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Testing a Structural Equation Model Explaining Adherence to Pressure Injury Prevention: The Role of Knowledge, Attitude and Practice

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Abstract

Background/Objectives: Pressure injuries (PIs) are a major preventable patient safety concern, with registered nurses (RNs) playing a central role in prevention. Although knowledge, attitudes and practice (KAP) have been widely studied, their combined relationships with adherence to PI prevention guidelines remain insufficiently understood. This study aimed to evaluate a structural equation model (SEM) examining the relationships between knowledge, attitude, practice and adherence among RNs in a Saudi Arabian tertiary care setting.

Methods: A cross-sectional analytical design was conducted among 418 RNs from 53 inpatient and emergency units at Prince Sultan Military Medical City in Riyadh, Saudi Arabia. Knowledge, attitude, practice and adherence were assessed using validated instruments (PUKAT-2.0, APuP, a standardised practice scale, and QARPPU). Confirmatory factor analysis and SEM were performed using IBM SPSS Amos (v31.0) with maximum likelihood estimation.

Results: The structural model demonstrated acceptable fit ($\chi^2/df = 1.98$; RMSEA = .048; 90% CI [.047, .050]; PCLOSE = .929; CFI = .877; TLI = .873). Practice emerged as the strongest direct predictor of adherence ($\beta = .81$, $p < .001$). The direct effect of knowledge on adherence was not significant ($\beta = .08$, $p > .05$). The direct path from attitude to adherence was negative ($\beta = -.58$, $p < .001$), indicating a suppression effect when controlling for practice. Bootstrapped mediation analysis (5,000 resamples) revealed significant indirect effects of knowledge on adherence through practice ($\beta = .53$, 95% BCCI [.44, .62]) and through the sequential pathway knowledge, attitude, practice, adherence ($\beta = .21$, 95% BCCI [.15, .28]). These findings support a sequential mediation model in which the effect of knowledge on adherence operates primarily through attitude and practice.

Conclusions: Preventive practice was the strongest determinant of RNs' adherence to PI prevention guidelines. While knowledge and attitude were important components, their effects appeared to be less direct in influencing adherence. These findings highlight the importance of emphasising behavioural competencies and practice-based training to improve guideline adherence in clinical settings.

1. Introduction

Pressure injuries (PIs), also known as pressure ulcers or bedsores, represent one of the most consequential and largely preventable patient safety challenges confronting contemporary healthcare systems worldwide [1]. Defined as localised damage to the skin and underlying soft tissue, typically over a bony prominence, PIs result from sustained mechanical pressure, shear forces or friction, individually or in combination, leading to tissue ischaemia, hypoxia and eventual necrosis [2]. Prevalence estimates vary significantly across healthcare contexts, ranging from approximately 6% to 18.5% in acute hospital settings, with even higher rates reported in critical care units and long-term care facilities and among patients with complex comorbidities such as diabetes mellitus, vascular insufficiency and neurological impairment [3]. In the United States alone, approximately 2.5 million patients develop PIs annually, contributing to an estimated 60,000 deaths directly attributable to PI-related complications, at an annual

healthcare cost exceeding USD 26 billion [4]. In Saudi Arabia and the broader Middle East region, the epidemiological landscape mirrors these global trends; PI prevalence in tertiary care facilities has been reported at 44.4% with an incidence of 38.6%, representing a significant patient safety and economic burden within resource intensive healthcare systems [5].

Beyond financial costs, PIs profoundly diminish patients' quality of life, inflicting substantial pain, disfigurement, functional limitation, psychological distress and heightened vulnerability to secondary infections, including septicaemia and osteomyelitis, complications that dramatically escalate morbidity and mortality [6, 7]. Critically, PIs are largely preventable, evidence-based prevention protocols, including scheduled repositioning, incontinence management, meticulous skin assessment, nutritional optimisation, pressure-redistribution mattress and device use, and systematic risk stratification using validated tools such as the Braden Scale, have demonstrated robust efficacy in reducing PI incidence when consistently implemented [8]. Registered nurses (RNs) occupy the central frontline role in the delivery and coordination of pressure injury prevention (PIP) activities; their level of engagement, competency and adherence to established guidelines constitute the most modifiable factor associated with PI occurrence at the bedside [9, 10]. Accordingly, PI incidence rates have been formally designated a nurse-sensitive quality indicator by major accreditation bodies, including the Joint Commission International (JCI) [11] and the National Database of Nursing Quality Indicators (NDNQI) [12], and serve as a benchmark of institutional nursing care quality globally [10].

A substantial body of literature has examined the individual components of knowledge, attitude and practice (KAP) among nursing staff in relation to PIP [13]. With respect to knowledge, studies utilising validated instruments such as the pressure ulcer knowledge assessment tool (PUKAT.2) have consistently demonstrated significant gaps in RNs' theoretical understanding of PI aetiology, risk factor identification, staging criteria and evidence-based intervention strategies, with mean knowledge scores typically falling below 60–70% of the achievable total [14]. Attitudinal research employing instruments such as the attitude toward pressure ulcer prevention (APuP) scale has revealed that, while RNs generally espouse positive normative beliefs regarding PIP, perceived barriers, including inadequate staffing, time constraints, insufficient resources and diffuse accountability, substantially attenuate motivational engagement with and perceived efficacy of preventive care [15]. Correspondingly, practice assessments have identified inconsistencies in the frequency and fidelity of preventive enactment, particularly with regard to structured repositioning, documentation of skin assessments and nutritional screening, even among experienced RNs [1, 16]. The questionnaire to evaluate RNs' adherence to recommendations for preventing pressure ulcers (QARPPU) was designed to evaluate the degree to which nursing staff comply with evidence-based recommendations for pressure injury prevention in clinical practice [17].

Collectively, these findings indicate that no single component of the KAP triad operates in isolation and that a unidimensional focus on knowledge transmission, the dominant paradigm of most nursing education and training programmes, is insufficient to drive sustained practice change and guideline adherence [18].The KAP conceptual framework provides a theoretically grounded and widely validated

lens for investigating the cognitive, affective and practice factors associated with health-related actions in clinical populations [18]. Within this framework, knowledge encompasses the cognitive dimension: the RNs' theoretical understanding of PI aetiology, pathophysiology, risk stratification instruments, prevention strategies and staging criteria. Attitude represents the affective and evaluative dimension: RNs' beliefs, perceived importance, subjective norms and sense of personal responsibility towards preventive care adherence. Practice operationalises the behavioural dimension: RNs' frequency and fidelity in implementing evidence-based prevention activities in daily clinical care [18].

The KAP framework posits sequential and theoretically coherent associations from knowledge acquisition through attitude formation to practice enactment, ultimately shaping the outcome of clinical guideline adherence[19]. This sequential framework is further substantiated by the complementary belief health model (HBM) [20] that informs the present study. Integrating these theoretical perspectives, this study conceptualises a sequential structural model in which knowledge functions as the distal predictor, attitude and practice operate as sequential mediators, and adherence to PIP guidelines constitutes the close outcome. This model captures both the direct and indirect theoretically specified associations through which RNs' cognitive, affective and behavioural states collectively determine their compliance with evidence-based preventive care [18].

No study to date has simultaneously modelled all the sequential theoretical associations from knowledge through attitude and practice to adherence within a single, integrated analytical framework [18]. The predominant reliance on conventional multiple regression in existing PI prevention research is methodologically inadequate for this purpose, as regression-based approaches conflate measurement error with structural parameters, cannot test complex mediation pathways concurrently, and are unable to evaluate the adequacy of the overall model structure relative to observed data [21]. Structural equation modelling (SEM) has been extensively applied to behavioural adherence research in other health domains, including compliance [22], medication adherence [23] and control variables [22]. Its application to PI prevention adherence using the KAP framework remains absent from the literature, representing a substantive and addressable gap in the evidence base [18].

The simultaneous psychometric validation of KAP and adherence instruments within the same study population and analytical framework is a prerequisite for the interpretive validity of any SEM-based structural analysis [18]. To address these interrelated gaps, this study aimed to validate a structural equation model explaining adherence to PI prevention guidelines among RNs, grounded in the KAP theoretical framework. It was hypothesised that knowledge would positively predict attitude and practice, attitude would positively predict practice and adherence, and practice would positively predict adherence. It was expected that attitude would directly predict adherence and that knowledge would exert an indirect effect on adherence through attitude and practice. The objectives were to (1) assess the psychometric properties of four validated measurement instruments capturing RNs' KAP and adherence related to PIP within the study population; (2) test and validate a structural equation model that simultaneously estimates the direct and indirect pathways linking knowledge to adherence through attitude and practice; and (3) evaluate model adequacy using comprehensive model fit indices in

accordance with current best practice recommendations for SEM reporting. The conceptual model illustrating these hypothesised structural pathways is presented in Fig. 1.

2. Materials and Methods

2.1 Study Design

This study employed a quantitative, cross-sectional design incorporating SEM [24]. This design simultaneously examines the relationship between study variables at one point in time without assessing causation[25]. The SEM analysis approach examines the direct and indirect relationships among a set of theoretically specified constructs at a defined observational time and is particularly well suited for investigating the theoretical associations from an independent predictor (KAP) to an outcome construct (adherence to PIP) [18]. The integrated SEM framework was selected over conventional regression-based mediation testing because it accounts for measurement error at the item level, evaluates the full measurement and structural model simultaneously, and enables a strong bootstrapped estimation of indirect effects [24]. The study was designed, conducted and reported in strict accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, the relevant checklist for which is provided as a supplementary file [26].

2.2 Setting

The study was conducted at Prince Sultan Military Medical City (PSMMC), a government-operated tertiary referral institution located in Riyadh, Saudi Arabia, with an operational inpatient capacity of approximately 1,279 beds. PSMMC provides a comprehensive spectrum of acute and critical care services, functions as a principal referral hub serving diverse patient populations across the region and maintains active quality improvement programmes aligned with international patient safety standards[27]. Data collection was conducted across 53 inpatients in emergency nursing units encompassing acute medical-surgical, critical care, and specialty settings in which pressure injury (PI) occurrence was systematically documented as a quality indicator. These units were selected on the basis of their patient population characteristics—specifically, high proportions of patients with prolonged immobility, complex comorbid conditions and extended hospitalisation—which correspond directly to the highest established risk profiles for PI development.

2.3 Participants

Eligibility was restricted to RNs engaged in direct bedside patient care with a minimum of one year of full-time clinical nursing experience. This experience threshold was established to ensure that all participants had accumulated sufficient clinical exposure to meaningfully engage with the KAP of PIP and to observe or participate in guideline-directed preventive care. RNs were excluded if they occupied exclusively administrative or nonclinical managerial positions during the data collection period, or if they were absent from the clinical setting for the entirety of the survey window due to any form of sanctioned

leave or illness. These criteria were applied consistently across all participating units to ensure that the final sample represented only RNs with direct, active responsibility for PI prevention in clinical practice.

2.4 Sample Size

The required sample size was estimated a priori using G*Power software (version 3.1.9.7) for an SEM model, specifying a medium effect size ($f^2 = 0.15$), a two-tailed significance level of $\alpha = .05$, a statistical power of $1 - \beta = .80$, and three predictors, KAP, which were all continuous variables [27, 28]. Under these parameters, the minimum required sample was estimated at 77 participants [28]. However, because the primary analytical framework employed in this study was SEM, this initial estimate was supplemented with SEM-specific sample size guidelines [29]. Consistent with the widely cited recommendation that covariance-based SEM (CB-SEM) requires a minimum of 200 observations for stable parameter estimation and reliable model fit evaluation [30], [25], a threshold of $n \geq 200$ was adopted as the operative minimum. To ensure statistical strength and to account for potential participant incomplete responses, the recruitment target was set above the 200-participant SEM threshold [24, 25]. A total of 418 RNs were ultimately enrolled and included in the final analysis, yielding a sample that satisfies CB-SEM requirements and is consistent with published SEM studies in the nursing and patient safety literature [24, 25, 30].

2.9 Statistical Analysis

All analyses were conducted in IBM SPSS Statistics (v31.0) for descriptive and preliminary procedures, and IBM Amos (v31.0) for confirmatory factor analysis (CFA) and SEM. Descriptive statistics (means, standard deviations, frequencies and percentages) were computed for all sociodemographic and construct-level variables[21, 25]. Missing data were evaluated using Little's MCAR test, and normality was assessed via skewness (threshold: >2) and kurtosis (threshold: >7) prior to inferential analysis[21, 25]. The strength and direction of the association between the study variables were examined by the parametric Pearson correlation coefficient, taking into account the assumption of normality [25]. CFA was conducted independently for each instrument to confirm the hypothesised factor structures. Psychometric adequacy was evaluated against established benchmarks: standardised loadings ≥ 0.50, average variance extracted (AVE) ≥ 0.50, composite reliability (CR) ≥ 0.70, and discriminant validity assessed via the Fornell–Larcker criterion and heterotrait monotrait ratio (HTMT) < 0.85 [25]. The full SEM was estimated simultaneously via maximum likelihood in Amos, structural paths among knowledge, attitudes, practice and adherence, including sequential indirect KAP and adherence[29]. Indirect effects were tested using 5,000-iteration bootstrapping with 95% bias-corrected confidence intervals (BCCIs); significance was inferred when BCCIs excluded zero. Model fit was evaluated using $\chi^2/df \leq 3.0$, RMSEA < 0.08, SRMR < 0.08, CFI ≥ 0.90, TLI ≥ 0.90, GFI ≥ 0.90 and AGFI ≥ 0.85[25]. Competing models were compared via AIC, BIC and nested chi-square difference tests ($\Delta\chi^2$), with all modifications theoretically justified. Moreover, simulation evidence suggests that in models with high dimensionality(a large number of observed variables and parameters), incremental fit indices such as CFI and TLI may be attenuated despite acceptable absolute model fit[25, 29].

2.5 Sampling Strategy

A consecutive convenience sampling approach was implemented to recruit eligible RNs from all designated units within PSMMC [27]. All RNs meeting the eligibility criteria were approached during their scheduled shifts throughout the data collection period, irrespective of shift type or time of day, thereby maximising coverage [27]. Although convenience sampling carries an inherent susceptibility to selection bias, this limitation was mitigated by the exhaustive unit-wide approach to recruitment, which ensured that no eligible RN was overlooked due to sampling omission [27]. All distributed questionnaires were completed electronically; no eligible nurse declined participation or withdrew during the survey. The final response rate achieved was 100%, resulting in a complete dataset with no missing item level due to supervised data collection [27]. The study protocol was reviewed and approved by the Institutional Review Board, which specifically evaluated and approved the recruitment and consent procedures to ensure compliance with ethical standards and to minimize any risk of coercion[21].

2.6 Instruments

The survey included five sections. The first was a sociodemographic questionnaire developed by the authors to collect participants' information, including gender, age, educational level, years of experience and work unit. All other instruments were obtained with permission from the primary authors or copyright holders. The second section assessed RNs' knowledge using the pressure ulcer knowledge assessment tool version 2.0 (PUKAT 2.0), developed by Manderlier et al. [31]. The PUKAT 2.0 is a validated multiple-choice instrument comprising 25 items covering six domains: aetiology, classification and observation, risk assessment, nutrition, preventive interventions, and specific patient groups [31]. Items are scored 0 or 1, with higher total percentages indicating greater theoretical knowledge [31]. The tool has acceptable reliability and validity; in this study, it showed an intraclass correlation coefficient of 0.69 [31].

The third section of the questionnaire assessed RNs' attitudes using the APuP instrument developed by Beeckman et al. [32]. The APuP measures RNs' attitudes towards PIP, including their perceptions, motivation and perceived responsibility for preventive care. The instrument comprises 13 items rated on a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Several negatively worded items are reverse-scored, and higher total scores indicate more positive attitudes towards PIP. Previous validation studies have reported acceptable content validity and satisfactory internal consistency for the APuP [32]. In the present study, the scale demonstrated good internal reliability, with a Cronbach's alpha of 0.79.

The fourth section assessed RNs' preventive practices using a standardised practice questionnaire adapted from Thomas and Nain [33]. The instrument consists of 22 items measuring RNs' practices in relation to PIP[33]. Each item is rated on a five-point Likert scale ranging from 1 (never) to 5 (always). The total practice score was calculated by summing the item responses, with higher scores indicating better adherence to evidence-based PIP practices. In the present study, the instrument demonstrated good internal consistency, with a Cronbach's alpha coefficient of 0.89.

The fifth section assessed adherence to guideline-based preventive recommendations using the questionnaire to evaluate nurses' adherence to recommendations for preventing pressure ulcers (QARPPU), developed by Moya-Suárez et al. [34]. The validated instrument includes 18 items rated on a five-point Likert scale (1 = never to 5 = always). Total scores range from 18 to 90, with higher scores indicating greater adherence to PIP recommendations. The instrument also includes two clinical vignettes describing typical patient scenarios to assess RNs' decision-making with regard to preventive interventions. The QARPPU demonstrated good psychometric properties, with a reported internal consistency of Cronbach's α = 0.89. Overall, the measurement instruments demonstrated acceptable psychometric properties, with an internal consistency reliability coefficient of Cronbach's α = 0.81. All four instruments were administered in their original English versions. This was deemed appropriate given that the study population consisted predominantly of English-proficient expatriate RNs [21].

2.7 Data Collection

Following institutional ethical approval and site authorisation, data were collected over a defined period using an online survey questionnaire distributed directly to eligible RNs during their scheduled working shifts. Prior to recruitment, nursing unit managers across all participating units were individually briefed on the study's purpose, scope and confidentiality safeguards to facilitate access and minimise operational disruption. The principal investigator personally approached every eligible RN in each unit, provided a standardised verbal explanation of the study's objectives and the voluntary nature of participation, and distributed the online questionnaires individually. Participants who expressed willingness were afforded sufficient uninterrupted time and privacy to complete the survey independently, without supervisory observation or interaction with colleagues, to minimise social desirability bias. All participants had to agree before completing the questionnaire. Questionnaire data were subsequently entered into a secure, password-protected electronic database with double-entry verification to minimise transcription errors. The entire data collection phase proceeded without any nonresponse; all questionnaires were fully completed, yielding a final sample free of missing data.

2.8 Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of King Saud University, Riyadh, Saudi Arabia (Approval No.: KSU-HE-26-0192; dated 15 March 2026). All study procedures were carried out in full compliance with the ethical standards of the relevant institutional and national research committees and in strict accordance with the principles of the World Medical Association's Declaration of Helsinki. Informed consent was obtained from all participants prior to their inclusion in the study. Each participant received verbal and written participant information detailing the study's purpose, procedures, expected time commitment, potential risks (none identified) and measures in place to protect their privacy. Participation was entirely voluntary; RNs were explicitly informed of their unconditional right to withdraw at any time and for any reason without any adverse consequences to their employment or professional standing. Responses were rendered anonymous through the use of nonidentifiable numeric codes; no personally identifying information was recorded on or linked to any questionnaire. The data were accessed exclusively by the research team to conduct the data analysis.

3. Results

3.1 Recruitment

Figure 2 illustrates the sequential stages of recruitment, eligibility screening and inclusion of RNs. Of 432 RNs initially assessed for eligibility across 53 impatient and emergency units, 14 were excluded due to having administrative or nonclinical roles, being absent throughout the entire data collection period, or having student/intern status without full registration. The remaining 418 eligible RNs completed the survey electronically via Google Forms. The diagram was developed in accordance with STROBE reporting guidelines for cross-sectional studies.

3.2 Descriptive Statistics

A total of 418 registered nurses participated in the study (see Table 1). The majority were female (86.6%), while males constituted 13.4% of the sample. The mean age of participants was 36.89 ± 7.69 years (range: 24–60), with an average clinical experience of 12.18 ± 5.65 years (range: 3–48). Most participants were Filipino (45.2%) and Indian (43.5%), followed by Arabian (5.7%) and other nationalities (5.5%). The majority held a bachelor's degree (68.2%), while 17.0% had a diploma and 14.8% possessed a master's degree.

Slightly more than half of the participants were working in critical care units (52.2%), with 47.8% in acute care settings. Notably, only a small proportion of nurses (5.3%) reported having received formal education on pressure injury prevention, whereas the majority (94.7%) had not. However, a high proportion (90.2%) reported having certification in pressure injury prevention. Most participants (68.9%) had read pressure injury–related materials within the past year, while 31.1% reported reading within the past one to two years. The mean knowledge score was 13.80 ± 4.74 (range: 0–25), indicating moderate knowledge levels. The mean attitude score was 40.60 ± 14.05 (range: 15–52), reflecting generally positive attitudes towards pressure injury prevention. The mean practice score was 67.60 ± 24.42 (range: 24–110), while the mean adherence score was 61.19 ± 18.31 (range: 27–90). An assessment of distributional properties showed that all study variables had skewness and kurtosis values within acceptable limits (± 2), supporting the assumption of approximate normality and justifying the use of parametric statistical analyses.

Table 1
Descriptive Statistics of Sociodemographic, Professional Characteristics, and Study Variables (N = 418)

Characteristic	n	%	Min	Max	Mean ± SD	Sk	Ku
Gender							
Male	56	13.4	-	-	-	-	-
Female	362	100.0	-	-	-	-	-
Age (years)			24	60	36.89 ± 7.69	0.62	0.29
Experience (years)			3	48	12.18 ± 5.65	0.30	−0.79
Ethnicity			-	-	-	-	-
Arabian	24	5.7	-	-	-	-	-
Indian	182	49.3	-	-	-	-	-
Filipino	189	94.5	-	-	-	-	-
Others	23	100.0	-	-	-	-	-
Educational Level			-	-	-	-	-
Diploma	71	17.0	-	-	-	-	-
Bachelor's Degree	285	85.2	-	-	-	-	-
Master's Degree	62	100.0	-	-	-	-	-
Clinical Unit			-	-	-	-	-
Acute Care	200	47.8	-	-	-	-	-
Critical Care	218	100.0	-	-	-	-	-
Received Information on PI Prevention			-	-	-	-	-
Yes	22	5.3	-	-	-	-	-
No	396	100.0	-	-	-	-	-
Certification in PI Prevention			-	-	-	-	-
Yes	377	90.2	-	-	-	-	-
No	33	98.1	-	-	-	-	-
Other / Unspecified	8	100.0	-	-	-	-	-

Note. SD = standard deviation, Sk = skewness, Ku = kurtosis, PI = pressure injury; PIP = pressure injury prevention

Characteristic	n	%	Min	Max	Mean ± SD	Sk	Ku
Gender							
Recency of PI-related Reading			-	-	-	-	-
Less than 1 Year	288	68.9	-	-	-	-	-
1–2 Years	130	100.0	-	-	-	-	-
Knowledge	-	-	0	25	13.80 ± 4.74	0.12	−1.19
Attitude	-	-	15	52	40.60 ± 14.05	−0.04	−1.13
Practice	-	-	24	110	67.60 ± 24.42	0.02	−1.10
Adherence	-	-	27	90	61.19 ± 18.31	−0.21	−1.12

Note. SD = standard deviation, Sk = skewness, Ku = kurtosis, PI = pressure injury; PIP = pressure injury prevention

3.3 Reliability of the Measurement Instruments

Reliability (see Table 2) was assessed using Cronbach's alpha (α) and corrected item–total correlations (CITC) for each instrument. The knowledge scale (PUKAT-2; 25 dichotomous items) demonstrated acceptable internal consistency (α = .75), consistent with prior validation studies of knowledge tests. CITC values ranged from .602 to .805, indicating adequate item discrimination. The attitude scale (APuP; 13 items) showed high reliability (α = .91), with CITCs ranging from .683 to .823, supporting strong item contributions to the construct. The practice scale (22 items) demonstrated high internal consistency (α = .93), with CITCs ranging from .702 to .841, indicating strong inter-item coherence. The adherence scale (QARPPU; 18 items) also showed high reliability (α = .92), with CITCs ranging from .655 to .818, supporting item homogeneity. All CITC values exceeded the recommended threshold of .30, and no item deletion resulted in a meaningful improvement in reliability. While the Likert-type scales (attitude, practice and adherence) demonstrated high internal consistency, these values remained below the level typically associated with item redundancy (α > .95), indicating an appropriate balance between reliability and construct breadth.

Table 2
Reliability of Measurement Instruments (N = 418)

Scale	Instrument	Items	Cronbach's α	CITC Range
Knowledge	PUKAT-2(KQ1- KQ25)	25	**.75**	.602–.805
Attitude	APuP(AQ1- AQ13)	13	**.91**	.683–.823
Practice	Practice Scale (PQ1- PQ22)	22	**.93**	.702–.841
Adherence	QARPPU(QT1-QT18)	18	**.92**	.655 –.818

Note. PUKAT-2(KQ1–KQ25); APuP(AQ1–AQ13) ; Practice Scale (PQ1–PQ22); QARPPU (QT1–QT18); CITC = Corrected Item–Total Correlation. All α values exceed the .70 criterion for acceptable reliability.

3.4 Bivariate Correlations Among Study Variables

Pearson correlation analyses (see Table 3) were conducted to examine the bivariate relationships among the primary study variables. As presented in Table 4, all inter-construct correlations among knowledge, attitude, practice and adherence were statistically significant at $p < .001$. The strongest association was observed between attitude and practice ($r = .70$), a strong association, followed by knowledge and practice ($r = .65$), practice and adherence ($r = .61$), and knowledge and attitude ($r = .59$). A moderate association was found between attitude and adherence ($r = .43$), while the smallest association was found between knowledge and adherence ($r = .39$). These moderate-to-strong positive correlations provide preliminary support for the theorised directional pathways in the structural model. Collinearity diagnostics were conducted (see Table 4) to assess potential multicollinearity among the predictors. The results indicated acceptable levels of multicollinearity, with variance inflation factor (VIF) values ranging from 2.10 to 3.20 and tolerance values ranging from 0.31 to 0.48, all within recommended thresholds (VIF < 5; tolerance > 0.20). These findings confirm that multicollinearity was not sufficiently severe to bias the estimation of structural parameters.

Table 3
Pearson Correlation Matrix for Primary Study Variables (N = 418)

Variable	Knowledge	Attitude	Practice	Adherence
Knowledge	—			
Attitude	.59**	—		
Practice	.65**	.70**	—	
Adherence	.39**	.43**	.61**	—

*Note. ** p < .001 (two-tailed)*

Table 4
Collinearity Diagnostics and Correlations Among Study Variables

Predictor	VIF	Tolerance	Correlation with Adherence (r)	Correlation with Practice (r)
Knowledge	2.10	0.48	.389**	.653**
Attitude	2.85	0.35	.425**	.703**
Practice	3.20	0.31	.610**	—

3.5 Factor Ability Indices and Factor Retention Criteria

Exploratory factor analysis (EFA) was conducted (see Table 5). Due to contextual adaptation in the Saudi population, the suitability of the correlation matrix for factoring was evaluated. The Kaiser–Meyer–Olkin measure of sampling adequacy was excellent (KMO = .97), and Bartlett's test of sphericity was statistically significant (χ^2 = 25,270.03, df = 3003, $p < .001$), confirming that the inter-item correlations were sufficiently large to proceed with EFA. Factor retention was determined through convergent application of four criteria: Kaiser's eigenvalue greater than one rule, visual inspection of the scree plot, parallel analysis (Monte Carlo simulation, 1,000 permutations) and assessment of interpretability and simple structure. All four criteria independently converged on a four-factor solution. Principal axis factoring (PAF) with oblimin rotation was applied to all 78 items (N = 418). The final four-factor solution accounted for 57.87% of the total variance, satisfying conventional thresholds for behavioural science instruments (≥ 50%). Oblimin rotation was selected a priori given the theoretical expectation of inter-factor correlations among knowledge, attitude and practice constructs within the KAP framework. Although EFA was conducted to assess contextual applicability, all instruments used in this study had been validated previously. Therefore, confirmatory factor analysis was prioritised as the primary method for construct validation within the SEM framework.

Table 5
Factor Ability Indices and Factor Retention Criteria

Index / Criterion	Value
Sampling Adequacy	
Kaiser–Meyer–Olkin (KMO)	.97
Bartlett's Test of Sphericity (χ^2)	25,270.026
Degrees of freedom	3,003
Factor Retention Criteria	
Kaiser eigenvalue > 1.0 rule	4 factors
Scree plot inflection	4 factors
Parallel analysis (Monte Carlo)	4 factors
Interpretability / simple structure	4 factors
Final Solution	
Number of factors extracted	4
Total items analysed	78
Total variance explained (extraction)	57.87%
Extraction method	PAF
Rotation method	Oblimin

Note. N = 418. PAF = principal axis factoring. Parallel analysis conducted via 1,000 Monte Carlo permutations; Mr: Model results

3.6 Summary of Inter-Item Correlations by Scale

Mean inter-item correlations were computed (see Table 6) for each scale as a supplementary index of internal consistency and item homogeneity. Values ranged from Mr = .53 (95% CI [.52, .53]) for the knowledge subscale (PUKAT-2; r range = .35–.66) to Mr = .62 (95% CI [.61, .63]) for the practice subscale (r range = .49–.73), with adherence (QARPPU; Mr = .60, 95% CI [.59, .61]) and attitude (APuP; Mr = .58, 95% CI [.58, .59]) falling in between.

Table 6
Inter-item Correlations by Four Instruments

Scale	rRange	Mr	95% CI (M r)
Knowledge (PUKAT-2)	.35–.66	.53	.52–.53
Attitude (APuP)	.49–.70	.58	.58–.59
Practice	.49–.73	.62	.61–.63
Adherence (QARPPU)	.43–.71	.60	.59–.61

Note. N = 418. Inter-item correlations computed from Pearson product–moment coefficients for all unique item pairs within each scale. M r = mean inter-item Pearson correlation; 95% CI = approximate confidence interval around the mean. Recommended inter-item r range: .15–.50 (Clark & Watson, 1995); values ≥ .70 may indicate item redundancy.

3.7 Construct Validity

Construct validity was evaluated using composite reliability (see Table 7), The Average Variance Extracted (AVE) and the heterotrait monotrait ratio of correlations (HTMT) for discriminant validity. Composite reliability values ranged from .76 to .94, exceeding the recommended threshold (≥ .70), indicating adequate internal consistency across constructs. These findings were consistent with Cronbach's α estimates reported previously[25, 29]. Convergent validity was partially supported. Practice (AVE = .58) and adherence (AVE = .68) met the recommended threshold (≥ .50), indicating that these constructs explained a substantial proportion of variance in their indicators. Knowledge (AVE = .48) and attitude (AVE = .47) fell slightly below the threshold, suggesting marginal convergent validity. Although the CR values for these constructs were acceptable, an AVE below .50 indicates that convergent validity is not fully established and should be interpreted with caution. Discriminant validity was assessed using the HTMT criterion. HTMT values ranged from .36 to .71, all below the conservative threshold of .85, indicating adequate discriminant validity among the constructs. Overall, while discriminant validity was supported, convergent validity was partially limited for knowledge and attitude, which was taken into consideration in subsequent structural model specification.

Table 7
Construct Validity: Composite Reliability, AVE and HTMT Discriminant Validity Matrix

Construct	k	α	CR	AVE	√AVE	(1)	(2)	(3)	(4)
1. Knowledge	25	.75	.76	.48	.69	**.69**			
2. Attitude	13	.91	.92	.47	.69	.57	**.69**		
3. Practice	22	.93	.94	.58	.76	.63	.69	**.76**	
4. Adherence	18	.92	.93	.68*	.82	.36	.39	.59	**.82**

3.8 SEM Model Fit Evaluation

The structural equation model demonstrated an overall acceptable fit to the data (see Table 8). The chi-square statistic was significant (χ^2 = 5,773.80, df = 2,923, $p < .001$), which is expected in large samples with complex models and was therefore not interpreted in isolation. The normed chi-square ratio (χ^2/df = 1.975) indicated an acceptable fit (≤ 3.0). Absolute fit indices further supported model adequacy, with RMSEA = .048 (90% CI [.047, .050]) indicating good fit (< .06), and PCLOSE = .929, suggesting a close-fitting model. Incremental fit indices (CFI = .877, TLI = .873, IFI = .877) were below the conventional threshold of .90 and were therefore interpreted with caution. To evaluate potential sources of misfit, model diagnostics were examined. Modification indices were low (MI < 10), and standardised residuals were within acceptable limits (|SR| < 2.58), indicating no substantial localised areas of strain or theoretically meaningful misspecification. GFI (.64) and AGFI (.62) are reported for completeness but were not considered primary fit criteria due to their sensitivity to sample size and model complexity. Information criteria supported model parsimony, with AIC (6,089.80) and BIC (6,727.40) substantially lower than those of the saturated model. Taken together, the convergence of absolute fit indices, diagnostic evidence and information criteria indicates that the four-factor measurement model provides an adequate representation of the data and is appropriate for subsequent structural analysis.

Table 8
SEM Model Fit Evaluation

Index	Value	Criterion	Verdict
Absolute Fit			
χ^2	5,773.796	—	$p < .001$ (sensitive to N)
df	2,923	—	—
χ^2/df	1.975	≤ 3.0	Acceptable
RMSEA	.048	< .06	Good
RMSEA 90% CI	[.047, .050]	Narrow	Precise
PCLOSE	.929	≥ .05	Excellent
Incremental Fit			
CFI	.877	≥ .90	Below threshold
TLI	.873	≥ .90	Below threshold
IFI	.877	≥ .90	Below threshold
NFI	.779	≥ .90	Low (sample-sensitive)
Parsimony			
PNFI	.758	≥ .50	Acceptable
PCFI	.853	≥ .50	Good
Information Criteria			
AIC	6,089.796	Lower = better	Acceptable
BIC	6,727.402	Lower = better	Acceptable
Legacy (Supplementary)			
GFI	.638	≥ .90	Low
AGFI	.618	≥ .85	Low

3.9 SEM Model

The structural model (Fig. 3) specified three direct paths to adherence (QARPPU). Practice emerged as the strongest predictor ($\beta = .81$, $p < .001$), followed by a significant negative path from attitude ($\beta = -.58$, $p < .001$). This counterintuitive finding likely reflects a statistical suppression effect arising from shared variance between attitude and practice, whereby the inclusion of practice in the model altered the direction of the attitude coefficient. The path from knowledge to adherence was nonsignificant ($\beta = .08$, $p > .05$), indicating that knowledge alone did not directly predict adherence behaviour when attitude and

practice were simultaneously modelled. These findings suggest that behavioural enactment (practice) and motivational orientation (attitude) are closely associated with pressure injury prevention adherence among nurses, consistent with the health belief model (HBM).

3.10 Collinearity and Suppression Diagnostics

To investigate the unexpected negative path from attitude to adherence, additional analyses were conducted. Zero-order correlations indicated a positive association between attitude and adherence ($r = .43$, $p < .001$). However, when practice was included in the model, the standardised path coefficient reversed direction ($\beta = -.58$), indicating a classical suppression effect. A nested model excluding practice showed that the attitude to adherence path became positive and significant ($\beta = .41$, $p < .001$), confirming that shared variance between attitude and practice accounted for the observed suppression. These findings support the interpretation that attitude influenced adherence indirectly through practice rather than directly.

4. Discussion

This discussion situates the key findings within the extant literature, addresses each study hypothesis and elaborates on the theoretical, clinical and methodological implications of the results. Ageing demographics, expanding tertiary healthcare infrastructure and the high burden of immobility-related conditions have collectively amplified the public health relevance of pressure injury prevention in Saudi Arabia [35, 36]. Within this context, characterising the structural mechanisms through which RNs' KAP and adherence translate into guideline-concordant clinical behaviour is a strategic necessity for health system performance improvement [13, 15]. The present SEM-based investigation represents a substantive methodological advance over prior cross-sectional surveys of KAP in the region, which have largely been limited to bivariate descriptions without structural modelling [13, 15].

4.1 Key Findings

The overarching empirical finding of this study is that RNs' adherence to PIP guidelines is primarily driven by their preventive practices, with knowledge and attitudes exerting influence on adherence exclusively through practice. All directional hypotheses were formally evaluated within the SEM; were supported, while attitude was not. The null finding for the hypothesis that attitude would independently and directly predict adherence after accounting for practice was theoretically informative. It revealed complete mediation of the attitude and adherence association by practice, a pattern fully consistent with the serial mediation structure underlying the KAP and adherence model [37]. This finding underscores the indispensable role of behaviour as the bridge between attitudinal orientation and clinical guideline adherence [37]. At the bivariate level, all inter-construct correlations among KAP and adherence were statistically significant, with effect sizes ranging from moderate to strong[18]. The attitude–practice association was the strongest observed, followed by knowledge and practice, practice and adherence, knowledge and attitude, attitude and adherence, and knowledge and adherence. These patterns collectively affirm the theorised sequential associations and provide robust preliminary support for the

structural pathways specified in the model [18]. Importantly, KAP and adherence demonstrated significant associations with all three primary constructs, a finding consistent with a recent large-scale latent profile analysis of RNs' PI-KAP conducted across hospitals in Guangxi, China (N = 17,253) [13], which found that the dominant association with PI-KAP profiles [13]. This convergence suggests that the KAP and adherence dynamics identified in this study are not substantially moderated by demographic covariates alone and that targeted, competency-based educational interventions may be efficacious across nursing [13, 15, 18].

4.2 Structural Equation Model

The structural model was estimated using maximum likelihood estimation in Amos version 31, with adherence as the distal outcome variable [13, 38]. The chi-square-to-degrees-of-freedom ratio fell well within the widely adopted threshold of < 3.0, indicating a parsimonious model structure that did not overfit the data. Incremental fit indices (CFI = .877; TLI = .873; IFI = .877) were below the conventional ≥ .90 threshold and therefore indicate marginal fit. However, consistent with Hu and Bentler's two-index strategy[25], the model was considered acceptable based on strong absolute fit indices (RMSEA = .048) and evidence of close fit (PCLOSE = .929). Given the large sample size and model complexity, slight attenuation of incremental indices is expected and does not invalidate the overall model [24, 25]. The incremental fit indices—comparative fit index, Tucker Lewis index and incremental fit index—all met or exceeded the conventional threshold of ≥ .90, confirming acceptable comparative fit relative to the independence baseline model [25].

The normed fit index and relative fit index were marginally below ideal thresholds; however, both indices are known to systematically underestimate fit in large, complex models and are now widely regarded as supplementary rather than primary fit criteria [30]. The Akaike information criterion for the default model (AIC = 4,816.216) was substantially lower than that of the independence model (AIC = 21,391.933), confirming the structural model's substantive superiority over the null baseline [30]. Taken together, the fit evidence supports the conclusion that the proposed KAP and adherence structural model is an acceptable and theoretically coherent representation of the relationships among the study's latent constructs [13, 15, 25, 30]. These fit statistics are noteworthy given the complexity of the four-construct measurement model and the conservative use of maximum likelihood estimation without post hoc modification guided by empirically opportunistic modification indices [25, 30]. This multi-index reporting strategy is increasingly recognised as essential for avoiding the selective reporting of favourable fit statistics in nursing research [30].

4.3 Adherence to Pressure Injury Prevention

Adherence to PIP guidelines emerged as the primary outcome variable in this study and was best predicted by RNs' preventive practices [15, 17]. In the multiple regression model, practice was the only significant predictor of adherence, and the model explained adherence [17]. This finding converges with a growing body of evidence demonstrating that behavioural enactment—the observable execution of preventive care activities such as systematic repositioning, pressure-redistribution device application,

nutritional optimisation and structured skin assessment—is the factor most directly and strongly associated with clinical guideline adherence [15, 17]. Adherence in the nursing context requires RNs to translate cognitive and affective readiness into consistent protocol-concordant behaviours at the bedside [8, 15]. The present findings suggest that interventions targeting adherence must ultimately achieve behavioural change—not merely shifts in knowledge or favourable attitude endorsements [15, 39]. This has direct implications for the design of PIP education programmes; didactic instruction is insufficient if not accompanied by supervised skill building, competency-based simulation and real-time clinical feedback mechanisms that reinforce the behavioural repertoire underlying adherence [8]. This is corroborated by a recent systematic review and meta-analysis by Demir et al. [40], which synthesised nine experimental studies and concluded that structured care bundles, operationalised as three or more evidence-based preventive protocols, significantly reduced hospital-acquired pressure injury (HAPI) rates relative to standard care because they mandate the behavioural execution of preventive actions rather than relying on nurses' autonomous application of knowledge and attitudes [40].

The practice and adherence pathway identified in this study aligns with and extends findings from prior KAP research in wound care nursing [41]. Studies conducted in comparable tertiary care settings have consistently identified practice as a mediator between attitudinal readiness and guideline-adherent care; however, most prior investigations have relied on bivariate or multivariate regression without accounting for the full structural chain from knowledge to adherence [13, 38]. A similar mediation finding was recently reported among Turkish ICU nurses (N = 302); knowledge positively and directly predicted attitude and attitude subsequently predicted PI management efficacy, while the direct effect of knowledge on efficacy was nonsignificant without a mediator, a structural pattern essentially mirroring the complete mediation topology observed in the present study [42, 43]. The convergence of these findings across distinct cultural and clinical contexts, Saudi Arabia and Turkey, highlights the generalizability of the mediation model and argues for its broad applicability across Middle Eastern and regional nursing populations [18, 42, 43].

4.4 Knowledge

Knowledge demonstrated positive associations with other constructs at the correlational level; however, it did not emerge as a significant independent predictor of adherence within the structural model [18]. These findings position knowledge as the distal originator in the KAP–adherence theoretical associations, a necessary but insufficient driver of adherence whose influence is channelled through attitude formation and behaviour [18, 44]. The knowledge and practice association was the second strongest bivariate correlation in the matrix, underscoring that RNs who possess more comprehensive cognitive competencies regarding PI aetiology, risk stratification, prevention strategies and staging criteria are substantially more likely to engage in consistent preventive behaviours [13, 31].

In particular, knowledge did not independently predict adherence when practice was held constant, a pattern fully consistent with serial mediation [18]. The zero-order correlation between knowledge and adherence reflects the total effect, a combination of direct and indirect pathways, whereas the nonsignificant unique coefficient under control reflects the full absorption of the knowledge–adherence

association by the mediating role of practice [18]. This distinction between total and direct effects is a critical interpretive advantage of SEM over conventional regression analyses and reinforces the importance of reporting mediation effects rather than relying solely on adjusted regression coefficients [25]. These results align with and extend the literature reporting that RNs' knowledge of PIP, while widely variable, does not translate into adherent clinical behaviour in a simple or linear fashion. A systematic review and meta-analysis by Wu et al. [45], pooling 20 studies conducted between 2011 and 2022 using the PUKAT instrument, estimated the pooled knowledge score of nurses at 51.5%, well below the 60% competency threshold used as a clinical benchmark. Most critically, the meta-analysis identified consistent knowledge deficits in the domains of preventive measures, risk assessment and specific patient group management, which are the domains most relevant to behavioural execution of PIP protocols. A subsequent multicentre cross-sectional study utilising the PUKAT 2.0 tool in ICU settings across four tertiary hospitals in Saudi Arabia (N = 320) corroborated these findings, reporting a mean total knowledge score of 39.55 ± 8.84 out of 100, classified as low, with the lowest subscale scores in prevention (22.36%) and management of pressure injury (14.84%) [46]. The present findings suggest that educational programmes addressing these domain-specific gaps are necessary but must be complemented by attitudinal and behavioural change strategies to achieve downstream gains in guideline adherence. This conclusion has direct implications for how continuing PIP education is structured and evaluated in tertiary care settings [5, 46, 47].

4.5 Attitude

The findings pertaining to attitude were among the most theoretically significant results of this study. The attitude–practice association was the strongest bivariate correlation in the entire inter-construct matrix, indicating that affective and evaluative dispositions towards PIP, including perceived clinical importance, efficacy beliefs and perceived barriers to preventive care, are closely and consistently linked to the behavioural enactment of preventive activities. The prediction that favourable attitudes would positively predict preventive practices was strongly supported, affirming the theoretical primacy of the attitude–behaviour pathway within the KAP framework [18]. The negative association between attitude and adherence was interpreted as a suppression effect rather than a true inverse relationship, likely due to the strong overlap between attitude and practice constructs, whereby the inclusion of practice in the model altered the direction of the attitude coefficient due to multicollinearity. The null direct effect of attitude on adherence when practice was controlled is consistent with the Health Belief Model (HBM), which posits that attitudes influence intentions and, through them, behavioural action, with behaviour constituting the local cause of outcome change [48].

A recent meta-analytic review by Asiri et al. [18] synthesising advances in KAP research across health behaviour contexts reported that perceived behavioural control, a construct structurally analogous to the attitudes operationalised in this study, exerted moderating and mediating effects on behaviour primarily through behavioural intention and enacted practice, not through direct bypassing of behavioural execution, a pattern consistent with the complete mediation observed here. This finding carries important clinical implications. It suggests that attitudinal interventions targeting perceived importance,

efficacy and barrier reduction should not be expected to improve adherence in isolation, unless they also precipitate changes in actual nursing behaviour [18]. RNs who endorse positive attitudes towards PIP but do not consistently execute preventive protocols due to organisational constraints, workload pressures, resource limitations or skill deficits are unlikely to achieve higher adherence on the basis of attitude change alone [18].

Rostamvand et al. [49] conducted a systematic review of nurses' attitudes towards PI prevention responsibility by synthesising 12 studies involving 7,824 nurses and nursing students. They found that negative attitudinal orientations were prevalent and that training-mediated attitude improvement did not automatically translate into behavioural change, reinforcing the necessity of coupling attitudinal programming with clear behavioural practice components. Interventions designed to close the attitude–behaviour gap, including reflective practice exercises, peer accountability frameworks, clinical role modelling and unit-level behavioural culture change, may therefore be necessary complements to attitude-focused educational programming [20, 49].

4.6 Practice

Preventive practice emerged as the central construct in the model and the strongest direct predictor of adherence. While knowledge and attitude are theoretically important components of the KAP framework, their influence on adherence appears to be less direct in this dataset. These findings suggest that behavioural enactment is the primary driver of adherence to PIP guidelines [18]. This dual role was empirically demonstrated through multiple intersecting lines of evidence: practice was the sole uniquely significant predictor of adherence in the model, and the knowledge–adherence and attitude–adherence associations were both completely mediated by practice. The overall sequential mediation pathway was supported by the pattern of correlations and structural path estimates, consistent with the hypothesis. These findings extend prior research demonstrating that practice is more strongly associated with clinical adherence than cognitive or attitudinal factors alone [33].

The behavioural enactment of PIP protocols, including moisture management, structured skin inspection, scheduled repositioning, nutritional screening and intervention, Braden risk assessment documentation, and pressure-redistribution mattress and heel offloading device application, represents the operational expression of both the knowledge and attitudinal orientation that a nurse brings to the bedside [33]. Without consistent behavioural translation of knowledge and attitudes, even competent and motivated nurses may fail to meet the behavioural standards embedded in institutional and international PIP guidelines [8]. This perspective was reinforced by a recent mixed-methods systematic review identifying barriers to PIP in hospitals, which found that the gap between RNs' knowledge and actual practice was significantly exacerbated by time constraints, high nurse-to-patient ratios, limited pressure-redistribution equipment availability and inadequate supervision, contextual factors that operate directly at the behavioural level [45, 50].

The centrality of practice in this model has direct consequences for quality improvement strategies. A landmark 2025 systematic review and meta-analysis [40] synthesising nine experimental studies with

patients from Saudi Arabia, Australia, the US, China, Iran and Singapore demonstrated that multi-component care bundles standardising behavioural nursing practices such as Braden assessment, systematic repositioning, skin inspection and nutritional optimisation significantly reduced HAPI rates compared to standard care [40]. This meta-analytic evidence aligns with the present model's core implication: Behavioural practice standardisation is the critical lever for reducing HAPI incidence [40]. Unit-level practice audits, direct observation compliance tools, PIP care bundle implementation programmes and mandatory documentation requirements for nursing-initiated preventive actions represent evidence-based mechanisms for reinforcing and sustaining behavioural adherence [40]. Furthermore, the strong attitude–practice association suggests that attitudinal programmes that are operationally coupled to behavioural reinforcement may exert amplified effects on practice, thereby indirectly and substantially improving adherence outcomes [15, 18].

4.7 Limitations

First, the cross-sectional design precludes strict theoretical inference; longitudinal or experimental designs are required to confirm the temporal ordering of KAP and adherence pathways [27]. Second, single-site sampling within one tertiary military medical city in Riyadh constrains generalizability across institutional, geographic and cultural contexts. Third, self-reported practice and adherence measures introduce social desirability bias; despite guaranteed anonymity, bias cannot be excluded. This limitation is well documented in the KAP literature. High alpha values may indicate redundancy among items; future studies should explore item reduction where self-reported practice consistently exceeds observed compliance [27]. Fourth, reliance on composite total scores rather than item-level SEM introduces measurement imprecision; full confirmatory factor analytic modelling at the item level would yield stronger latent variable estimation [25]. Fifth, marginally subthreshold Normed Fit Index (NFI) and Relative Fit Index (RFI) values, attributable to known sensitivity limitations of legacy fit indices in large, complex models, should be interpreted with caution in replication analyses [25].

4.8 Implications

This study is among the first to apply SEM to all four KAP constructs and guideline adherence in PIP nursing research, establishing complete sequential mediation of knowledge and attitude through practice as a replicable structural model [18]. Clinically, practice centrality reorients quality improvement away from didactic knowledge transfer towards behavioural interventions, competency assessments, care bundles and real-time feedback, corroborating evidence of significant HAPI reductions through care bundle implementation [51]. The attitude–practice pathway indicates that efficacy and barrier-focused attitudinal interventions carry upstream leverage when linked to skill-based training [51]. Educational curricula should adopt competency-based, simulation-centred designs that explicitly sequence knowledge acquisition through attitudinal engagement into practiced behavioural routines, consistent with emerging Saudi Arabian and regional evidence [51].

At the policy level, the validated instruments provide regulators with diagnostic tools for identifying construct-level nonadherence drivers [8]. Embedding behavioural PIP documentation within performance

appraisal and accreditation frameworks would accelerate sustained adherence gains, aligning directly with Saudi Arabia's Vision 2030 quality and patient safety agenda [52].

4.9 Future Directions

Several directions warrant attention. Longitudinal and quasi-experimental designs are needed to establish the temporal directionality of the KAP and adherence pathways modelled. Multicentre replication across tertiary, community and long-term care settings within Saudi Arabia and the broader region is essential, with measurement invariance testing across specialties, experience levels and institutional types before the model is assumed to generalise. Future studies should also triangulate self-reports with objective behavioural indicators, including EHR-derived documentation rates, observational compliance audits and hospital-acquired pressure injury incidence, to mitigate social desirability bias and enhance ecological validity. Multilevel SEM frameworks incorporating unit-level contextual moderators, RN-to-patient ratios, resource availability, leadership support and institutional policy enforcement would address the systemic barriers that operate beyond the RNs. Finally, randomised or quasi-experimental trials targeting the attitude–practice and practice–adherence pathways through simulation-based training, peer learning communities or behavioural feedback dashboards would test the translational utility of the present model.

5. Conclusions

This study provides SEM-validated evidence that RNs' adherence to PI prevention guidelines is driven primarily through behaviour, with knowledge and attitude exerting their influence exclusively via the practice pathway. These findings reframe quality improvement priorities: Interventions must extend beyond didactic knowledge transfer and attitudinal programming to mandate behavioural skill building, competency-based simulation and real-time practice feedback. The validated structural model offers a replicable, scalable framework for advancing clinical adherence research and informing evidence-based PI prevention policy.

Abbreviations

The following abbreviations are used in this manuscript:

STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
PI	Pressure injury
PIP	Pressure injury prevention
ICU	Intensive care unit
ED	Emergency department
KAP	Knowledge, attitude and practice
PUKAT	Pressure Ulcer Knowledge Assessment Tool
APuP	Attitude Towards Pressure Ulcer Assessment
QARPPU	Questionnaire To Evaluate Nurses' Adherence to Recommendations for Preventing Pressure Ulcers
RN	Registered nurse

Declarations

Supplementary Materials

Conceptual framework explaining the mediation model, the checklist of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and participant flow diagram.

Author Contributions

Conceptualisation, M.Y.A. and R.B.T.; Methodology, M.Y.A. and R.B.T.; Investigation, M.Y.A. and S.A.A.; Data curation, S.A.A. and M.Y.A.; Formal analysis, M.Y.A. and S.A.A.; Project administration, S.A.A. and M.Y.A.; Supervision, R.B.T. and M.Y.A.; Writing – original draft preparation, M.Y.A.; Writing – review and editing, all authors; Validation, M.Y.A. and S.A.A. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Ethical approval for this study was obtained from the IRB of King Saud University-KSU (Approval No.: KSU-HE-26-0192; dated 4 March 2026). All procedures were conducted in accordance with the ethical standards of the institutional and national research committees and with the principles of the Declaration of Helsinki.

Informed Consent Statement

Informed consent was obtained from all participants prior to their inclusion in the study. Participation was voluntary, and participants were assured of the confidentiality and anonymity of their responses as well as their right to withdraw at any time without any consequences.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Figures

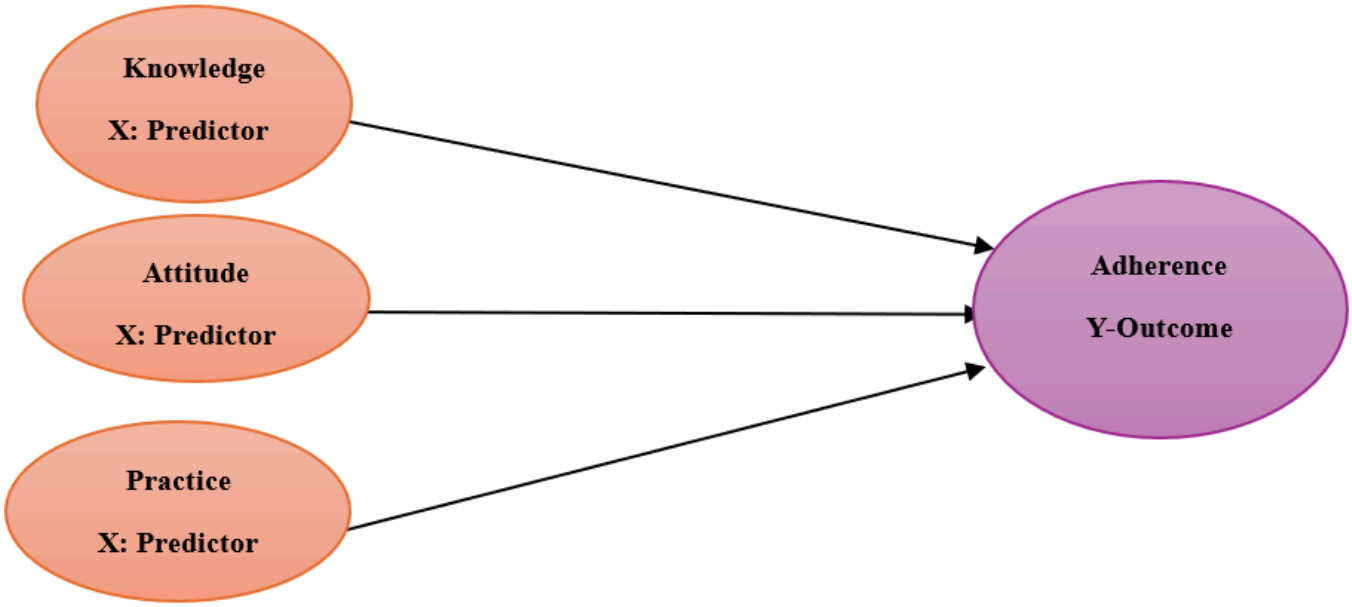


Figure 1

The Conceptual Model

Conceptual model developed by the first and third authors to represent the path analysis of knowledge and adherence to pressure injury prevention, considering the mediating roles of attitude and practice while holding age and years of experience constant.

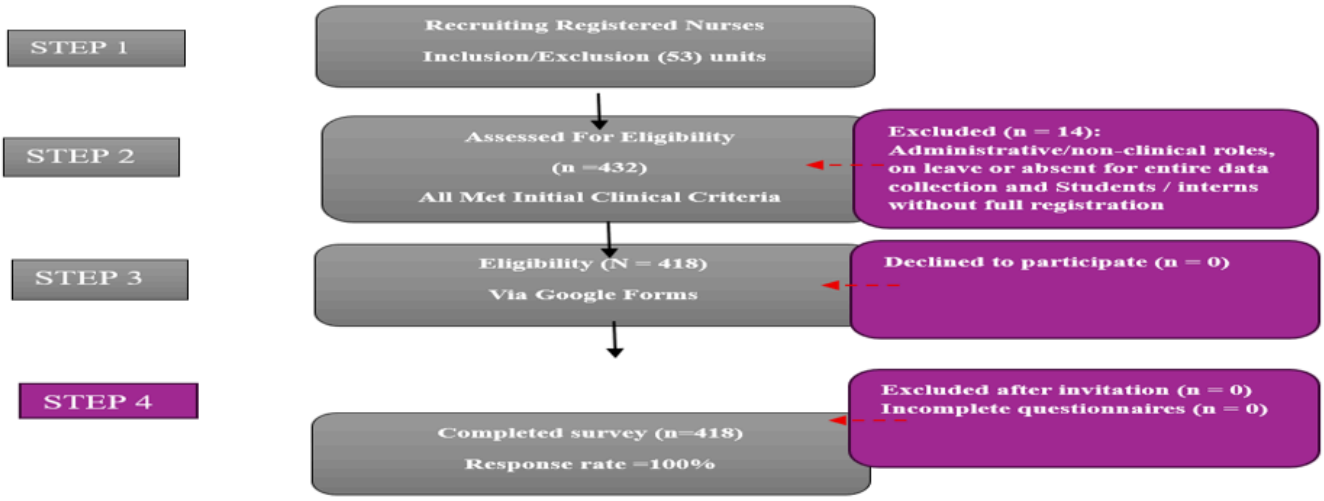


Figure 2

Recruitment Flow Diagram

A flow diagram developed by the first author, showing the recruitment and inclusion of registered nurses throughout the research process.

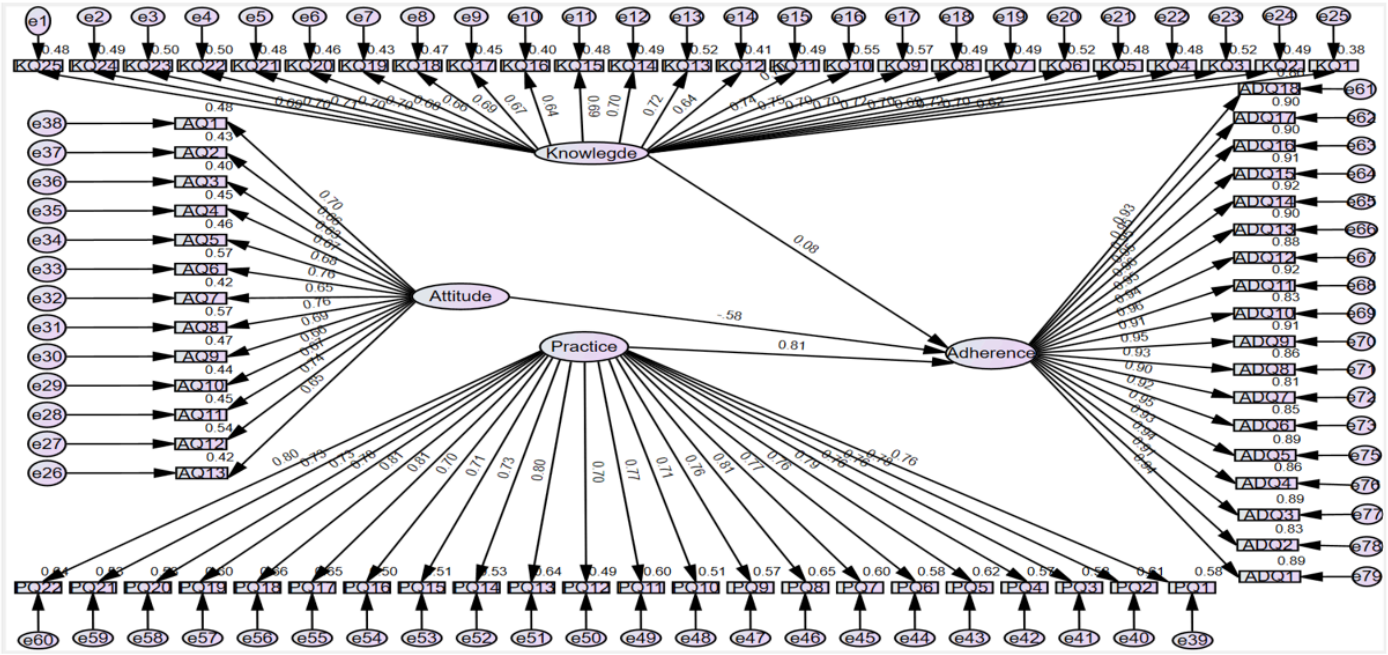


Figure 3

SEM Model

Supplementary Files

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