Research article

Risk factors associated with pressure injuries among adults admitted to intensive care units

Rula Alsous[1] MSN, RN, **Mohammad Al Qadire***[1] PhD, RN, **Hanan Abdelrahman** PhD, RN[2]

[1]Faculty of Nursing, Al Al-Bayt University, Mafraq, Jordan
[2]Manning College of Nursing and Health Sciences, University of Massachusetts, USA; Faculty of Nursing, Suez Canal University, Ismailia, Egypt
*Corresponding author email mohammadqadire@gmail.com

ABSTRACT

Background Pressure injuries (PIs) remain a major concern in intensive care units (ICUs), where immobility and critical illness increase vulnerability. Despite advances in prevention, gaps in practice persist.

Aim To identify risk factors and characteristics of pressure injuries among adult ICU patients in Jordan and evaluate preventive measures currently in use.

Methods A case-control study was conducted in the ICUs of two tertiary hospitals in Jordan. A total of 300 adult patients were included: 150 with PIs (cases) and 150 without (controls). Data were extracted from medical records using the Braden Scale and a structured risk factor tool.

Results The mean age of cases was 66.0 years compared to 54.9 years among controls. Males predominated in both groups, particularly among cases (61.3%). Preventive practices were inconsistent: none had pressure-relieving mattresses, and repositioning was often reactive. Logistic regression identified significant predictors: male gender (OR=8.6), older age (OR=1.04 per year), prolonged ICU stay (OR=1.52), higher BMI (OR=1.12), mechanical ventilation (OR=22.0), oedema (OR=5.53), reduced consciousness (OR=8.41), and incontinence-associated dermatitis (OR = 9.0). Adequate preventive care reduced PI likelihood substantially (OR=31.0).

Conclusions The findings emphasise the importance of integrating early, targeted interventions into routine ICU practice to minimise patient harm and improve outcomes.

Implications for clinical practice Findings highlight the urgent need for standardised preventive strategies, resource allocation and adherence to evidence-based guidelines to reduce PI incidence and improve ICU patient outcomes.

Keywords pressure, injuries, ICU, risk, prevention

For referencing Alsous R, Al Qadire M, Abdelrahman H. Risk factors associated with pressure injuries among adults admitted to intensive care units . Journal of Wound Management. 2026;27(1):79-87.

DOI https://doi.org/10.35279/jowm2026.27.01.11

Submitted 27 August 2025, Accepted 28 October 2025

KEY MESSAGE

- This case–control study investigated the risk factors, characteristics, and preventive practices related to pressure injuries (PIs) among adults admitted to intensive care units in Jordan.
- The study aimed to identify demographic and clinical risk factors associated with ICU-acquired PIs and to evaluate the adequacy of preventive measures currently in use.
- Most ICU patients with pressure injuries were older, male, and had longer hospital stays, with injuries mainly at the sacrum and commonly Stage 2. Significant predictors included mechanical ventilation, oedema, reduced consciousness and incontinence-associated dermatitis, while adequate preventive care greatly reduced risk.

BACKGROUND

Pressure injuries (PIs), formerly referred to as pressure ulcers (PUs), are localised damage to the skin and underlying tissues, typically occurring over bony prominences due to sustained pressure, shear forces, and friction.[1] Beyond physical tissue damage, PIs profoundly affect patients' well-being. They lead to pain, discomfort, reduced mobility and impaired quality of life. Many patients also experience psychological distress, as they become increasingly dependent on healthcare providers for wound care and daily assistance.[2] From a health systems perspective, PIs require extensive resources, including pressure-relieving equipment, longer hospitalisations, additional staff hours, and costly wound management, placing a substantial burden on healthcare services worldwide.[3,4] Despite advances in clinical practice, PIs remain a global challenge, especially in high-risk populations, such as patients in intensive care units (ICUs), where immobility and invasive treatments are common.[5]

Epidemiological evidence underscores this concern. Globally, the prevalence of hospital-acquired PIs is estimated at 12.8%, with regional variations: 14.5% in Europe, 13.6% in North America, 12.7% in South America, and 3–9% in Australia,[5] ICU-acquired PIs are even more frequent; a meta-analysis reported a pooled prevalence of 16.6% in the Eastern Mediterranean

region.[6] In Jordan, prevalence rates across all PI stages were 11.5%, with Stage 1 and Stage 2 injuries most commonly reported, each accounting for 40% of cases.[7]

Among critically ill patients, the sacrum (57.4%), heels (35.2%), and face (8.7%) are the most common sites of PI development, with severe injuries comprising 40.8% of all cases.[8] Risk factors in ICUs include immobility, prolonged mechanical ventilation, vasopressor use, hemodynamic instability, and inadequate repositioning practices.[9] Additional predictors include advanced age, prolonged ICU stays, and sedation.[10] Consequently, PI prevention is recognised as a cornerstone of nursing practice, requiring accurate risk assessment, timely detection, and evidence-based interventions.[11] Moreover, PIs are often considered indicators of nursing care quality, underscoring the importance of adequate training and continuous education for healthcare providers.[12]

In Jordan, although nurses recognise PI prevention as a fundamental responsibility, barriers such as limited access to preventive devices, insufficient training, and staffing shortages hinder effective implementation.[13] These systemic constraints, compounded by individual knowledge gaps, perpetuate the occurrence of PIs in critical care. Therefore, this study aims to identify risk factors and characteristics of PIs among adult ICU patients in Jordan, while also evaluating preventive measures currently in use.

METHODS

Design

A case-control design was employed in this study.

Setting and sample

Settings

This study was conducted in the ICUs of two large tertiary hospitals in Jordan. The first hospital, located in the capital city, is a major national referral center and includes three ICUs: an Emergency Room ICU (19 beds), a Surgical ICU (24 beds), and a Burn ICU (9 beds). The second hospital, situated in northern Jordan, is a teaching hospital affiliated with a public university and contains 120 ICU beds across several specialised units, including the Coronary Care Unit (CCU), Cardiac Intensive Care Unit (CICU), and General Intensive Care Unit (GICU). These hospitals were selected because they provide advanced critical care services and admit patients from diverse clinical backgrounds, making them suitable for investigating pressure injury risk factors and prevention.

Sample and sampling

The study sample consisted of adult patients admitted to the ICUs of the two selected hospitals. Convenience sampling was employed to recruit participants. Cases were defined as adult ICU patients (≥18 years) who had been hospitalised for at least 48 hours and developed a new pressure injury during their ICU stay, confirmed by direct assessment and medical record documentation. Controls were ICU patients admitted for more than 48 hours during the same study period who did not develop any pressure injury. Patients with pre-existing pressure injuries on admission, or those for whom accurate assessment was not feasible, were excluded from both groups.

Sample size

The required sample size was determined based on the planned logistic regression analysis. According to the criterion N≥10m (where m is the number of predictors), and with 15 predictors included in the model, a minimum of 150 patients was needed for each outcome category (case and control). This resulted in a total sample size of 300 patients, which was considered sufficient for the purposes of this study.

Data collection tools

Two instruments were used to collect data: the Braden Scale and the Pressure Injury Prevention and Risk Factors Data Extraction Sheet.

Braden Scale

The Braden Scale, developed by Bergstrom, Demuth[14], is a widely used tool to assess risk for pressure injuries. It consists of six subscales: Sensory Perception, Moisture, Activity, Mobility, Nutrition, and Friction/Shear. Each subscale is scored individually, with a total score ranging from 6 to 23. Lower scores indicate higher risk of PI development. In this study, patients with a Braden score of 18 or below were classified as being at risk, with the following categories: 15–18 (mild risk), 13–14 (moderate risk), 10–12 (high risk), and ≤9 (very high risk).

The Braden Scale has demonstrated predictive validity and reliability across multiple clinical settings; however, evidence indicates that its validity is only moderate when applied in ICU populations.[15, 16] Reported Cronbach's alpha values range from 0.43 to 0.85, supporting its internal consistency.[17]

PI prevention and risk factor data extraction sheet

This researcher-developed tool was designed to extract data systematically from patient medical records. It captured demographic and clinical characteristics, including age, gender, marital status, educational level, hospital, and ward/unit of admission. Clinical data included medical diagnosis, length of stay prior to pressure injury formation, Glasgow Coma Scale (GCS) score, and the presence of a family caregiver.

The tool also recorded details about pressure injuries, including number, stage, and anatomical location, as well as the severity and location of the most significant injury. Risk factors such as incontinence, body mass index (BMI), white blood cell count, haemoglobin level, serum albumin level, comorbidities (such as diabetes, hypertension, heart failure, kidney failure, cancer or neurological disorders), smoking status, history of pressure injuries, mechanical ventilation use, and oedema were included.

In addition, the tool documented preventive and therapeutic measures, such as mattress type (standard, alternating air or static pressure-redistributing), frequency of repositioning, heel protection, nutritional support, incontinence care and protective dressings for bony prominences. The adequacy of prevention was further analysed using the European Pressure Ulcer Advisory Panel (EPUAP) methodology, classifying patients into three categories.

Data collection procedure

Following ethical approval and institutional permissions, patient eligibility was assessed through admission logs and electronic medical records in collaboration with ICU staff and hospital information departments. Because many ICU patients

were unconscious or clinically unstable, no direct interviews were conducted. Instead, demographic and clinical data were extracted from medical records using the Braden Scale and the Pressure Injury Prevention and Risk Factors Data Extraction Sheet.

Pressure injuries were identified from patients' electronic medical records, where ICU nurses routinely documented Braden Scale scores and wound assessments using the NPUAP/EPUAP/PPPIA classification system[1] as part of daily care. This system categorises pressure injuries into Stage 1 (non-blanchable erythema of intact skin), Stage 2 (partial-thickness skin loss with exposed dermis), Stage 3 (full-thickness skin loss), Stage 4 (full-thickness skin and tissue loss), Unstageable (obscured full-thickness skin and tissue loss), and Deep Tissue Pressure Injury (persistent non-blanchable deep red, maroon, or purple discoloration). Data were systematically extracted by the first author using the researcher-developed Pressure Injury Prevention and Risk Factors Data Extraction Sheet, which captured sociodemographic characteristics, clinical variables, preventive interventions and outcomes. The extracted data were then entered into SPSS for analysis and stored on a secured, password-protected laptop. No post-discharge follow-up was performed.

Data analysis

Data were checked for completeness and accuracy before analysis. All statistical analyses were performed using IBM SPSS Statistics, version 30 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to summarise demographic and clinical characteristics, as well as preventive measures implemented.

To assess the association between preventive interventions, and the occurrence of pressure injuries, simple logistic regression was performed. Multiple logistic regression was subsequently conducted to identify independent predictors of pressure injury development. All theoretically relevant variables, supported by existing literature, were included to minimise omitted-variable bias. This approach is consistent with best practices in regression modelling, which emphasise the inclusion of clinically significant variables rather than relying solely on bivariate associations.[18, 19] A p-value of ≤0.05 was considered statistically significant for all analyses.

Ethical and institutional approvals

Ethical approval was obtained from the Ethics Committee of the public university (15 July 2024), the Ministry of Health (14 August 2024), and the Ethics Committee of King Abdullah University Hospital (4 September 2024). All patients, or their legal guardians where applicable, received full information about the study's purpose, procedures, risks, and benefits. Written informed consent was obtained prior to data collection.

Participants were assured that involvement was voluntary and would not affect their treatment. They were also informed of their right to withdraw at any time without repercussions. Confidentiality was strictly maintained; no personal identifiers were included in the study records. All collected data were securely stored and accessible only to the research team.

RESULTS

Participants' demographic characteristics

A total of 300 patients were included, with 150 having pressure injuries (cases) and 150 without (controls). As shown in Table 1, males predominated in both groups, particularly among cases (61.3%). The mean age was higher among cases (66.0 years, SD=16.8) compared to controls (54.9 years, SD=17.6). Likewise, the mean length of hospital stay was longer for cases (20.2 days, SD=12.0) than controls (6.6 days, SD=3.2). Marital status showed no marked difference, though educational attainment was lower among cases, with 78% having primary education or less compared to 62.7% in controls.

Most participants had a family caregiver, with the proportion slightly lower among cases (88.7%) than controls (92.7%). Respiratory (20%) and cardiac diseases (16%) were more prevalent among cases, whereas surgical conditions were more common in controls (20%). Glasgow Coma Scale scores also differed, with 52% of cases showing severe impairment (≤8) compared to 61.3% of controls with minor impairment (≥13).

Clinical characteristics of pressure injuries in ICU patients

Among the 150 cases, most patients had a single injury (38%, n=57), while 23.3% (n=35) had two and only a few had three (2%, n=3) or four (0.7%, n=1). Regarding ulcer grading, grade 2 was most frequent (62%, n=93), followed by grade 1 (36.7%, n=55). Grade 3 injuries were less common (6%, n=9), and none of the patients had grade 4, unstageable, or deep-tissue injuries.

The sacrum was the most common site (72.7%, n=109), followed by buttocks (32.7%, n=49) and heels (15.3%, n=23). A few injuries occurred on the ear, scapula, and gluteal regions, with none on elbows, knees, or trochanter. Braden Scale assessment showed that fewer classified as high (18%), moderate (18.7%), or mild (3.3%). See Table 2.

Strategies to reduce pressure injuries in ICUs

Table 3 summarises the preventive measures applied to cases (n=150) and controls (n=150). All participants used standard mattresses, with no pressure-relieving alternatives. Repositioning differed notably: 79% (n=119) of cases were repositioned every two hours, while 74.7% (n=112) of controls were not repositioned. Heel protection was more common among cases (94.7%, n=142), whereas 52% (n=79) of controls did not receive it. High-calorie diets were more frequently provided to cases (58%, n=88), while other diets predominated among controls (76%, n=114). Nearly all cases used absorbent products (99.3%) and special dressings (100%), unlike controls.

Prevention was considered adequate if patients were regularly repositioned and used a pressure-relieving mattress. It was classified as some prevention if patients were either regularly repositioned or used a pressure-relieving mattress. Finally, patients who were neither repositioned nor received pressure-relieving support, relying solely on a standard hospital mattress, were categorised as receiving no prevention.

A simple logistic regression analysis was conducted to examine the association between the adequacy of preventive measures and the occurrence of pressure injuries in adult ICU patients in Jordan. The results indicated that patients who received adequate preventive care had a significantly

lower likelihood of developing pressure injuries compared to those who did not (B=3.43). This association was statistically significant (OR=31.0; 95% CI: 15.7–61.1; p<0.05).

Predictors of pressure injuries among adult ICU patients

A multiple logistic regression analysis was conducted to identify predictors of pressure injury development among adult ICU patients in Jordan. Variables included sex, age, length of hospital stay, BMI, smoking status, mechanical ventilation, oedema, GCS score and incontinence-associated dermatitis. The overall model was statistically significant ($\chi^2(10)=301.3$, p<0.001), accounting for 63% to 84% of the variance in pressure injury occurrence. The Hosmer-Lemeshow test indicated a good model fit ($\chi^2(8)=5.74$, p=0.67).

Several variables emerged as significant predictors. Male patients had a higher likelihood of developing pressure injuries than females (OR=8.6, p<0.001). Age was also significant, with each additional year increasing risk (OR=1.04, p=0.007). Prolonged hospitalisation (OR=1.52, p<0.001) and higher BMI (OR=1.12, p=0.006) were associated with elevated risk. Other predictors included smoking (OR=0.19, p=0.008), mechanical ventilation (OR=22.0, p=0.013), oedema (OR=5.53, p=0.008), moderate GCS (OR=8.41, p=0.003), and incontinence-associated dermatitis (OR=9.0, p=0.004). Detailed results are presented in Table 4.

DISCUSSION

Pressure injury characteristics

This study found that most ICU patients in Jordan developed a single pressure injury, with a smaller proportion experiencing multiple lesions. Over half of these injuries were classified as Stage 2 (partial-thickness skin loss), followed by Stage 1 (non-blanchable erythema). This distribution contrasts with earlier national data, which reported Stage 1 as the most common; however, those findings included all hospital wards.[20] The predominance of Stage 2 injuries in ICU patients may reflect rapid progression due to immobility and critical illness.

Table 1. Demographic characteristics of participants (n=300)

Variable	Control (n=150)		Case (n=150)	
	Frequency (%)	Mean (SD)	Frequency (%)	Mean (SD)
Hospital				
Al-Basheer	74 (44.3)		55 (36.7)	
KAUH	76 (50.7)		95 (63.3)	
Gender				
Female	68 (45.3)		58 (38.7)	
Male	82 (54)		92 (61.3)	
Age		54.9 (17.6)		66 (16.8)
Length of stay		6.6 (3.2)		20.2 (12)
Marital status				
Not married	63 (42)		72 (84)	
Married	87 (58)		78 (52)	
Educational level				
Primary and lower	94 (62.7)		117 (78)	
Secondary and above	56 (37.3)		33 (22)	
Family caregiver				
No	11 (7.3)		17 (11.3)	
Yes	139 (92.7)		133 (88.7)	
Medical diagnosis				
Cancer	12 (8)		22 (14.7)	
Cardiac	20 (13.3)		24 (16)	
Respiratory	23 (15.3)		30 (20)	
Gastro	14 (9.3)		8 (5.3)	
Sepsis	7 (4.7)		14 (9.3)	
Neuro	18 (12)		17 (11.3)	
DKA	7 (4.7)		6 (4)	
Renal	11 (7.3)		14 (9.3)	
Surgical	30 (20)		6 (4)	
Trauma	8 (5.3)		9 (6)	
Glasgow coma scale				
Minor GCS ≥13	92 (61.3)		13 (8.7)	
Moderate GCS 9-12	36 (24)		59 (39.3)	
Sever GCS 8 or less	22 (14.7)		78 (52)	

Table 2. Clinical characteristics of pressure ulcers in adult patients (n=150)

Variable	Frequency (%)
Number of PU	
Blanched erythema	54(36)
One	57(38)
Two	35(23.3)
Three	3(2)
Four	1(0.7)
PU grade	
PU grade 1	55 (36.7)
PU grade 2	93 (62)
PU grade 3	9 (6)
PU grade 4	0 (0.0)
PU unstageable	0 (0.0)
PU deep tissue	0 (0.0)
PU location	
PU heels	23 (15.3)
PU sacrum	109 (72.7)
PU scapula	2 (1.3)
PU gluteal	2 (1.3)
PU buttocks	49 (32.7)
PU elbow	0 (0.0)
PU knee	0 (0.0)
PU trochanter	0 (0.0)
PU ear	4 (2.7)
Braden cale	
Sever risk	90 (60)
High risk	27 (18)
Moderate risk	28 (18.7)
Mild risk	5 (3.3)
No risk	0 (0.0)

Anatomical sites were consistent with regional and international literature, with the sacrum being most frequently affected, followed by the buttocks and heels.[6, 21, 22] Notably, 95% of patients had heel protection, possibly contributing to the relatively low incidence of heel injuries (5%) compared to higher rates reported elsewhere. The absence of injuries at less common sites (such as elbows and trochanters) likely relates to supine positioning and minimal patient movement. These findings support global evidence that sacrum and heel are the most vulnerable sites, highlighting the need for targeted interventions, such as sacral padding and heel offloading, to reduce risk in ICU populations.

Preventive measures

This study revealed major deficiencies in implementing key interventions, particularly in the availability of pressure-relieving surfaces and the consistency of repositioning practices. Notably, none of the patients had access to advanced pressure-relieving mattresses, suggesting systemic gaps in ICU resource allocation.

International guidelines recommend high-specification foam or alternating-pressure mattresses for at-risk patients,

Table 3. Pressure ulcers preventive measures

Preventive measures	Control (n=150) Frequency (%)	Case(n=150) Frequency (%)
Mattress		
Standard mattress	150 (100)	150 (100)
Pressure relieving (powered)	0 (0.0)	0 (0.0)
Pressure relieving (non-powered)	0(0.0)	0 (0.0)
Repositioning (n)		
Not repositioned/ irregular	112 (74.7)	13 (8.7)
Regularly repositioned (Every 2 h)	26 (17.3)	119 (79)
Regularly repositioned (Every 4 h)	12 (8)	18 (12)
Heel protection		
With bellow	79 (52)	142 (94.7)
No protection	71 (74)	8 (5.3)
Nutrition		
Other nutrition	114 (76)	62 (41.3)
High calorie	36 (24)	88 (58)
Absorbent		
No	62 (41)	1 (0.7)
Yes	88 (58)	149 (99.3)
Special dressing		
No	150 (100)	0 (0.0)
Yes	0 (0.0)	150 (100)

supported by strong evidence for reducing injury incidence.[23] The absence of such equipment in this study aligns with prior Jordanian findings, which reported that essential preventive tools were lacking in many hospitals.[24, 25] Based on Donabedian's model, this represents a structural deficiency that likely impairs care delivery and worsens outcomes.

Repositioning practices were also inconsistent. Although 79% of patients with pressure injuries were repositioned every two hours, 75% of those without injuries were turned irregularly. This suggests a reactive rather than preventive approach, where increased repositioning occurred only after signs of skin compromise. These findings underscore the importance of standardised, risk-based repositioning protocols.[26] Heel protection devices were more frequently used for patients with pressure injuries (94.7%) than those without (48%), indicating potential overreliance on reactive interventions. The effectiveness of heel offloading remains uncertain due to limited high-quality evidence.[27] Nutritional support also differed significantly; 58% of patients with injuries received high-calorie enteral nutrition, compared to only 24% of those without injuries. This likely reflects either the severity of illness or delayed intervention. Guidelines recommend early, protein-rich feeding to support tissue repair.[28] Overall, the findings point to significant shortfalls in both resource availability and adherence to evidence-based prevention protocols. There is a clear need for systemic improvements in practice and further clinical trials to strengthen the evidence base supporting specific interventions for pressure injury prevention in ICU settings.

Table 4. Logistic regression model examining risk factors for pressure injuries

Predictor	B	df	P value	Odds Ratio	95% CI
Gender (male with reference to female)	2.15	1	< 0.001	8.6	2.44 to 30.4
Age (years)	0.04	1	0.007	1.04	1.01 to 1.08
Length of stay (days)	0.42	1	< 0.001	1.52	1.33 to 1.75
Body mass index	0.12	1	0.006	1.12	1.03 to 1.22
Smoking (yes, with reference to no)	-1.67	1	0.008	0.19	0.05 to 0.64
Mechanical ventilator (yes, with reference to no)	3.09	1	0.013	22	1.90 to 256.3
Oedema (yes with reference to no)	1.71	1	0.008	5.53	1.57 to 19.4
GCS moderate (moderate with reference to minor)	2.12	1	0.003	8.41	2.02 to 34.8
GCS severity (severe with reference to minor)	-0.07	1	0.617	0.52	0.04 to 6.69
Incontinence dermatitis (yes, with reference to no)	2.19	1	0.004	9.01	2.02 to 40.2
Constant	-13.4	1	0.00	0.00	

Predictors for pressure injuries

This study identified several significant predictors for PI development in ICU patients, including male gender, older age, prolonged ICU stay, elevated BMI, smoking, use of mechanical ventilator (MV), oedema, reduced consciousness and IAD. These findings provide important insight into multifactorial risks in critically ill populations and support targeted preventive measures.

Gender emerged as a particularly strong predictor, with male patients exhibiting an 8.6-fold increased risk of PI development compared to females. This is consistent with Nguvulu[29] and Sunga et al,[30] who reported higher PI incidence in male ICU patients—possibly linked to the higher prevalence of traumatic injuries and spinal cord damage in this group. Although some studies, like Serrano et al[9], have reported no significant gender difference or even elevated risk among females in specific subpopulations, the present study suggests that male gender remains a consistent clinical marker for increased vulnerability. The observed relationship may be partially explained by age and comorbid burden—male patients in this cohort tended to be older and have multiple risk factors such as immobility and nutritional compromise. Furthermore, gender-based health behaviour disparities, including lower engagement in preventive care and reduced adherence to hygiene practices, may indirectly contribute to poorer skin integrity and higher complication rates among males.[31]

Age was another notable independent predictor. Advancing age contributes to skin atrophy, reduced microcirculation, and delayed wound healing, compounding the effects of immobility and comorbidities such as diabetes, vascular disease and malnutrition. These physiological vulnerabilities, widely supported in the literature[9,22,32], are particularly pronounced in ICU settings, where patients often have multiple systemic insults. Digesa et al[32] found that patients aged ≥40 were three times more likely to develop PIs than their younger counterparts, reinforcing the impact of aging on tissue breakdown.

Length of ICU stay was a robust predictor, reflecting the cumulative burden of illness and prolonged exposure to pressure and shear forces. Prolonged immobilisation, the use of medical devices, and longer time spent in catabolic states exacerbate the risk of tissue injury. Previous studies[9, 33] have confirmed that extended ICU stays are linearly associated with increased PI incidence, with some showing risk increasing significantly for each additional day in the ICU.

BMI also demonstrated a significant correlation. Historically, low BMI has been associated with poor nutritional reserves and inadequate cushioning over bony prominences, increasing susceptibility to skin breakdown.[34] An ICU cohort study found that patients with a BMI <18.5 had a significantly higher incidence of pressure injuries compared to normal weight patients, corresponding to an increased relative risk.[35] This finding is consistent with a recent meta-analysis, which reported that underweight individuals had more than a two-fold higher risk (OR≈2.3) of developing pressure injuries compared to those of normal weight.[36] Conversely, higher BMI may reduce mobility and impair perfusion. Studies have suggested a U-shaped relationship, with underweight and obese patients both being more vulnerable.[9] However, some authors, like Workum et al[37], argue that obesity alone is not independently predictive. In this cohort, the association may reflect the combined effects of immobility, metabolic stress and delayed wound healing in patients with abnormal BMI.

Smoking was significantly associated with PI development. Tobacco use impairs microvascular blood flow and delays tissue repair. For example, Wu et al[38] found a 1.5-fold increase in PI risk among smokers. Nicotine-induced vasoconstriction, along with other toxic substances such as carbon monoxide and hydrogen cyanide, reduces tissue oxygenation and directly interferes with collagen synthesis.[39, 40] The impaired wound healing and reduced tissue tolerance in smokers make this a modifiable but critical risk factor.

Mechanical ventilation (MV) emerged as a highly significant contributor. Patients requiring MV often experience deep sedation or paralysis, prolonged immobilisation, and reduced perfusion, all of which predispose to PI development. The

literature supports this: MV is responsible for up to 28% of PIs in critically ill patients,[41] and the association is especially strong in COVID-19 ICU cohorts using prone positioning.[42]Medical devices themselves—such as endotracheal tubes, straps, and oxygen masks—also serve as localised pressure sources. Praneetha[43] and Najjar et al[44] have both identified device-related PIs as a common complication in MV patients, especially those using non-invasive ventilation with face masks, which accounted for nearly 16% of such cases in coronary care settings.

Oedema, indicative of fluid overload or systemic inflammation, reduces capillary oxygen exchange and stretches the skin, making it more vulnerable to shear and pressure. Studies have demonstrated a clear association between oedema and PI development.[45-47] Oedematous tissue also retains pressure marks longer, increasing the duration of unrelieved compression.

GCS scores were also predictive. Patients with reduced consciousness are unable to sense discomfort or reposition themselves, increasing their risk of prolonged pressure exposure. Consistent with findings by Razi-Chafi et al[47] and Mobayen et al[48], the present study found a clear association between declining GCS scores and PI risk, particularly among those with moderate impairments. Sedation, sensory deficits, and impaired responsiveness exacerbate this risk. Finally, incontinence-associated dermatitis (IAD) stood out as a significant marker for PI development. Patients with IAD were nearly nine times more likely to develop PIs. This is because IAD denotes already-compromised skin due to prolonged moisture exposure and pH imbalance, often in the sacral or gluteal area. It also signals frequent cleaning, which can increase friction. The relationship between IAD and PI is well-documented in the literature,[49, 50] supporting IAD's role as both a warning sign and direct contributor to PI development.

While many international studies have identified risk factors for pressure injuries in ICU patients, our study adds originality by addressing a context that has been underexplored in the Eastern Mediterranean region. Unlike most prior reports, all patients in our cohort were managed without pressure-relieving mattresses, and repositioning was often reactive rather than preventive, revealing systemic gaps that were rarely quantified in previous research. Moreover, although predictors, such as advanced age and immobility are consistently reported, the exceptionally high odds ratios observed in our data, such as MV (OR=22.0) and incontinence-associated dermatitis (OR = 9.0), underscore the magnitude of risk in our setting. These findings highlight both structural deficiencies and clinical vulnerabilities, distinguishing our study from earlier work, and providing new evidence that is critical for guiding practice and policy in resource-limited ICUs.

Limitations

This study presents important findings on ICU-acquired pressure injuries; however, limitations must be acknowledged. First, the research was confined to Jordanian intensive care units, which may limit the generalisability of results to healthcare settings with different clinical practices, resource availability, and organisational structures. Second, the case-control design—although effective for identifying associations—does not allow for causal inference, and therefore, observed relationships should be interpreted with caution. Third, the use of the Braden Scale as the primary tool for pressure injury risk assessment. Although it is widely applied and demonstrates acceptable validity in general clinical settings, evidence suggests that its predictive accuracy is only moderate among critically ill ICU patients. This limitation may reduce the precision of risk stratification in our cohort. To address this, we incorporated additional clinical variables into our analysis, but future studies should consider modified or ICU-specific tools to enhance assessment accuracy. Finally, the study did not explore broader contextual or environmental variables—such as workload, staffing ratios, or institutional policies—that could impact PI prevention efforts. Future research should incorporate longitudinal and interventional designs across diverse healthcare settings to enhance the applicability and causal understanding of these findings.

CONCLUSION

This study highlights the multifactorial and preventable nature of ICU-acquired PIs. The findings underscore the urgent need for systematic implementation of evidence-based preventive strategies, including routine repositioning, timely nutritional support, and equitable access to pressure-relieving equipment. Structural gaps and inconsistent practices must be addressed through policy reform, interprofessional collaboration and sustained clinical oversight. Advancing PI prevention requires not only clinical vigilance but also organisational accountability to embed safety at the core of critical care delivery.

IMPLICATIONS FOR CLINICAL PRACTICE

- Early, proactive preventive measures (such as repositioning, sacral padding, heel offloading) are essential rather than reactive care.
- Equitable access to pressure-relieving equipment (such as specialised mattresses) must be prioritised to reduce incidence.
- Interprofessional collaboration and continuous staff education are critical to improve prevention and adherence to evidence-based guidelines.

FURTHER RESEARCH

- Longitudinal and interventional studies are needed to establish causal links between identified risk factors and pressure injury development.
- Randomised controlled trials should evaluate the effectiveness of educational and preventive interventions, including emerging technologies, such as wearable sensors and AI-based monitoring.
- Future research should actively involve patients and caregivers in co-designing preventive strategies and self-care approaches.

ORCID IDS

Mohammad Al Qadire 0000-0001-7004-6782
Hanan Abdelrahman 0000-0003-1226-9034

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

This research received no external funding.

REFERENCES

1. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, Pan Pacific Pressure Injury Alliance. *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline.* EPUAP/NPIAP/PPPIA; 2019.
2. Roussou E, Fasoi G, Stavropoulou A, Kelesi M, Vasilopoulos G, Gerogianni G, et al. Quality of life of patients with pressure ulcers: a systematic review. *Med Pharm Rep.* 2023;96(2):123.
3. Padula WV, Delarmente BA. The national cost of hospital-acquired pressure injuries in the United States. *Int Wound J.* 2019;16(3):634–640.
4. Demarré L, Van Lancker A, Van Hecke A, Verhaeghe S, Grypdonck M, Lemey J, et al. The cost of prevention and treatment of pressure ulcers: A systematic review. *Int J Nurs Stud.* 2015;52(11):1754–1774.
5. Li Z, Lin F, Thalib L, Chaboyer W. Global prevalence and incidence of pressure injuries in hospitalised adult patients: a systematic review and meta-analysis. *Int J Nurs Stud.* 2020;105:103546.
6. Isfahani P, