficiency may even suppress the motivation for in-depth reflection under certain circumstances. Therefore, nursing educators and administrators should no longer equate AI literacy merely with basic tool proficiency, but evaluate digital competency within a systematic framework that emphasizes coordinated development with critical thinking.

## **Occupational and Educational Predictors of Latent Profile Membership**

### **Special AI Training**

This study found that nurses who received specialized AI training exhibited significantly higher odds of belonging to the High AI Literacy & High Critical Thinking Group (OR = 1.813). The underlying mechanism is that high-quality AI training not only reduces extraneous cognitive load but also embodies the application of critical thinking within digital decision-making scenarios via simulated drills including debriefing of erroneous AI outputs and clinical compatibility verification, effectively fostering the ability to mobilize germane cognitive load. Nevertheless, most existing training programs only focus on technical operation rather than reflective practice, which explains why a large proportion of nurses remain trapped in the imbalanced High AI Literacy & Moderate Critical Thinking profile. Accordingly, AI training should be upgraded from manual-style operational tutorials to reflective practice training with embedded cognitive activation modules such as algorithm bias identification, counterfactual reasoning, and context-based clinical assessment<sup>[35]</sup>.

### **Regular AI Tool Utilization**

Regular use of AI nursing tools positively predicted membership in high-competency subgroups, with the strongest predictive effect observed for the High AI Literacy & Moderate Critical Thinking Group (OR = 1.991). This differentiated outcome indicates that routine AI application does not inherently drive synchronous development of both competencies. When nurses passively treat AI merely as an efficiency tool, it only alleviates extraneous cognitive load without triggering cognitive processes of verification and reflection over algorithm outputs. Conversely, mechanical, unreflective AI use cultivates cognitive inertia and overreliance on algorithms, which constitutes the core pathway forming the High AI Literacy & Moderate Critical Thinking subtype and aligns fully with the predictions of Automation Bias Theory. Simply encouraging frequent AI

utilization cannot guarantee sound clinical decision-making; the core intervention goal is to shift nurses from passive tool users to active critical evaluators<sup>[9]</sup>.

## Hospital Tier and Clinical Department

Nurses working in tertiary hospitals and surgical departments were more likely to develop balanced dual competencies. Tertiary hospitals provide richer AI application scenarios, more frequent opportunities for evidence-based practice, and comprehensive continuing education resources that serve as practice fields integrating AI literacy and critical thinking. Moreover, highly standardized enhanced recovery after surgery (ERAS) protocols and the early rollout of surgical AI tools enable surgical nurses to accumulate abundant experience in integrated human-AI decision-making<sup>[36,37]</sup>. In contrast, secondary hospitals, certain internal medicine wards, and auxiliary departments lack standardized carriers for evidence-based practice and adequate AI access, depriving nurses of consistent opportunities to practice both core competencies simultaneously. Nursing administrators should facilitate the dissemination of high-quality digital resources and build standardized evidence-based practice workflows across all departments to narrow competency gaps across institutional and specialty boundaries.

## Demographic Factors

Age  $\leq 30$  years acted as a negative predictor of membership in higher-competency latent profiles. Junior nurses are still in the accumulation phase of clinical proficiency, where critical thinking is transitioning from textbook theory to bedside practice, and they lack accumulated experience embedding AI into evidence-based workflows. This finding echoes previous research among nursing undergraduates by Zhu et al.<sup>[38]</sup>, which reported inferior integrated development of AI literacy and critical thinking among young nursing staff. Nursing education should integrate collaborative training of the two competencies starting at the undergraduate stage, and modular training programs tailored to junior nurses should be developed to lower learning barriers, fill competency gaps, and ease role adaptation stress.

## Associations Between Latent Profiles and Evidence-Informed Decision-Making Competence

Statistically significant intergroup differences in total evidence-informed decision-making (EDM) scores and all three subdimensions (knowledge and skills, beliefs, behaviors) were detected across the four latent profiles (all  $P < 0.001$ ). The hierarchical gradient of EDM proficiency followed the order: High AI Literacy & High Critical Thinking Group > High AI Literacy & Moderate Critical Thinking Group > Low AI Literacy & High Critical Thinking Group > Low AI Literacy & Low Critical Thinking Group. Hierarchical linear regression further quantified this association: after adjusting for all demographic and occupational confounders, latent profile membership independently explained 29.6% of the total variance in EDM ( $\Delta R^2 = 0.296$ ,  $P < 0.001$ ). This confirms that the combined configuration of AI literacy and critical thinking represents a core intrinsic factor accounting for disparities in nurses' EDM levels, and validates research Hypotheses H2 and H3.

