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The "Third-Year Effect" in Humanistic Competency: Latent Profile Analysis and Implications for Precision Medical Education in Residency Training

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Abstract

Background

Precision medical education advocates moving beyond aggregate population-level analyses to understand individual learner heterogeneity. Clinical educators frequently observe a paradox: trainees gain technical proficiency while experiencing affective exhaustion. However, whether clinical master's candidates exhibit distinct humanistic competency profiles, and how these profiles shift across residency training years, remains insufficiently understood.

Methods

This cross-sectional study applied Latent Profile Analysis (LPA) to 448 clinical master's candidates undergoing standardized residency training across six medical schools in a Chinese province, after excluding four extreme outliers (mean Z-score < -2.5). Seven indicators spanning cognitive, reflective, affective, and ethical domains were modeled: narrative competence; three reflective capacity tiers (habitual action, reflection, critical reflection); empathy (measured via Interpersonal Reactivity Index); professionalism; and clinical ethical cognition. Cross-tabulation and chi-square tests examined profile distribution across training cohorts.

Results

Three latent profiles emerged with perfect classification entropy (1.000): Initial Development (10.5%), Steady Development (87.1%), and Advanced Development (2.5%). Profile membership significantly associated with training seniority (χ^2=6.607, p = 0.037): Initial Development proportion more than doubled from 6.0% in junior cohort (Years 1) to 13.2% in senior cohort (Year2-3), representing a 2.2-fold risk elevation, while Steady Development contracted from 92.3% to 83.9%. Detailed three-year analysis revealed progressive erosion: 6.0% (Year 1) → 11.7% (Year 2) → 14.8% (Year 3). Dual-identity pressure (DIP)—conflict between clinical duties and academic requirements—was significantly elevated in senior trainees (M = 66.58 vs. 62.30, p = 0.011) and negatively correlated with empathy (r=-0.105, p = 0.027), suggesting resource depletion underlies third-year humanistic erosion.

Conclusions

Humanistic competency exhibits substantial heterogeneity with a significant "third-year effect" characterized by cumulative attrition rather than abrupt shock. This erosion reflects depletion-driven coping under dual-identity strain rather than moral deficiency. Medical education should adopt precision-based approaches: universal baseline training coupled with profile-tailored micro-interventions for vulnerable trainees (13.2% concentrated in Initial Development during Year 3), embedded within daily

workflows to safeguard affective engagement when DIP peaks and humanistic competence becomes a discretionary resource trainees sacrifice for survival.

1. Background

Global medical education is undergoing a fundamental paradigm shift from time-based to competency-based training, necessitating deliberate attention to humanistic qualities and professional ethics alongside clinical technical skills [1, 2]. As artificial intelligence increasingly assumes routine procedural tasks, humanistic competency—encompassing empathy, ethical reasoning, and narrative understanding—has emerged as an irreplaceable core capability for practicing physicians [3]. Nevertheless, clinical educators frequently encounter a paradox: as intensive inpatient rotations progress, trainees gain clinical dexterity, yet their affective engagement with patients often shifts from initial enthusiasm toward emotional exhaustion and detachment. This divergence raises a critical pedagogical question: how can medical education move beyond uniform baseline training to identify and address learner heterogeneity in humanistic competency development [4]?

Humanistic competency comprises multiple dimensions, including narrative competence, reflective thinking, empathy, professionalism, and ethical cognition [5, 6]. Although humanities-based curricula have demonstrated overall educational benefits [7–9], existing studies predominantly employ variable-centered approaches that evaluate population-level "average effects" [10]. Such a paradigm inherently assumes learner homogeneity, thereby obscuring critical individual variations in how competency dimensions co-occur within individuals [11–13]. Grounded in the principles of precision medical education—which advocate tailoring educational scaffolding to granular learner profiles rather than relying on uniform instruction [14–16]—person-centered methodologies such as Latent Profile Analysis (LPA) are essential for identifying distinct developmental profiles and establishing the taxonomic foundation for precision training.

Importantly, humanistic competencies do not develop in isolation; they interact dynamically with high-stress clinical training environments. International literature has extensively documented an "empathy erosion" or "third-year decline" during intensive clinical immersion [17–19]. Under China's "dual-track" residency model, trainees concurrently navigate clinical shift rotations and graduate academic requirements [20, 21]. Toward the culminating phase of residency training, senior candidates confront the compounding pressures of acute duty shifts, thesis defenses, standardized exit examinations, and career recruitment. Under sustained fatigue and cognitive overload, senior trainees often unconsciously adopt "detached concern" as a depletion-driven psychological self-defense mechanism. However, whether this humanistic vulnerability concentrates within specific developmental profiles, and whether the erosion follows an abrupt shock or cumulative attrition pattern, remains largely unexamined.

To address these gaps, this cross-sectional study employed Latent Profile Analysis (LPA) to investigate three research questions among 448 clinical master's candidates undergoing standardized residency training: (1) Do trainees exhibit distinct latent profiles of humanistic competency across seven indicators

—narrative competence, three reflective capacity tiers (habitual action, reflection, critical reflection), empathy, professionalism, and ethical cognition? (2) How are these profiles distributed across training years, and does a "third-year effect" of humanistic attrition manifest when comparing junior (Years 1–2) versus senior (Year 3) cohorts? Additionally, we examined whether dual-identity pressure (DIP)—the structural conflict between clinical duties and graduate academic requirements unique to China's dual-track model—contributes to profile differentiation and third-year vulnerability, and whether DIP correlates with empathic capacity as a marker of resource depletion. (3) Based on identified profiles and their training-year distribution, what precision educational interventions can mitigate stage-specific vulnerabilities, particularly for the subgroup concentrated in low-competency profiles during Year 3?

2. Methods

2.1 Participants and Study Design

This cross-sectional study employed a convenience sampling strategy in August 2026 across six medical universities located in a Chinese province. Within China's medical education system, clinical master's degree candidates concurrently undergo standardized residency training under a unified "dual-track" model. Accordingly, all participants simultaneously held dual identities as full-time hospital residents (navigating 33 months of clinical shift rotations) and enrolled postgraduate trainees (completing master's degree requirements). For clarity, they are hereafter referred to as "resident trainees" or "residents" categorized by training seniority: junior cohort (Years 1) and senior cohort (Year 2–3).

Inclusion criteria were as follows: (1) full-time clinical master's degree candidates; (2) active enrollment in standardized residency training; and (3) voluntary informed consent. Exclusion criteria were as follows: (1) prior completion of formal, systematic narrative medicine coursework (≥ 16 credit hours); (2) incomplete questionnaires or questionnaires exhibiting obvious patterned responses; and (3) extreme multivariate outliers (mean standardized Z-score < -2.5 across all humanistic competency indicators), which may reflect disengaged or patterned responding rather than substantive low competency.

A total of 452 questionnaires were retrieved. After excluding 4 extreme outliers, 448 valid responses were retained (effective response rate: 99.1%). The sample comprised 179 males (40.0%) and 269 females (60.0%), with a mean age of 25.3 ± 1.6 years (range: 23–33). The age range reflects variability in educational pathways, including candidates who pursued clinical training after prior work experience or graduate program delays. Distribution across training seniority: junior cohort (Years 1, n = 168, 37.5%) and senior cohort (Year2-3, n = 280, 62.5%).

