

## Nursing Assistant Students' Digital Cultural Intelligence and Clinical Adaptability in a North African Health College: A Cross-Sectional Study

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### ABSTRACT

**Purpose of the study:** This study examined the predictive relationship between digital cultural intelligence and clinical adaptability among nursing assistant students at a health sciences college in Morocco.

**Methodology:** A cross-sectional design was employed with 287 students who had completed at least one clinical placement. Data were analysed using partial least squares structural equation modelling (PLS-SEM) to test a theory-driven conceptual framework. Measurement model evaluation confirmed satisfactory reliability and validity (CR > 0.90; AVE > 0.50; HTMT < 0.85). Structural analysis revealed that digital cultural intelligence significantly predicted clinical adaptability ( $\beta = 0.64$ ,  $p < 0.001$ ), explaining 41% of the variance ( $R^2 = 0.41$ ). Predictive relevance was supported ( $Q^2 = 0.29$ ), and robustness checks using covariance-based SEM confirmed acceptable model fit indices.

**Main Findings:** The findings indicate that the capacity to navigate culturally diverse interactions within digitally mediated healthcare environments is a substantial determinant of adaptive clinical reasoning, flexible communication, and ethical responsiveness. By empirically validating digital cultural intelligence as a multidimensional construct in vocational nursing education, this study advances theoretical integration between intercultural competence and adaptive expertise frameworks.

**Novelty/Originality of this study:** This study contributes Global South evidence to international nursing education research and provides a predictive model for curriculum innovation in digitally transitioning healthcare contexts.

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## 1. INTRODUCTION

Global migration, digital transformation, and the expansion of multicultural healthcare systems have intensified the demand for culturally responsive and technologically competent health professionals [1]-[3]. In contemporary clinical environments, cultural competence is no longer limited to interpersonal sensitivity but increasingly intersects with digital communication, telehealth interaction, and cross-border information exchange [4]-[6]. Within this evolving landscape, healthcare professionals must navigate culturally diverse patient populations while simultaneously adapting to digitally mediated care systems [7]-[9]. Failure to integrate cultural responsiveness with digital competence may compromise patient safety, continuity of care, and clinical effectiveness.

Cultural competence has traditionally been conceptualised as the ability to deliver safe and effective care while respecting patients' cultural backgrounds, values, and health beliefs [10]-[12]. However, recent scholarship argues that the digitalisation of healthcare requires an expanded construct often conceptualised as digital cultural intelligence which refers to an individual's capability to function effectively in culturally diverse contexts mediated by digital technologies [13]-[15]. Digital cultural intelligence encompasses metacognitive awareness, behavioural adaptability, ethical sensitivity in online communication, and the ability to interpret culturally embedded information within digital platforms [16] [18]. For nursing assistant students, who frequently serve as frontline caregivers in resource-variable settings, such competence is critical to ensuring equitable and context-sensitive care delivery.

Parallel to this development, clinical adaptability has emerged as a key competency in healthcare education. Clinical adaptability refers to the capacity to adjust clinical reasoning, communication strategies, and procedural behaviours in response to dynamic patient needs, technological systems, and institutional environments [19]-[21]. In increasingly hybrid healthcare systems where face-to-face care intersects with electronic health records, teleconsultation, and digital monitoring adaptability is essential for safe practice [22]-[24]. Students who lack adaptive capacity may struggle when transitioning from classroom-based knowledge to unpredictable clinical environments, particularly in culturally diverse and digitally evolving settings.

Existing literature in nursing education has predominantly examined cultural competence within the context of international mobility programs, intercultural placements, or study-abroad experiences. Previous reviews have highlighted themes such as culture shock, language barriers, supervisory support, and professional identity transformation [25]-[27]. While these studies provide valuable insight into experiential learning in cross-border settings, three critical gaps remain.

First, empirical research rarely integrates cultural competence with digital capability into a unified analytical framework. The emerging concept of digital cultural intelligence remains underexplored in nursing assistant education, particularly in non-Western contexts [28]-[30]. Second, most studies employ qualitative designs, limiting the development of explanatory or predictive models capable of informing curriculum reform [31], [32]. Third, African and North African health education contexts are significantly underrepresented in global nursing education research, despite their rapidly evolving healthcare infrastructures and growing digital integration [31]-[33].