Compared with the dual-high group, nurses in the High AI Literacy & Moderate Critical Thinking Group demonstrated significantly lower EDM performance. Although they can rapidly generate preliminary evidence-based frameworks with AI assistance, their average critical thinking capacity fails to establish independent contextual screening barriers for algorithmic outputs. This competency mismatch predisposes them to overreliance on templated AI recommendations during clinical judgment. Such covert decision biases are difficult to capture by conventional quality monitoring systems and constitute potential threats to patient safety<sup>[39]</sup>.

Nurses in the Low AI Literacy & High Critical Thinking Group also scored markedly lower on EDM than the dual-high subgroup. Despite well-established traditional evidence appraisal skills, their insufficient AI proficiency forces full manual retrieval and screening of research literature. Massive basic information processing exhausts limited working memory and reduces available cognitive resources for evidence synthesis and clinical reasoning. Mechanistically, this disadvantage arises from structural misallocation of cognitive resources: excessive mental effort is consumed on extraneous load of literature

searching, which impairs germane integration of new evidence with existing clinical knowledge—the core cognitive foundation of high-quality evidence-based decision-making<sup>[40,41]</sup>.

The Low AI Literacy & Low Critical Thinking Group exhibited the poorest EDM proficiency. This subgroup lacks both the digital skills to streamline evidence-based workflows and critical reasoning capacity to identify biases embedded within AI outputs<sup>[9]</sup>. Confronted with complex clinical scenarios, they easily fall into a vicious cycle of information overload and absent standardized decision-making, often resorting to experience-driven intuitive judgment that violates systematic evidence-based practice standards. Nevertheless, this group exhibits high intervention plasticity, as their AI usage habits remain uncrystallized; basic targeted interventions can yield substantial marginal gains. Compared with the AI-dependent moderate critical thinking subgroup, the dual-low population represents the optimal window to establish normative human-AI collaborative reasoning patterns.

Collectively, distinct latent profiles correspond to graded EDM performance, highlighting the necessity of concurrent cultivation of digital operational skills and clinical critical thinking. Formulating stratified competency promotion and ward management protocols for each profile bears crucial clinical value for elevating overall evidence-based practice, mitigating AI-associated care risks, and safeguarding patients' fundamental care rights.

## Implications for Nursing Administration

The four competency latent profiles identified in this study constitute an actionable empirical framework for precision workforce management under digital nursing transformation. Targeted recommendations for each subgroup are outlined below:

**Low AI Literacy & Low Critical Thinking Group (high-vulnerability high-risk population)** This subgroup receives top intervention priority due to high cognitive malleability and unformed AI usage habits that allow easy establishment of normative human-AI collaboration. A two-stage tiered training model is recommended: decouple basic AI operation workshops from structured clinical reasoning sessions in the initial phase to avoid working memory overload; integrate combined training of AI output interpretation and contextual patient verification after foundational skills are mastered. In workforce allocation, assignment to AI-intensive units such as intelligent monitoring wards should be deferred.

**Low AI Literacy & High Critical Thinking Group (moderate overt-risk population)** This cohort possesses mature clinical reasoning, so interventions focus on targeted AI literacy reinforcement. Scenario-based micro-practical training concentrating on high-frequency demands including AI evidence retrieval and rapid output validation is recommended<sup>[42]</sup>. A peer mentorship program pairing dual-high nurses with this subgroup can accelerate the integration of digital tools with their existing clinical cognitive schemas.

**High AI Literacy & Moderate Critical Thinking Group (covert high-risk population)** This subgroup requires priority surveillance under nursing quality control systems. Mandatory manual review mechanisms for all AI-generated nursing plans should be implemented at the ward level, with standardized checklists requiring documented individualized patient adjustments prior to adopting algorithmic advice. Regular cognitive reflection activities including clinical reasoning workshops, debriefing of conflicting patient cases, and Balint groups should be organized to guide nurses to treat AI outputs as provisional references rather than definitive clinical decisions<sup>[9,43]</sup>.

**High AI Literacy & High Critical Thinking Group (benchmark population)**

Hospital-wide mentorship, evidence-based case sharing, and interdisciplinary collaboration platforms<sup>[44]</sup> should be leveraged to systematically summarize and disseminate their exemplary human-AI collaborative decision-making experience to create a demonstration spillover effect.

In summary, nursing administrators should incorporate nurses' dual-competency profiles into standardized stratified training and staffing metrics. Differentiated digital access permissions and career development support should be allocated according

to each subgroup's characteristics to optimize the cost-effectiveness of limited educational and quality control resources through precise targeted investment.

## Limitations

Several limitations of this study should be acknowledged. First, the cross-sectional design precludes causal inference; longitudinal follow-up research will be conducted to track dynamic shifts in competency profiles and their correlations with clinical adverse events. Second, all data rely on self-reported questionnaires, which may introduce social desirability bias and common method variance. Although reverse-scored items, logical validation filters, and anonymous surveys were deployed to mitigate bias, future studies should integrate multi-source objective indicators to cross-validate the present findings. Third, AI training and AI usage were only recorded as binary categorical variables without granular measurement of training modules, usage scenarios, or daily operation duration; dedicated multi-dimensional AI behavior scales will be adopted in subsequent investigations. Fourth, over 70% of the sample consisted of tertiary hospital nurses from central and eastern China, with insufficient representation of secondary facilities and western rural medical institutions. Generalization to primary grassroots care settings requires caution, and future sampling will expand geographic and hospital-tier diversity.

## Conclusion

This study innovatively integrates latent profile analysis with Cognitive Load Theory and identifies four heterogeneous joint developmental profiles of AI literacy and critical thinking among clinical nurses. The degree of balanced development of the two competencies directly determines the quality of evidence-informed clinical decision-making. Notably, the High AI Literacy & Moderate Critical Thinking subgroup (20.56% of participants) exhibits a covert risk pattern marked by operational efficiency masking insufficient clinical reflection, whose cognitive mechanisms can be explained by Automation Bias Theory. The multicenter localized empirical evidence generated herein informs stratified continuing nursing education and human-AI collaborative safety management in digital wards. Longitudinal interventional trials are warranted to establish causal relationships between study variables, and multi-scenario objective outcome indicators should be incorporated to enrich the translational evidence base linking theory to clinical nursing practice.

## Declarations

### Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its subsequent amendments. The research protocol was reviewed and approved by the Ethics Committee of Nanxishan Hospital of Guangxi Zhuang Autonomous Region (The Second People's Hospital of Guangxi Zhuang Autonomous Region) (approval number: NXSYY-2026-076[Y]). The Ethics Committee's comprehensive review encompassed: written informed consent procedures, full participant anonymization throughout the study, de-identification of all questionnaire data, encrypted cloud-based data storage, and restricted data access to research team members only. All participants provided written informed consent prior to enrollment. All nurses were informed that participation was entirely voluntary and that they could withdraw from the survey at any time without providing a reason and without any negative consequences.

### Consent for publication

Not applicable. This manuscript contains no individual person's data in any form (including individual details, images, or videos).

## Competing interests

The authors declare that they have no competing interests.

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# Author Contribution

Qiuyuan Yi, Haiyan Luo conceived and designed the whole study, submitted ethical applications, performed statistical analyses and drafted the original manuscript. Jiefang Gao, Lin Su carried out multicenter participant recruitment, questionnaire distribution and data quality control. Qiuyuan Yi completed scale reliability and validity testing and latent profile modeling. Liping Wu interpreted statistical results, wrote the discussion section and revised the full manuscript. All authors reviewed the manuscript and read and approved the final submitted version.

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# Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to institutional data governance policies and participant privacy protection requirements, but are available from the corresponding author upon reasonable request. All data are de-identified and stored in encrypted format with access restricted to the research team. Requests for data access should be directed to the corresponding author and will be subject to institutional review and approval.

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## Figures

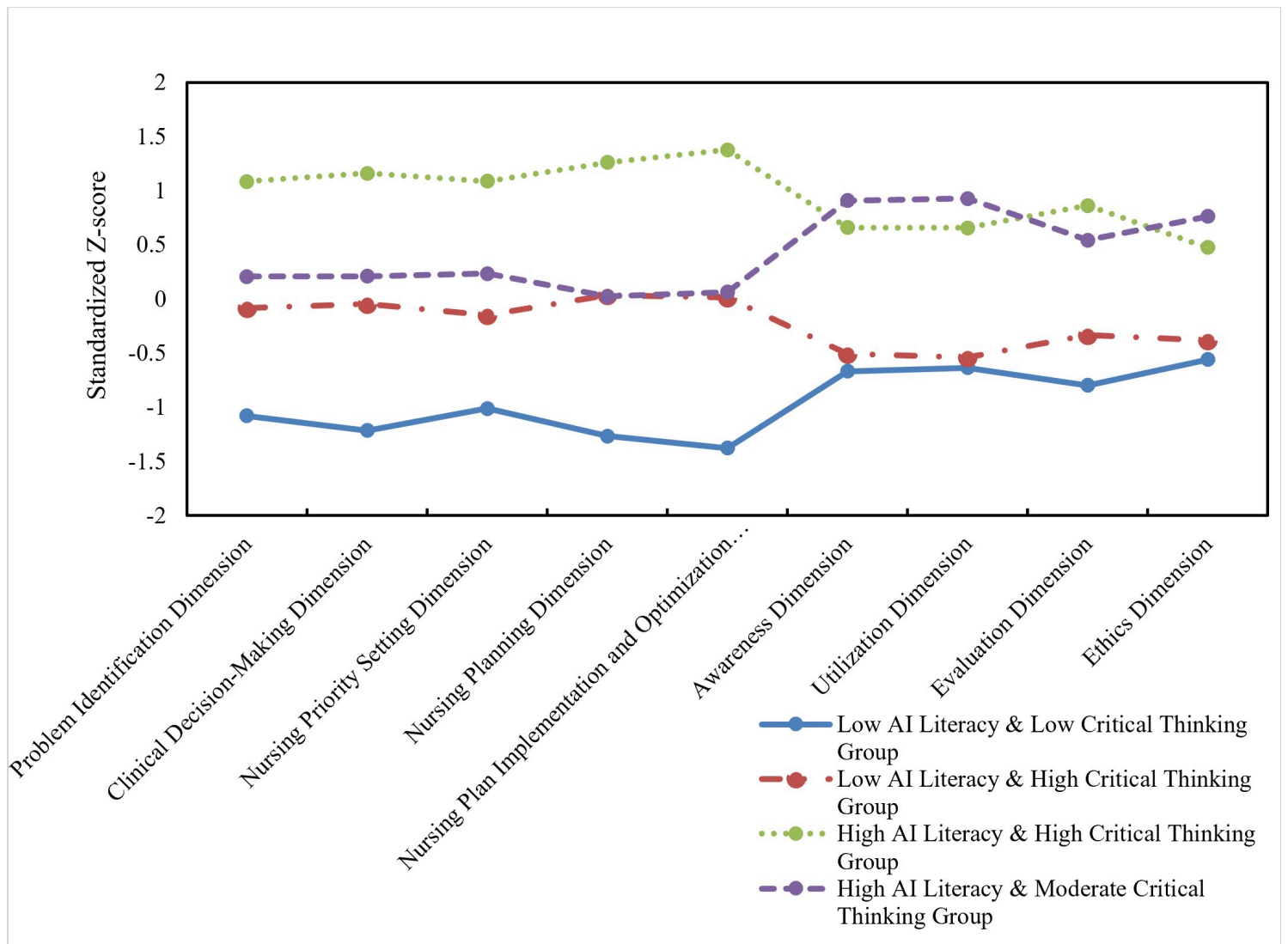


**Figure 1**

Potential Profile Characteristics of Clinical Nurses' AI Literacy and Critical Thinking