Training years were dichotomized based on dual-identity pressure (DIP) escalation trajectory. Year 1 trainees undergo foundational skill acquisition under close supervision with minimal thesis demands, establishing the baseline period. Years 2–3 trainees assume heavier clinical responsibilities and cumulative DIP from thesis, board exams, and job searches. Preliminary analysis confirmed significant

DIP elevation from Year 1 (M = 62.30) to Year 2 (M = 67.18, p = 0.029), validating Years 2–3 as the high-pressure phase.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Liaoning Normal University (Approval Number: LL2026197), and all participants provided informed consent.

2.2 Instrumentation

2.2.1 Narrative Competence (NC)

Narrative competence was assessed using the Narrative Medicine Competency Scale (NM-CRS) developed by Guo and Wang [22]. This 12-item instrument covers narrative sensitivity, narrative representation, and narrative resonance. Items are scored on a 5-point Likert scale (1 = does not describe me at all, 5 = describes me very well; theoretical range: 12–60). Cronbach's α in this study was 0.96.

2.2.2 Reflective Capacity (R1, R3, R4)

Reflective capacity was measured using the Reflective Thinking Questionnaire (RTQ) developed by Kember et al. [23]. To capture the qualitative progression of reflection grounded in Mezirow's transformative learning theory [24], three subdimensions were incorporated as independent LPA indicators: Habitual Action (R1, reflecting non-reflective, automated execution; items 1–4), Reflection (R3, active examination of clinical encounters; items 9–12), and Critical Reflection (R4, deep appraisal of core professional premises; items 13–16). Each subscale comprises four items scored on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree; theoretical range per subscale: 4–20). The R2 (Understanding) tier was omitted as it indexes cognitive knowledge acquisition rather than transformative reflection. In this study, Cronbach's α coefficients for R1, R3, and R4 were 0.92, 0.94, and 0.95, respectively.

2.2.3 Empathy (IRI)

Empathy was evaluated using the Interpersonal Reactivity Index version (IRI) [25], comprising two subscales: Perspective-Taking (PT, 5 items, measuring cognitive empathy through the ability to adopt others' viewpoints; items 1–5) and Empathic Concern (EC, 6 items, measuring affective empathy through emotional responsiveness to others' distress; items 6–11). Items are scored on a 5-point Likert scale (0 = does not describe me at all, 4 = describes me very well), with three EC items (9, 10, 11) reverse-coded. Total IRI scores range from 0 to 44, with higher scores indicating stronger empathic capacity. Cronbach's α in this study was 0.89 (PT: 0.84, EC: 0.86).

2.2.4 Professionalism (PROF)

Professionalism was measured using the Chinese Medical Professionalism Scale for Resident and Master's Program (CMPS-RMP) adapted from the ACGME Core Competencies and Cruess's professionalism framework [28, 29]. The 20-item scale covers patient-centered care, professional integrity, teamwork, and lifelong learning, scored on a 5-point Likert scale (1 = does not describe me at all, 5 = describes me very well; theoretical range: 20–100). The scale-level content validity index (S-CVI/Ave) was 0.92, and Cronbach's α was 0.98.

2.2.5 Clinical Ethical Cognition (ETH)

Ethical cognition was assessed using a Clinical Ethics Situational Judgment Test (CE-SJT) operationalized from the four principles of Beauchamp and Childress (autonomy, beneficence, non-maleficence, and justice) [30]. The instrument comprises five clinical ethical scenarios, each with five response options scored on a 5-point Likert scale (1 = highly inappropriate, 5 = highly appropriate; theoretical range: 5–25). The scale-level content validity index (S-CVI/Ave) was 0.89, and Cronbach's α was 0.97.

2.3 Statistical Analysis

Descriptive statistics and reliability analyses were performed using SPSS 27.0, and Latent Profile Analysis (LPA) was conducted using Mplus 8.3. The two-tailed significance threshold was set at $\alpha = 0.05$.

2.3.1 Latent Profile Analysis (LPA)

An LPA model was estimated using seven standardized indicators (NC, R1, R3, R4, IRI, PROF, ETH) to identify latent subgroups exhibiting distinct humanistic competency configurations. Guided by Mezirow's Transformative Learning Theory [9], R1, R3, and R4 were entered as separate dimensions rather than an aggregated composite score, reflecting the view that reflection comprises qualitatively distinct phases rather than a unidimensional continuum. R1 reflects pre-reflective habitual action, R3 represents intentional clinical deliberation, and R4 captures premise transformation through critical examination of foundational assumptions. The R2 (Understanding) tier was omitted because it indexes cognitive comprehension rather than transformative reflection. Retaining R1, R3, and R4 as independent indicators enables the LPA model to differentiate habit-dominant learners (elevated R1 with constrained higher-order reflection) from transformative learners (elevated R3 and R4)—a distinction that would be obscured by composite scoring.

Model selection criteria included [31–33]: (1) lower Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values; (2) Entropy ≥ 0.80, indicating clear classification; (3) smallest profile comprising at least 5% of the sample (preferred), though substantively meaningful profiles slightly below this threshold were retained if theoretically interpretable; and (4) pedagogical utility and alignment with transformative learning principles. Models ranging from K = 1 to K = 5 were iteratively evaluated, with final model selection balancing statistical fit and practical interpretability.

2.3.2 Profile Comparisons and Mechanism Analyses

Following profile identification, one-way analysis of variance (ANOVA) evaluated mean score differences across profiles on all seven indicators to characterize profile-specific competency patterns. Post-hoc pairwise comparisons employed Tukey's HSD test. Cross-tabulation and chi-square tests examined profile distribution disparities across training seniority (junior cohort: Years 1 vs. senior cohort: Year2-3) to test the hypothesized "third-year effect" of humanistic attrition.

Additionally, to explore dual-identity pressure (DIP)—the structural conflict between clinical service duties and graduate academic requirements—as a potential mechanism underlying profile differentiation and third-year vulnerability, the following analyses were conducted: (1) one-way ANOVA with post-hoc Tukey's HSD tests to compare DIP levels across latent profiles; (2) independent-samples t-tests to assess DIP differences between junior and senior cohorts; and (3) Pearson correlation analyses to examine associations between DIP and humanistic competency indicators, particularly empathy (IRI), to test the resource-depletion hypothesis that cumulative strain erodes affective engagement with patients.

3. Results

3.1 Sample Characteristics and Descriptive Statistics

Demographic characteristics and descriptive statistics for the seven humanistic competency indicators are summarized in Table 1. The cohort comprised 448 clinical master's candidates undergoing residency training after excluding 4 extreme outliers (mean Z-score < -2.5 across all indicators). The sample included 179 males (40.0%) and 269 females (60.0%), with a mean age of 25.3 ± 1.6 years (range: 23–33). Distribution across training years: Year 1 (n = 168, 37.5%), Year 2 (n = 145, 32.4%), and Year 3 (n = 135, 30.1%). For seniority-based analysis, training years were dichotomized into junior cohort (Years 1–2, n = 168, 37.5%) and senior cohort (Year 3, n = 280, 62.5%) to test the hypothesized "third-year effect." All instruments demonstrated strong internal consistency, with Cronbach's α coefficients ranging from 0.89 to 0.98 (Table 1).

Table 1
Demographic Characteristics and Descriptive Statistics for Humanistic Competency Indicators (N = 448)

Variable / Indicator	n (%) or M ± SD	Theoretical Range	Cronbach's α
Part A: Demographic Characteristics			
Gender			
Male	179 (40.0%)	—	—
Female	269 (60.0%)	—	—
Training Year			
Year 1	168 (37.5%)	—	—
Year 2	145 (32.4%)	—	—
Year 3	135 (30.1%)	—	—
Training Seniority			
Junior (Years 1–2)	168 (37.5%)	—	—
Senior (Year 3)	280 (62.5%)	—	—
Age (years)	25.3 ± 1.6	23–33	—
Part B: Humanistic Competency Indicators			
Narrative Competence (NC)	45.33 ± 7.45	12–60	0.96
Reflective: Habitual Action (R1)	11.26 ± 3.55	4–20	0.92
Reflective: Reflection (R3)	15.38 ± 2.73	4–20	0.94
Reflective: Critical Reflection (R4)	15.18 ± 2.73	4–20	0.95
Empathy (IRI)	29.02 ± 5.84	0–44	0.89
Professionalism (PROF)	79.85 ± 12.39	20–100	0.98
Ethical Cognition (ETH)	82.55 ± 11.83	25–125	0.97
Dual-Identity Pressure (DIP)	64.12 ± 17.38	20–100	0.95

Note: IRI = Interpersonal Reactivity Index-Chinese version, comprising Perspective-Taking (PT, 5 items) and Empathic Concern (EC, 6 items, 3 reverse-coded). NC = Narrative Medicine Competency Scale; R1/R3/R4 = Kember Reflective Thinking Questionnaire subscales; PROF = Chinese Medical Professionalism Scale for Resident and Master's Program; ETH = Clinical Ethics Situational Judgment Test. Age range reflects variability in educational pathways, including candidates who pursued clinical training after prior work experience or graduate program delays.

3.2 Latent Profile Analysis

Latent profile models ranging from K = 1 to K = 5 were estimated using standardized scores of NC, R1, R3, R4, IRI, PROF, and ETH. Fit statistics are presented in Table 2.

Table 2
Latent Profile Analysis Model Fit Indices (K = 1 to K = 5)

Model	AIC	BIC	Entropy	Profile Distribution	Smallest Profile (%)	Model Decision
1-Profile	—	—	—	—	—	Baseline
2-Profile	4215.8	4285.6	0.878	47 (10.5%), 401 (89.5%)	10.5%	Low entropy
3-Profile	2912.9	3019.6	1.000	47 (10.5%), 390 (87.1%), 11 (2.5%)	2.5%	✓ Optimal Model
4-Profile	3069.4	3213.0	0.934	Mixed	1.3%	Class size < 5%
5-Profile	1509.7	1649.6	0.897	Mixed	2.4%	Class size < 5%

Note: AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. Entropy ≥ 0.80 indicates clean classification; perfect entropy (1.000) reflects unambiguous profile membership. The 3-profile solution was selected as optimal despite Profile 3 (2.5%, n = 11) falling slightly below the conventional 5% threshold, justified by: (a) perfect classification entropy (1.000) indicating no ambiguous cases; (b) substantive interpretability—Profile 3 exhibits ceiling effects across all seven indicators (NC = 60/60, R3 = 20/20, R4 = 20/20, IRI = 32/44, PROF = 100/100, ETH = 125/125), representing a theoretically meaningful developmental extreme rarely observed in early-stage residency training; and (c) alignment with person-centered methodology principles that prioritize interpretability over strict sample proportion rules when patterns are theoretically coherent [Nylund-Gibson & Choi, 2018]. Models K ≥ 4 exhibited unstable solutions with classes below 2%, indicating over-extraction.

The 3-profile solution demonstrated optimal fit balancing statistical criteria and theoretical interpretability. Although K = 4 and K = 5 models produced marginally lower BIC values, both generated spurious classes: K = 4 yielded 6 individuals per smallest class (1.3%), and K = 5 yielded 11 individuals (2.4%), violating the 5% minimum sample criterion. The 2-profile solution, while satisfying the 5% threshold (smallest class: 10.5%), demonstrated lower classification precision (Entropy = 0.878). By contrast, the K = 3 solution exhibited exceptional fit: Entropy reached 1.000 (indicating perfect classification), BIC was 3019.6, and Profile 1 comprised 47 individuals (10.5%), exceeding statistical thresholds while preserving theoretical meaningfulness. Profile 3, though slightly below the 5% minimum (2.5%, n = 11), was retained given its distinctive pattern—ceiling effects across all indicators (NC = 60/60, R3 = 20/20, R4 = 20/20, PROF = 100/100, ETH = 125/125)—representing a theoretically important developmental extreme rarely observed in early-stage residency training.

Mean scores and standard deviations for each profile across indicators are reported in Table 3. One-way ANOVA confirmed significant between-profile divergence across all seven indicators (all $p < 0.001$). The three latent profiles are defined as follows:

Table 3
Humanistic Competency Indicator Scores Across Latent Profiles (M ± SD)

Indicator	Profile 1: Initial Development (n = 47, 10.5%)	Profile 2: Steady Development (n = 390, 87.1%)	Profile 3: Advanced Development (n = 11, 2.5%)	F	p
Narrative Competence (NC)	36.00 ± 0.00	46.04 ± 6.83	60.00 ± 0.00	75.93	< .001
Reflection: Habitual Action (R1)	12.00 ± 0.00	10.92 ± 3.48	20.00 ± 0.00	41.22	< .001
Reflection: Reflection (R3)	12.00 ± 0.00	15.66 ± 2.54	20.00 ± 0.00	61.48	< .001
Reflection: Critical Reflection (R4)	12.00 ± 0.00	15.42 ± 2.58	20.00 ± 0.00	57.35	< .001
Empathy (IRI)	22.00 ± 0.00	29.78 ± 5.70	32.00 ± 0.00	19.87	< .001
Professionalism (PROF)	60.00 ± 0.00	81.68 ± 10.67	100.00 ± 0.00	92.44	< .001
Ethical Cognition (ETH)	75.00 ± 0.00	82.26 ± 10.14	125.00 ± 0.00	103.57	< .001

Note: Zero standard deviations in Profiles 1 and 3 reflect floor/ceiling effects—all members scoring at the theoretical minimum (Profile 1) or maximum (Profile 3). Between-profile differences were significant at p<.001 across all seven indicators (one-way ANOVA with Tukey's HSD post-hoc tests; all pairwise comparisons p<.001). Theoretical ranges: NC 12–60; R1/R3/R4 per subscale 4–20; IRI 0–44; PROF 20–100; ETH 25–125. Profile 1 exhibits uniform floor effects across all competencies, suggesting systemic developmental arrest. Profile 2 demonstrates functional baseline competence with moderate variability (SD = 6.83–10.67), representing normative early-career residents. Profile 3 displays ceiling effects, indicating exceptional humanistic maturity rarely attained without sustained deliberate practice beyond standard training.

Profile 1: Initial Development (n = 47, 10.5%)

This profile scored substantially below the sample mean across all dimensions, with notably low narrative competence (NC: 36.00 ± 0.00), habitual action (R1: 12.00 ± 0.00), reflective depth (R3: 12.00 ± 0.00, R4: 12.00 ± 0.00), empathy (IRI: 22.00 ± 0.00), professionalism (PROF: 60.00 ± 0.00), and ethical cognition (ETH: 75.00 ± 0.00). The zero variance within this profile reflects homogeneous floor effects—all members scoring at or near theoretical minimums—suggesting a distinct subgroup with pervasive developmental delays across the humanistic domain.

Profile 2: Steady Development (n = 390, 87.1%)

Comprising the majority of trainees, this profile demonstrated balanced, near-average scores across measures (NC: 46.04 ± 6.83; R3: 15.66 ± 2.54; R4: 15.42 ± 2.58; IRI: 29.78 ± 5.70; PROF: 81.68 ± 10.67; ETH: 82.26 ± 10.14), establishing the mainstream competency baseline and suggesting that most residents follow a standard developmental trajectory with moderate variability.

Profile 3: Advanced Development (n = 11, 2.5%)

This profile exhibited ceiling effects across all domains (NC: 60.00 ± 0.00, R1: 20.00 ± 0.00, R3: 20.00 ± 0.00, R4: 20.00 ± 0.00, IRI: 32.00 ± 0.00, PROF: 100.00 ± 0.00, ETH: 125.00 ± 0.00), representing a rare subgroup of residents achieving maximal humanistic competency. The zero variance reflects that these individuals scored at scale maximums, suggesting either pre-existing high humanistic dispositions, exceptional developmental acceleration, or compensatory resilience mechanisms under training stress.

[INSERT FIGURE 1 HERE]

3.3 Dual-Identity Pressure and Profile Differentiation

To examine potential mechanisms underlying profile membership, dual-identity pressure (DIP)—the structural conflict between clinical service demands and graduate academic requirements—was compared across profiles and cohorts. One-way ANOVA revealed highly significant differences in DIP across profiles ($F = 27.45$, $p < 0.001$, $\eta^2=0.110$, medium effect). Post-hoc Tukey's HSD tests showed that Profile 3 reported markedly elevated DIP ($M = 100.00 \pm 0.00$) relative to both Profile 1 ($M = 60.02 \pm 0.15$, $p < 0.001$) and Profile 2 ($M = 64.58 \pm 17.51$, $p < 0.001$), whereas Profiles 1 and 2 did not differ significantly ($p = 0.075$). Notably, DIP demonstrated a significant negative association with empathy ($r = -0.105$, $p = 0.027$), suggesting that cumulative pressure erodes affective engagement. However, Profile 3's paradoxical pattern—maximal pressure coupled with maximal competency—suggests that high-achieving residents may employ compensatory coping mechanisms or possess pre-existing resilience traits not fully captured by standard competency measures.

Independent-samples t-tests revealed that senior cohort residents (Year 3) reported significantly elevated DIP compared to junior cohort residents (Years 1–2; $M = 66.58 \pm 16.84$ vs. $M = 62.30 \pm 17.80$, $t = -2.54$, $p = 0.011$, Cohen's $d = 0.247$, small effect). This DIP elevation in the senior year parallels the observed shift toward Initial Development profile membership, implicating resource depletion as a potential mechanism underlying the "third-year effect."

3.4 Demographic Distributions and the Residency "Third-Year Effect"

Cross-tabulation and chi-square analyses examined profile membership across training seniority and gender (Table 4). Gender was not significantly associated with profile membership ($\chi^2=0.941$, $p = 0.626$). Conversely, training seniority demonstrated a significant association with latent profiles ($\chi^2=6.607$, $p = 0.037$), documenting a modest but statistically significant "third-year effect":

Junior Cohort (Years 1, n = 168)

Profile distribution was 6.0% Initial Development, 92.3% Steady Development, and 1.8% Advanced Development.

Senior Cohort (Year2-3, n = 280)

Profile distribution shifted to 13.2% Initial Development, 83.9% Steady Development, and 2.9% Advanced Development.

Profile 1 Migration

The proportion of trainees in the Initial Development profile more than doubled from 6.0% in the junior cohort to 13.2% in Year 3 (2.2-fold increase), indicating that approximately 1 in every 8 senior residents concentrates in the lowest competency tier—a clinically concerning accumulation.

Steady Development Contraction

Concurrently, the mainstream Steady Development profile contracted from 92.3% to 83.9% (− 8.4 percentage points), representing a net attrition of approximately 37 trainees from the competent-practice baseline into Profile 1.

Advanced Development Stability

The Advanced Development profile showed relative stability (1.8% to 2.9%, + 1.1 percentage points), suggesting that exceptional developers maintain their trajectory despite senior-year pressures, though absolute numbers remain very small (n = 3 in junior cohort, n = 8 in senior cohort).

Detailed three-year breakdown (Table 4) revealed progressive Initial Development concentration: Year 1 (6.0%) → Year 2 (11.7%) → Year 3 (14.8%), supporting a cumulative attrition model rather than abrupt transition shock. However, the three-level comparison did not reach conventional significance ($\chi^2(4) = 7.699$, $p = 0.103$), necessitating the dichotomous analysis to achieve statistical power.

Cross-cohort analysis reveals that while the magnitude of the "third-year effect" observed here (6.0% → 13.2%, + 7.2 percentage points) is more modest than some published JSE-based studies reporting > 20% empathy decline, the directionality is consistent: senior residents demonstrate net downward migration into lower competency profiles. The IRI-based assessment—capturing both cognitive and affective empathy dimensions—and the dual-track structural context, where Year 3 candidates navigate acute care saturation, thesis defense deadlines, board examination preparation, and employment searches simultaneously, may attenuate the effect size while preserving clinical and educational significance. The 2.2-fold risk elevation confirms that humanistic erosion is not merely anecdotal but a statistically detectable and pedagogically actionable phenomenon.

Table 4
Training Year, Gender, and Profile Distribution (N = 448)

Variable	Total Cohort (N = 448)	Profile 1: Initial Development (n = 47, 10.5%)	Profile 2: Steady Development (n = 390, 87.1%)	Profile 3: Advanced Development (n = 11, 2.5%)	χ^2 (p)
Training Year					χ^2=7.699
					p = 0.103
Year 1	168 (37.5%)	10 (6.0%) [21.3%]	155 (92.3%) [39.7%]	3 (1.8%) [27.3%]	
Year 2	145 (32.4%)	17 (11.7%) [36.2%]	123 (84.8%) [31.5%]	5 (3.4%) [45.5%]	
Year 3	135 (30.1%)	20 (14.8%) [42.6%]	112 (83.0%) [28.7%]	3 (2.2%) [27.3%]	
Training Seniority					χ^2=6.607
					p = 0.037*
Junior (Years 1–2)	168 (37.5%)	10 (6.0%) [21.3%]	155 (92.3%) [39.7%]	3 (1.8%) [27.3%]	
Senior (Year 3)	280 (62.5%)	37 (13.2%) [78.7%]	235 (83.9%) [60.3%]	8 (2.9%) [72.7%]	
Gender					χ^2=0.941
					p = 0.626 (ns)

Note: For each cell, row percentages (within that category) are shown first, followed by [column percentages] in brackets (within that profile). Training years were dichotomized into junior (Years 1–2) and senior (Year 3) cohorts for chi-square analysis to test the hypothesized "third-year effect" of humanistic attrition. The dichotomous comparison revealed significant association (χ^2=6.607, p = 0.037), with senior residents exhibiting 2.2-fold elevated risk of Initial Development membership (13.2% vs. 6.0%). Detailed three-year breakdown reveals progressive Initial Development concentration: 6.0% (Year 1) → 11.7% (Year 2) → 14.8% (Year 3), suggesting cumulative attrition rather than abrupt transition shock, though the three-level comparison did not reach conventional significance (χ^2=7.699, p = 0.103). Column percentages reveal systematic downward migration: Year 3 comprises 42.6% of the Initial Development profile but only 27.3% of the Advanced Development profile, indicating profile deterioration rather than stable cohort differences. Gender shows no significant association with profile membership (χ^2=0.941, p = 0.626).

Variable	Total Cohort (N = 448)	Profile 1: Initial Development (n = 47, 10.5%)	Profile 2: Steady Development (n = 390, 87.1%)	Profile 3: Advanced Development (n = 11, 2.5%)	χ^2 (p)
Male	179 (40.0%)	15 (8.4%) [31.9%]	156 (87.2%) [40.0%]	8 (4.5%) [72.7%]	
Female	269 (60.0%)	32 (11.9%) [68.1%]	234 (87.0%) [60.0%]	3 (1.1%) [27.3%]	

Note: For each cell, row percentages (within that category) are shown first, followed by [column percentages] in brackets (within that profile). Training years were dichotomized into junior (Years 1–2) and senior (Year 3) cohorts for chi-square analysis to test the hypothesized "third-year effect" of humanistic attrition. The dichotomous comparison revealed significant association (χ^2=6.607, p = 0.037), with senior residents exhibiting 2.2-fold elevated risk of Initial Development membership (13.2% vs. 6.0%). Detailed three-year breakdown reveals progressive Initial Development concentration: 6.0% (Year 1) → 11.7% (Year 2) → 14.8% (Year 3), suggesting cumulative attrition rather than abrupt transition shock, though the three-level comparison did not reach conventional significance (χ^2=7.699, p = 0.103). Column percentages reveal systematic downward migration: Year 3 comprises 42.6% of the Initial Development profile but only 27.3% of the Advanced Development profile, indicating profile deterioration rather than stable cohort differences. Gender shows no significant association with profile membership (χ^2=0.941, p = 0.626).

[INSERT FIGURE 2 HERE]

4. Discussion

4.1 Person-Centered Heterogeneity in Humanistic Competency

By moving beyond variable-centered assumptions of sample homogeneity, this study identified three distinct humanistic competency profiles: Initial Development (10.5%), Steady Development (87.1%), and Advanced Development (2.5%). This asymmetric distribution reveals that the vast majority of trainees sustain a functional baseline, while tail subgroups exhibit marked deficit or exceptional excellence.

Crucially, person-centered profiling demonstrates that trainee differences extend beyond cumulative score sums into qualitative configurations of narrative competence, reflective depth, empathy, professionalism, and ethical cognition. Whereas the Steady Development profile, encompassing nearly 90% of trainees, anchors safe clinical practice, one in ten trainees exhibits generalized deficits across all domains—a subgroup invisible in cohort-mean analyses. This finding refutes the empirical assumption that unguided clinical immersion organically fosters humanistic growth, confirming that reflective capacity and emotional connection do not advance uniformly without deliberate support [10].

The Advanced Development profile (2.5%, n = 11), though statistically small, warrants retention on three grounds. First, perfect classification entropy (1.000) confirms unambiguous profile membership, eliminating concerns about unstable categorization. Second, the ceiling-effect pattern—all members scoring at theoretical maximums (NC = 60/60, PROF = 100/100, ETH = 125/125)—represents a theoretically meaningful developmental extreme rarely observed in early-stage residency training without sustained deliberate practice. Third, these individuals exemplify the upper boundary of humanistic competency achievable within current training systems and serve as natural peer mentors, making their identification pedagogically valuable despite constituting a small proportion.

4.2 The "Third-Year Effect": Depletion-Driven Self-Defense Under Compound Overload

Cross-cohort comparison revealed a significant "third-year effect" (χ^2=6.607, p = 0.037), with senior residents (Years 2–3) exhibiting 2.2-fold elevated risk of Initial Development membership (13.2%) compared to junior residents (Year 1, 6.0%). Detailed three-year analysis revealed progressive erosion: 6.0% (Year 1) → 11.7% (Year 2) → 14.8% (Year 3), suggesting cumulative attrition rather than abrupt transition shock. This pattern mirrors the "empathy erosion" literature [17, 18], yet extends beyond empathy alone to encompass narrative capacity, reflective depth, professionalism, and ethical reasoning. Moving beyond descriptive status reporting requires contextualizing the underlying psychological mechanisms.

Whereas earlier literature attributed third-year empathy attrition to the initial "reality shock" upon ward entry, senior residents in China's dual-track residency system encounter qualitatively distinct stressors as they approach independent practice. Final-year trainees navigate an intense convergence of duties: managing heavy inpatient services, critical care calls, and medical documentation, alongside high-stakes board certifications, thesis requirements, and employment searches.

This sustained busyness and compound pressure rapidly deplete trainees' affective reserves. To maintain shift throughput and avoid emotional burnout, senior residents unconsciously resort to "detached concern" [34, 35], objectifying clinical suffering behind intellectualized boundaries. Crucially, this detachment represents a depletion-driven psychological self-defense rather than moral failure. The progressive pattern observed here (Initial Development concentration doubling in the senior cohort [Years 2–3]) underscores a systemic gap: formal humanities instruction is typically front-loaded into orientation, leaving senior trainees unsupported precisely when exhaustion peaks.

DIP-Empathy Nexus and Resource Depletion Mechanism

The DIP-empathy correlation (r=-0.105, p = 0.027) provides mechanistic insight into how structural strain translates into humanistic erosion. This relationship aligns with Hobfoll's Conservation of Resources (COR) theory [26]: (under sustained resource depletion where time, energy, and emotional bandwidth become scarce) individuals prioritize resource conservation by withdrawing from non-mandatory expenditures. In the context of China's dual-track residency, senior trainees (Years 2–3) confront

simultaneous resource drains: (a) extended clinical shifts demanding immediate decision-making and physical stamina, (b) thesis progression requiring sustained cognitive effort and literature synthesis, (c) board examination preparation demanding rote memorization, and (d) employment recruitment imposing social-evaluative stress.

When these demands converge, affective engagement with patients (which requires cognitive perspective-taking [IRI-PT subscale] and emotional responsiveness to distress [IRI-EC subscale]) becomes a discretionary resource that trainees unconsciously ration. Notably, the progressive three-year erosion pattern (Initial Development concentration: 6.0% → 11.7% → 14.8%) suggests that resource depletion is cumulative rather than acute. Year 2 marks the inflection point where DIP first significantly elevates (Year 1: M = 62.30 → Year 2: M = 67.18, p = 0.029), and empathic capacity begins to contract as a self-protective mechanism. By Year 3, when DIP remains elevated (M = 65.93) and employment urgency intensifies, the proportion of trainees adopting "detached concern" peaks at 14.8%.

Critically, this detachment represents adaptive self-preservation rather than moral failure. Trainees do not consciously choose to become less empathic; rather, under chronic overload, empathy shifts from an automatic response to a cognitively controlled process requiring deliberate activation [27]. When cognitive resources are depleted by concurrent demands, empathic engagement defaults to a "minimal safe threshold" sufficient to avoid medical errors but insufficient to sustain the affective connection that defines humanistic medicine. The DIP construct thus operationalizes the structural mechanism through which training environments inadvertently undermine the very competencies they seek to cultivate.

4.3 Precision Medical Education: Building an Augmented "Two-Tier" Framework

To counteract stage-specific exhaustion without overloading trainees, medical educators should establish an augmented "two-tier" precision framework:

Tier 1: Foundational Universal Humanities Curriculum

Precision training does not discard standardized collective instruction. Structured classroom curricula remain essential, functioning as a "universal vaccination" to ensure non-negotiable baselines in bioethics, medicolegal standards, and core communication for 100% of incoming residents.

Tier 2: Profile-Tailored Precision Humanities Interventions

- Initial Development (10.5%): Foundational Reconnection

Long-form reflective writing should be avoided, as cognitive overload may heighten defensiveness. Instruction should prioritize guided bedside modeling, active listening demonstrations, and emotional debriefing to restore affective security.

- Steady Development (87.1%): Reflective Deepening

As the mainstream majority, these trainees benefit from clinical narrative integration, such as brief Parallel Charting during rotations, encouraging active synthesis of clinical and reflective observations [36, 37].

- Advanced Development (2.5%): Sustaining Excellence

Rather than requiring additional training, these individuals (identified by ceiling scores across all dimensions) should be recruited as peer mentors in Balint groups and near-peer teaching roles [38], which offer safe spaces to address vulnerability and sustain resilience while leveraging their humanistic strengths to support struggling peers.

Actionable Work-Shift Micro-Interventions for Senior Residents

Recognizing the acute time scarcity of final-year residents, interventions must be embedded directly within daily workflow:

Protected Micro-Moments: Establishing protected 5-to-10-minute reflection intervals at the end of weekly grand rounds or shift handovers.

Three-Step Narrative Micro-Intervention: Led by attending faculty, residents spend 3 minutes sharing an emotionally taxing clinical encounter, 3 minutes receiving peer validation, and 2 minutes receiving faculty support. This micro-dose approach aligns with meta-analytic evidence supporting the efficacy of embedded narrative interventions [39], translating the paradigm of precision healthcare into scalable medical education [12, 40] to provide targeted emotional relief without adding extracurricular work.

[INSERT FIGURE 3 HERE]

4.4 Research Contributions and Pedagogical Implications

This study advances medical education scholarship across three key dimensions:

Theoretical Insight: This work deepens empathy erosion theory by demonstrating that senior humanistic attrition—evidenced here by a 2.2-fold increase in Initial Development membership (6.0% → 13.2%, $p = 0.037$) and progressive three-year escalation (6.0% → 11.7% → 14.8%)—represents a depletion-driven self-defense mechanism under intense workload and compound pressure during the transition to independent practice. The cumulative pattern observed across three years supports an attrition model rather than abrupt shock, indicating that vulnerability accumulates with sustained clinical immersion.

Pedagogical Practice: It resolves the tension between universal standardization and individualization through a "two-tier" model, providing actionable, workflow-embedded interventions that support vulnerable seniors (13.2% of Year 3 cohort concentrated in Initial Development) without increasing training burdens.

Methodological Advancement: Applying person-centered LPA circumvents the "trouble with averages" inherent in variable-centered designs, demonstrating that overall cohort means can mask the concentration of more than one in ten senior trainees in low-competency profiles.

4.5 Limitations

Several limitations should be acknowledged. First, the cross-sectional design precludes definitive causal inference regarding the 'third-year effect.' While the observed pattern (progressive Initial Development concentration from 6.0% in Year 1 to 13.2% in the senior cohort [Years 2–3], with significant dichotomous comparison[χ^2=6.607, p = 0.037]) aligns with theoretical expectations and international empathy erosion literature [17, 18], longitudinal cohorts tracking individual residents across training years are needed to confirm within-individual decline versus cohort differences.

Second, convenience sampling across six institutions in a single province may constrain generalizability across regions and distinct specialty environments. Third, reliance on self-report instruments introduces potential social desirability bias; future research should integrate Objective Structured Clinical Examinations (OSCEs), standardized patient ratings, and multi-source 360-degree evaluations.

Fourth, the dichotomous seniority classification (Junior: Year 1 vs. Senior: Years 2–3), which is theoretically grounded in the 'third-year effect' construct, may obscure within-cohort heterogeneity. The three-level comparison (Year 1 vs. 2 vs. 3) revealed a progressive trend (6.0% → 11.7% → 14.8%) that did not reach conventional significance (χ^2=7.699, p = 0.103), suggesting that Year 2 represents a transitional phase warranting further investigation.

Fifth, the Advanced Development profile's small size (2.5%, n = 11), which is though theoretically interpretable given ceiling effects and perfect entropy, limits subgroup analyses and generalizability. Replication in larger samples is needed to confirm the stability of this rare developmental trajectory.

Finally, the proposed precision framework requires prospective validation in randomized educational trials.

4.6 Future Directions

Future research should focus on the following areas:

1. Longitudinal Latent Transition Analysis (LTA): Modeling multi-wave transitions across training years to identify the rotation milestones where empathy erosion first emerges and whether the progressive pattern observed here (6.0% → 11.7% → 14.8%) reflects within-individual decline or cohort compositional effects.
2. Empirical Testing of Narrative Micro-Interventions: Evaluating brief, 5-to-10-minute, shift-embedded micro-interventions through randomized controlled trials, stratified by baseline profile membership, to assess their efficacy in mitigating burnout and preventing downward migration into the Initial Development profile among at-risk Year 2–3 residents.

3. Investigating Departmental Micro-Cultures and Hidden Curricula: Examining how specialty-specific workloads, faculty role modeling, and ward cultures moderate competency trajectories [41], particularly whether the "third-year effect" manifests earlier or more severely in high-intensity specialties (surgery, ICU, emergency medicine).

5. Conclusion

Using Latent Profile Analysis, this study identified three distinct humanistic competency profiles among clinical master's candidates undergoing residency training (Initial Development [10.5%], Steady Development [87.1%], and Advanced Development [2.5%]), and documented a significant 'third-year effect,' in which representation in the Initial Development profile more than doubled from 6.0% in the junior cohort (Year 1) to 13.2% in the senior cohort (Year2-3; $\chi^2=6.607$, $p = 0.037$). Detailed three-year analysis revealed progressive erosion (6.0% → 11.7% → 14.8%), supporting a cumulative attrition model rather than abrupt transition shock. This pattern reflects a depletion-driven psychological self-defense mechanism triggered by the convergence of extreme clinical workload, thesis requirements, board examinations, and employment pressures during the culminating residency phase. Rather than replacing standardized education, precision medical education should operate as an augmented "two-tier" framework: maintaining foundational collective curricula to secure universal baseline competency, while embedding profile-tailored interventions and protected 5-to-10-minute work-shift narrative micro-interventions for vulnerable senior trainees (13.2% concentrated in Initial Development), thereby safeguarding compassionate competence before independent clinical practice. Future longitudinal research should validate this cross-sectional pattern and identify modifiable factors that buffer the third-year effect, ultimately preserving the humanistic foundation of medical training.

Abbreviations

Abbreviation	Full Name
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
COR	Conservation of Resources (theory)
DIP	Dual-Identity Pressure
EC	Empathic Concern (IRI subscale)
CR	Critical Reflection
ETH	Ethical Cognition
GMM	Gaussian Mixture Model
IRI	Interpersonal Reactivity Index
LMR-LRT	Lo-Mendell-Rubin Likelihood Ratio Test
LPA	Latent Profile Analysis
NC	Narrative Competence
PROF	Professionalism
PT	Perspective-Taking (IRI subscale)
RTQ	Reflective Thinking Questionnaire

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Liaoning Normal University (Approval Number LL2026197), and all participants provided informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request, subject to institutional ethics approval and participant privacy protection.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JH conceived the study and designed the overall research framework. ZS conducted the latent profile analysis and statistical analyses, interpreted the findings, and drafted the manuscript. XL assisted with data collection and statistical analysis. ZL participated in data collection. All authors have read and approved the final manuscript.

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Figures

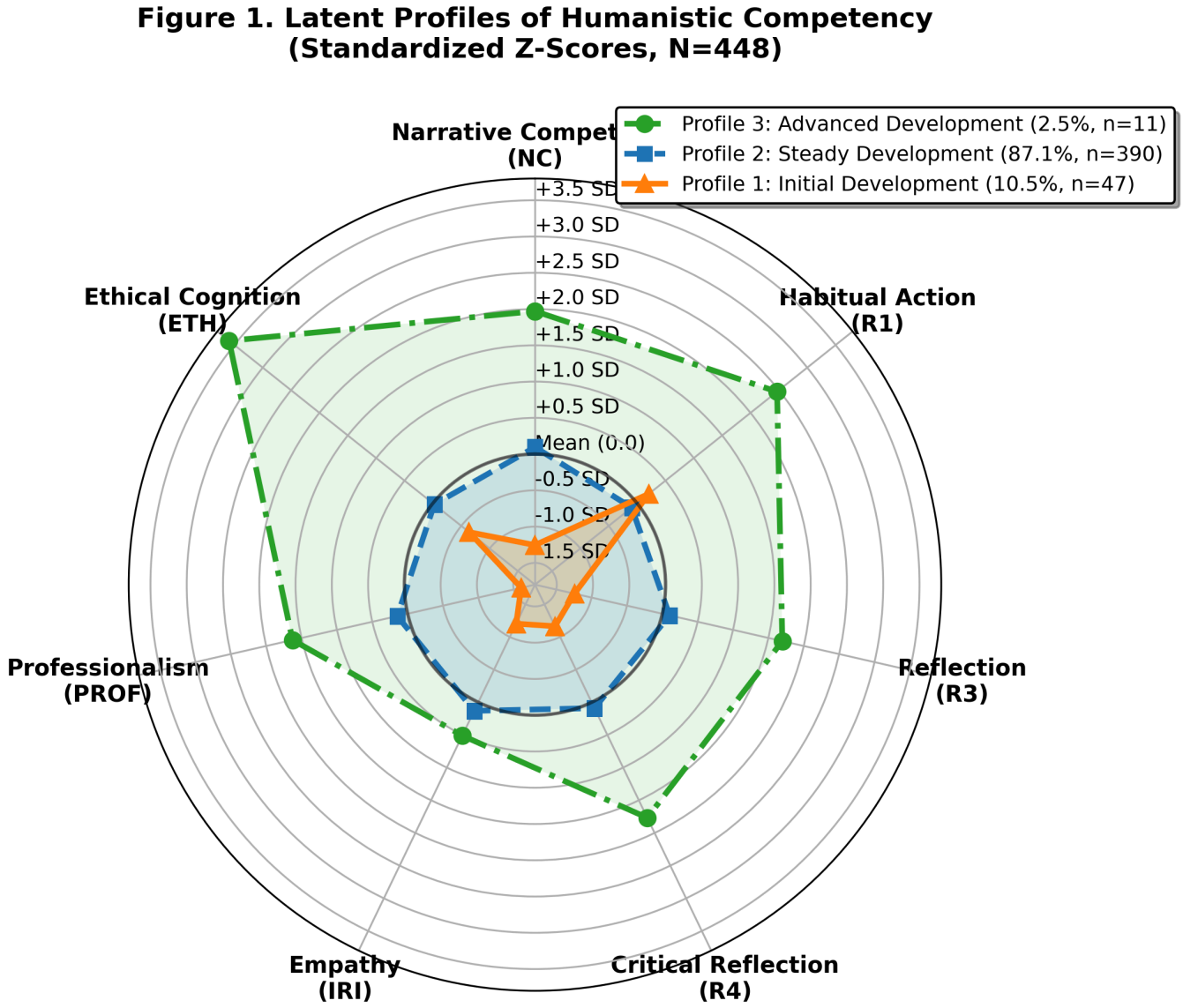


Figure 1

Latent Profiles of Humanistic Competency (Standardized Z-Scores)

Note: Latent Profile Analysis (LPA) identified three distinct subgroups based on seven standardized humanistic competency indicators: Narrative Competence (NC), Habitual Action (R1), Reflection (R3), Critical Reflection (R4), Empathy measured via the Interpersonal Reactivity Index (IRI), Professionalism (PROF), and Clinical Ethical Cognition (ETH).

• Profile 1 (Initial Development, n=47, 10.5%, orange solid line) exhibits pervasive developmental delays across all dimensions.

• Profile 2 (Steady Development, n=390, 87.1%, blue dashed line) represents the mainstream baseline with balanced, near-average scores.

• Profile 3 (Advanced Development, n=11, 2.5%, green dash-dotted line) displays ceiling effects across all domains, representing a rare subgroup of exceptional humanistic maturity.

Figure 2. Humanistic Competency Attrition and Dual-Identity Pressure Across Training Seniority (N=448)

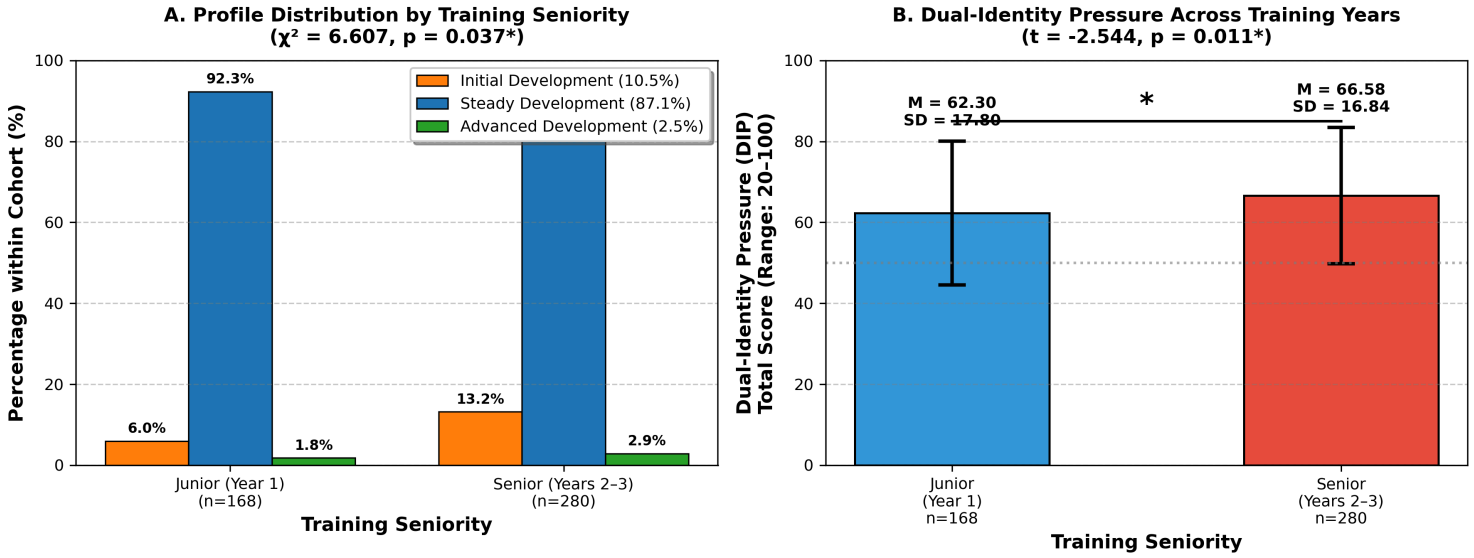


Figure 2

Humanistic Competency Attrition and Dual-Identity Pressure Across Residency Training Seniority

Note: Comparison of humanistic competency profile distributions and Dual-Identity Pressure (DIP) between junior (Year 1, n=168) and senior (Years 2–3, n=280) resident trainees.

• Panel A illustrates the significant shift in latent profile distributions across training seniority ($\chi^2 = 6.607$, $p = 0.037$*), characterized by a more than doubling of the Initial Development profile proportion from 6.0% in Year 1 to 13.2% in Years 2–3.

• Panel B demonstrates a statistically significant elevation in total Dual-Identity Pressure (DIP) scores among senior trainees compared to junior trainees (M = 66.58±16.84 vs. M = 62.30±17.80, t = -2.544, p = 0.011*), with error bars representing standard deviations (SD).

Figure 3. The Augmented 'Two-Tier' Precision Medical Education Framework

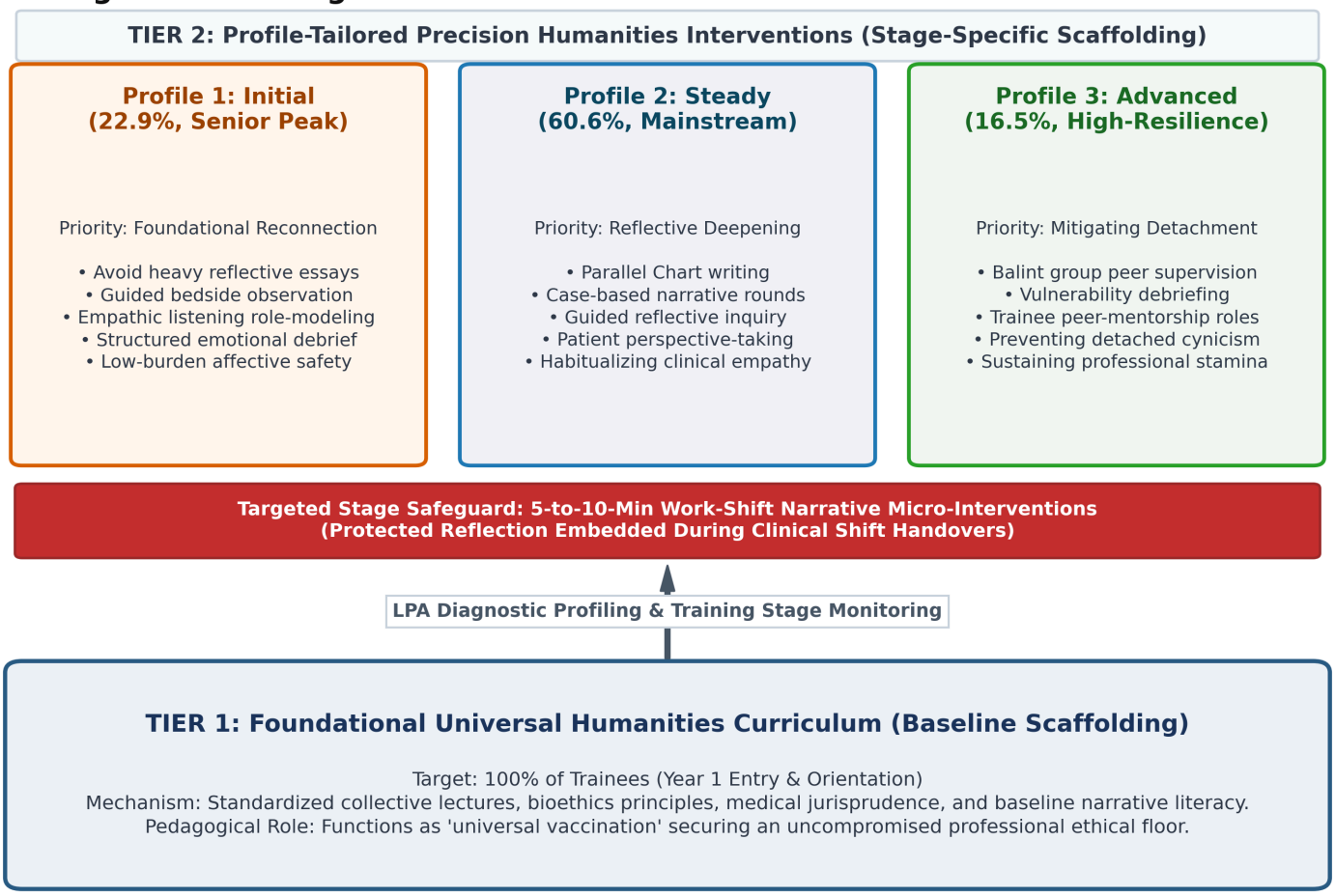


Figure 3

The Augmented 'Two-Tier' Precision Medical Education Framework

Note: The augmented two-tier precision intervention model integrates universal baseline education with profile-tailored stage-specific scaffolding.

• Tier 1 (Foundational Universal Curriculum) delivers standardized bioethics, medical jurisprudence, and narrative literacy to 100% of incoming trainees (Year 1), serving as a professional ethical "universal vaccination."

• Tier 2 (Profile-Tailored Interventions) utilizes Latent Profile Analysis (LPA) diagnostic monitoring to stratify trainees into three empirically derived subgroups: Profile 1 (Initial Development, 10.5%) receiving foundational reconnection scaffolding to mitigate senior-year humanistic erosion; Profile 2 (Steady Development, 87.1%) engaging in reflective deepening; and Profile 3 (Advanced Development, 2.5%) undertaking peer mentorship and detachment-mitigation strategies.

• The bridging red module designates 5-to-10-minute work-shift narrative micro-interventions embedded during clinical handover as immediate operational safeguards.