Morocco, positioned at the intersection of African, Arab, and European health systems, presents a unique multicultural and digitally transitioning healthcare landscape. Nursing assistant students at the college of health sciences casablanca are educated within a system characterised by linguistic plurality (Arabic, French, and increasingly English), socio-cultural diversity, and expanding digital health initiatives. Yet, there is limited empirical evidence examining how these students develop digital cultural intelligence and whether such competence predicts their clinical adaptability. The absence of context-specific quantitative modelling represents a substantial knowledge gap with implications for global nursing education discourse [34], [35].

Addressing this gap is urgent for three reasons. First, healthcare digitalisation is accelerating across low- and middle-income countries, necessitating workforce readiness beyond traditional cultural competence frameworks. Second, nursing assistant students constitute a critical segment of the healthcare workforce, yet remain underrepresented in high-impact educational research. Third, developing predictive structural models can inform evidence-based curriculum design aligned with global competency standards. The present study therefore moves beyond descriptive accounts of intercultural experiences and advances a theoretically integrated, quantitatively tested model linking digital cultural intelligence and clinical adaptability among nursing assistant students in a North African health college. By situating the investigation within Morocco, this study contributes a Global South perspective to international nursing education scholarship and responds to calls for more diverse, model-driven research designs.

Accordingly, the aim of this cross-sectional study is to examine the relationship between digital cultural intelligence and clinical adaptability among nursing assistant students at the College of Health Sciences – Casablanca. The study seeks to answer the following research question, To what extent does digital cultural intelligence predict clinical adaptability among nursing assistant students in a North African health education context?

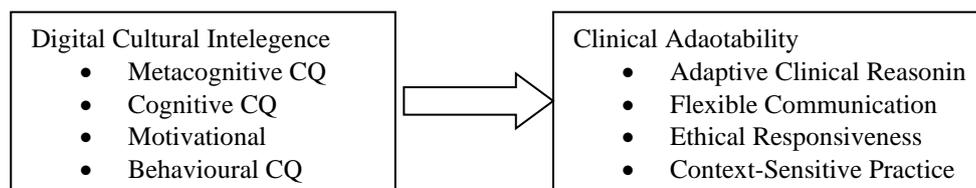


Figure. 1. Conceptual framework illustrating the hypothesised relationship between digital cultural intelligence and clinical adaptability among nursing assistant students

## 2. RESEARCH METHOD

### 2.1 Study design

This study employed a quantitative, cross-sectional, explanatory design to examine the predictive relationship between digital cultural intelligence and clinical adaptability among nursing assistant students. A structural equation modelling (SEM) approach was adopted to test the hypothesised conceptual framework (Fig. 1). A cross-sectional design was considered appropriate because objective was to examine structural relationships between latent constructs rather than causal longitudinal change [36], [37]. The study adhered to the STROBE guidelines for reporting cross-sectional research.

### 2.2 Sample size and sampling strategy

This study was conducted in the 2025 academic year at the college of health sciences in casablanca, Morocco, which offers vocational education and diploma programs for nursing assistant students. Students participated in theoretical classroom learning and clinical practicums at various hospitals with diverse cultural backgrounds. Inclusion criteria included students enrolled in their first to third year of nursing assistantship, having completed at least one clinical practicum, and providing written informed consent. Exclusion criteria included students on academic leave and respondents with incomplete questionnaires (more than 20% of data missing).

Stratified random sampling was used to ensure proportional representation of each academic year. Sample size was determined using two approaches. First, a power analysis was conducted using software with an effect size ( $f^2$ ) assumption of 0.15 (medium category), a significance level ( $\alpha$ ) of 0.05, a power ( $1-\beta$ ) of 0.95, and one predictor, thus obtaining a minimum sample size of 129 respondents. Second, using the rule of thumb in PLS-SEM (10-times rule), which is ten times the number of the largest structural paths leading to a construct (1 path), thus obtaining a minimum requirement of 100 respondents. To increase the power of the analysis and anticipate the possibility of non-response, a total of 320 questionnaires were distributed. Of these, 287 responses were declared valid and were analyzed with a response rate of 89.7%. This number has exceeded the minimum limit recommended to ensure the stability of the analysis in both PLS-SEM and CB-SEM.

### 2.3 Measures

All instruments were administered in French (primary instructional language), using a translation-back translation procedure to ensure semantic equivalence.

#### 2.3.1 Digital cultural intelligence (DCQ)

Digital cultural intelligence was measured using an adapted version of the Cultural Intelligence Scale (CQS), extended to digital healthcare contexts. The instrument consisted of 16 items across four dimensions:

- Metacognitive digital CQ
- Cognitive digital CQ
- Motivational digital CQ
- Behavioural digital CQ

Responses were recorded on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

#### 2.3.2 Clinical adaptability scale

Clinical adaptability in this study was measured using an instrument developed from the framework of adaptive expertise and modern clinical competencies. Clinical adaptability is understood not only as technical ability, but also as cognitive, communicative, ethical, and contextual capacity to deal with the variety of patient cases and the complexity of the healthcare environment. This instrument consists of 14 items reflecting four main dimensions: adaptive clinical reasoning skills, flexible communication, ethical responses to clinical dilemmas, and practice that is sensitive to the patient's social and cultural context. Each item is measured using a five-point Likert scale, ranging from strongly disagree to strongly agree, allowing for a more comprehensive exploration of students' levels of perception and adaptive readiness. To provide a more systematic overview of the constructs used in study, Table 1 presents the characteristics of variable, along with the sources of adaptation and the measurement scales used.

Table 1. Constructs and measurement characteristics

Construct	Dimensions	Items	Source Adaptation	Scale
Digital Intelligence	Metacognitive, Motivational, Behavioural	Cognitive, 16	Adapted CQS (digital context)	5-point Likert
Clinical Adaptability	Reasoning, Communication, Context practice	Ethics, 14	Adaptive expertise frameworks	5-point Likert

As shown in the table, both constructs were measured using a multidimensional approach to ensure depth of analysis. Digital Cultural Intelligence was adapted from the Cultural Intelligence Scale and adapted to the digital context, while Clinical Adaptability was developed based on an adaptive expertise framework relevant to nursing practice. The use of a five-point Likert scale for both variables aimed to maintain measurement consistency and facilitate interpretation of the results of further statistical analysis.

## 2.4 Validity and reliability

Instrument's validity and reliability testing procedures were conducted in stages to ensure optimal measurement quality [38]. Initially, instrument was reviewed by three international experts in nursing education and intercultural health. The assessment focused on clarity of wording, relevance of substance, and contextual suitability to the characteristics of nursing assistant students [39]. The assessment results showed a content validity index (CVI) of 0.91, indicating excellent content validity and high agreement among experts on the instrument's suitability. Next, a pilot study was conducted with 40 respondents to evaluate internal consistency and item clarity. The analysis revealed Cronbach's alpha values ranging from 0.82 to 0.90, indicating high reliability for each construct measured. These findings confirmed that the instrument had adequate stability and internal consistency before use in the main study.

Construct validity was evaluated through testing the measurement model using a Structural Equation Modeling approach. All indicators showed factor loadings above 0.70, indicating a strong contribution to their respective constructs. The composite reliability (CR) value exceeded 0.70, and average variance extracted (AVE) was above 0.50, thus meeting the convergent validity criteria. Furthermore, discriminant validity was confirmed by the heterotrait-monotrait ratio (HTMT) value, which was below the threshold of 0.85, indicating that each construct has empirically distinct and non-overlapping characteristics. Data collection was conducted from March to May 2025, coinciding with scheduled academic sessions to ensure respondent accessibility. Participation was voluntary and anonymous to maintain confidentiality and reduce the potential for social bias. The questionnaire was distributed in paper-and-pencil format and completed under controlled supervision to minimize response bias and ensure the completeness of the collected data.

## 2.5 Statistical analysis

Data analysis was conducted in stages using SPSS version 27 for descriptive analysis and initial screening, and SmartPLS version 4 for structural model testing [40], [41]. In the preliminary stage, data screening was performed to ensure the quality and feasibility of further analysis. The percentage of missing data was recorded at less than 3%, thus requiring no special imputation procedures. Normality tests showed skewness values within the  $\pm 2$  range and kurtosis within the  $\pm 7$  range, indicating acceptable data distribution for multivariate analysis. Furthermore, multicollinearity testing revealed a variance inflation factor (VIF) value below 3.3, indicating no high correlation between predictors.

To test the predictive relationship between digital cultural intelligence and clinical adaptability, this study employed a structural equation modeling (SEM) approach [42], [43]. Methodologically, Partial Least Squares-SEM (PLS-SEM) was chosen because this research focuses on predicting and developing a relatively new construct, namely digital cultural intelligence, as an extension of cultural intelligence theory in a digital context. Unlike covariance-based SEM (CB-SEM), which emphasizes confirmation of established theoretical models and requires strict multivariate normality and large sample sizes, PLS-SEM is more flexible with respect to data distribution and efficient for medium sample sizes.

Furthermore, digital cultural intelligence is modeled as a second-order construct using a reflective-reflective approach, a hierarchical structure that can be handled more efficiently in SmartPLS. However, to ensure model robustness and enhance the credibility of the findings, additional analyses using the CB-SEM approach were conducted as a robustness test. The results indicated adequate model fit indices (CFI > 0.90 and RMSEA < 0.08), thus providing cross-method validation.

The structural model evaluation in PLS-SEM included path coefficient ( $\beta$ ) analysis, significance testing using a bootstrapping procedure with 5,000 resamples, and coefficient of determination ( $R^2$ ), effect size ( $f^2$ ), and predictive relevance ( $Q^2$ ) using a blindfolding procedure. Statistical significance level was set at  $p < 0.05$ . To clarify the criteria for interpreting the analysis results, Table 2 presents the thresholds for evaluating the structural model used in this study.

Table 2. Structural model evaluation criteria

Indicator	Threshold	Interpretation
Path coefficient ( $\beta$ )	> 0.10	Meaningful relationship
$R^2$	0.25 / 0.50 / 0.75	Weak / Moderate / Substantial
$f^2$	0.02 / 0.15 / 0.35	Small / Medium / Large effect
$Q^2$	> 0	Predictive relevance
HTMT	< 0.85	Discriminant validity

Overall, the combination of PLS-SEM as the primary analysis and CB-SEM as an additional confirmatory test provides a strong methodological foundation. This approach not only supports the research's predictive objectives but also ensures the statistical stability and consistency of the model, thus providing a more comprehensive level of reliability and validity for the results.

## 2.6 Ethical considerations

Ethical approval was obtained from Institutional Research Ethics Committee of the College of Health Sciences Casablanca (Ref: CHSC/2025/017). Participants provided written informed consent. Data confidentiality and anonymity were strictly maintained.

## 3. RESULTS AND DISCUSSION

### 3.1. Participant characteristics

A total of 287 nursing assistant students were included in the final analysis. The majority were female (72.5%), reflecting the gender distribution typical of nursing education in Morocco. Participants' mean age was 20.8 years (SD = 1.9). Year-level distribution was relatively balanced (Year 1: 34.1%; Year 2: 33.4%; Year 3: 32.5%). All participants had completed at least one clinical placement in public or private healthcare institutions. Preliminary screening confirmed no substantial missing data (<3%), no multicollinearity concerns (VIF range: 1.42–2.31), and acceptable distributional properties for PLS-SEM analysis [42], [44].

### 3.2. Measurement model assessment

Reflective measurement model was evaluated in terms of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. All item loadings exceeded the recommended threshold of 0.70, ranging from 0.71 to 0.88, indicating satisfactory indicator reliability.

Table 3. Outer loadings of measurement items

Construct	Item Code	Loading
Digital Cultural Intelligence	DCQ1	0.82
	DCQ2	0.79
	DCQ3	0.85
	DCQ4	0.83
	DCQ5	0.76
	DCQ6	0.88
	DCQ7	0.81
	DCQ8	0.74
	DCQ9	0.77
	DCQ10	0.84
	DCQ11	0.80
	DCQ12	0.73
	DCQ13	0.86
	DCQ14	0.78
	DCQ15	0.75
	DCQ16	0.82
Clinical Adaptability	CA1	0.83
	CA2	0.79
	CA3	0.81
	CA4	0.76
	CA5	0.85
	CA6	0.74
	CA7	0.78
	CA8	0.87
	CA9	0.72
	CA10	0.80
	CA11	0.82
	CA12	0.75
	CA13	0.84
	CA14	0.77

All loadings were statistically significant ( $p < 0.001$ ) based on bootstrapping (5,000 resamples). Composite reliability (CR) values ranged from 0.91 to 0.95, exceeding the recommended 0.70 threshold. Average variance extracted (AVE) values were above 0.50, confirming convergent validity.

Table 4. Reliability and convergent validity

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE
Digital Cultural Intelligence	0.94	0.95	0.56
Clinical Adaptability	0.92	0.93	0.58

Discriminant validity was assessed using the heterotrait–monotrait ratio (HTMT). The HTMT value between digital cultural intelligence and clinical adaptability was 0.63, well below the 0.85 threshold, indicating adequate discriminant validity.

### 3.3 Structural model assessment

Structural model evaluated by examining path coefficients ( $\beta$ ), coefficient of determination ( $R^2$ ), effect size ( $f^2$ ), and predictive relevance ( $Q^2$ ).

Table 5. Structural model results

Hypothesis	Path	$\beta$	t-value	p-value	$f^2$	Decision
H1	Digital Cultural Intelligence → Clinical Adaptability	0.64	14.87	<0.001	0.69	Supported

Digital cultural intelligence showed significant positive effect on clinical adaptability  $\beta = 0.64$ ,  $t = 14.87$ , and  $p < 0.001$ . This indicates a strong and statistically significant predictive relationship. The effect size of digital cultural intelligence on clinical adaptability was  $f^2 = 0.69$ . This indicates a large effect according to Cohen's criteria (0.35 = large).

Table 6. Model summary

Indicator	Value	Interpretation
$R^2$ (Clinical Adaptability)	0.41	Moderate explanatory power
$Q^2$	0.29	Predictive relevance established
HTMT	0.63	Discriminant validity confirmed

The  $R^2$  value for clinical adaptability was  $R^2 = 0.41$ . This suggests that digital cultural intelligence explains 41% of the variance in clinical adaptability, representing a moderate-to-substantial explanatory power in educational research contexts. Blindfolding procedures yielded  $Q^2 = 0.29$ . Since  $Q^2 > 0$ , the model demonstrates adequate predictive relevance.

This study examined the predictive relationship between digital cultural intelligence and clinical adaptability among nursing assistant students in a North African health education context. The findings demonstrate that digital cultural intelligence exerts a strong and statistically significant effect on clinical adaptability ( $\beta = 0.64$ ,  $p < 0.001$ ), explaining 41% of the variance in students' adaptive clinical performance. These results suggest that the capacity to navigate culturally diverse interactions within digitally mediated healthcare environments is not merely a complementary competence, but a central determinant of adaptive clinical functioning.

The findings extend Cultural Intelligence Theory beyond its traditional interpersonal and cross-border applications into digitally mediated clinical environments. While earlier conceptualisations emphasised metacognitive awareness, cultural knowledge, motivation, and behavioural flexibility in face-to-face intercultural encounters, the present study demonstrates that these dimensions retain predictive relevance when embedded within hybrid healthcare systems characterised by electronic documentation, digital communication, and multicultural service delivery.

From an adaptive expertise perspective, clinical adaptability is understood as the ability to apply knowledge flexibly in novel or uncertain situations. The significant explanatory power observed ( $R^2 = 0.41$ ) indicates that culturally informed digital cognition enhances students' readiness to adjust reasoning patterns, communication strategies, and ethical decision-making in complex care contexts. This supports the growing global argument that adaptability in healthcare is cognitively and culturally constructed rather than purely procedural. Importantly, the strength of the structural path ( $\beta = 0.64$ ) exceeds effect sizes commonly reported in traditional cultural competence studies, suggesting that integrating digital dimensions may capture a more contemporary and ecologically valid form of intercultural readiness.

The present study addresses several persistent gaps in global nursing education research. First, although cultural competence has been widely examined, the construct has predominantly been explored through

qualitative inquiry and international mobility contexts, limiting the development of predictive and generalisable explanatory models [45]. Empirical structural modelling of intercultural capabilities within vocational nursing education remains scarce. By employing PLS-SEM to test a theory-driven framework, this study provides novelty by advancing the field of descriptive accounts toward predictive modelling, thereby responding to calls for more analytically rigorous and quantitatively robust investigations in nursing education scholarship.

Second, digital transformation has reshaped healthcare delivery worldwide, yet research rarely integrates digital capability with cultural intelligence into a unified construct [46]. Most existing studies treat digital literacy and cultural competence as separate competencies, overlooking their convergence in contemporary hybrid care environments. By operationalising and empirically validating digital cultural intelligence as a multidimensional latent construct, this study introduces a conceptually integrated framework that reflects the realities of technologically mediated multicultural healthcare systems [47], [48], [49]. This integration constitutes a substantive theoretical advancement, moving beyond static competence paradigms toward digitally embedded intercultural capability models [46], [50], [51].

Third, the geographical context of this research addresses a critical imbalance in global knowledge production [52]. Nursing education literature indexed in high-impact journals remains disproportionately concentrated in western, high-income settings [53]. Empirical evidence from North African vocational nursing programs is notably limited. By situating the investigation within a Moroccan health sciences college, the study contributes contextually grounded Global South evidence, thereby enhancing epistemic diversity and strengthening the cross-cultural generalisability of intercultural competence theory. The strong predictive relationship identified ( $\beta = 0.64$ ) suggests that digital cultural intelligence is not culturally bounded to Western systems but holds explanatory relevance within multilingual and socio-culturally plural African contexts.

The practical and policy implications of these findings are substantial. If digital cultural intelligence explains a significant proportion of adaptive clinical performance, then curricular reform must reflect this structural interdependence [54], [55], [56]. Educational institutions should move beyond fragmented training approaches and instead design integrated learning modules combining digital simulation, intercultural communication, and adaptive clinical reasoning [57], [58], [59]. Policy-makers in emerging health systems should also recognise nursing assistants as critical frontline actors in digitally transitioning care environments. Embedding digitally mediated intercultural competence into competency frameworks may strengthen patient safety, ethical responsiveness, and equity-oriented service delivery [60], [61].

Nevertheless, several limitations must be acknowledged. The cross-sectional design constrains causal inference and does not capture developmental trajectories of competence formation. Self-reported measures may introduce perceptual bias, and the single-institution sample limits broader institutional generalisation. Furthermore, while the model explained 41% of variance in clinical adaptability, additional constructs such as digital self-efficacy, emotional intelligence, or clinical exposure intensity may further refine explanatory power. Future research should therefore employ longitudinal, multi-site, and cross-national comparative designs to validate and expand proposed framework across diverse healthcare systems.

#### 4. CONCLUSION

This study aimed to examine whether digital cultural intelligence predicts clinical adaptability among nursing assistant students in a North African health education context. The findings provide clear empirical support for this relationship, demonstrating that digital cultural intelligence is a strong and significant predictor of adaptive clinical performance. The model explained a substantial proportion of variance in clinical adaptability, confirming that the ability to navigate culturally diverse interactions within digitally mediated healthcare systems is central to effective frontline practice. These results extend intercultural competence theory into digitally embedded care environments and highlight the importance of integrating cultural awareness, digital cognition, motivational engagement, and behavioural flexibility within vocational nursing education. In increasingly hybrid healthcare systems, adaptability is not merely procedural but cognitively and culturally constructed. Based on these findings, curriculum developers should incorporate structured digital intercultural simulations, telehealth communication training, and adaptive clinical reasoning exercises into nursing assistant programs. Institutional policy-makers should embed digital cultural competence within graduate competency frameworks to align education with contemporary workforce demands. At a broader level, health education systems in emerging economies should prioritise integrated competence models that reflect the intersection of multicultural care and digital transformation. Future research should adopt longitudinal and multi-institutional designs to examine competence development trajectories and expand the model by integrating additional psychological and contextual predictors. Strengthening evidence in this direction will support the development of globally responsive, digitally capable, and culturally intelligent healthcare professionals equipped for twenty-first-century clinical realities.

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## USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors confirm that no artificial intelligence (AI)-assisted technologies were utilized in the preparation, analysis, or writing of this manuscript. All stages of the research process, including data collection, data interpretation, and the development of the manuscript, were conducted solely by the authors without any support from AI-based tools.

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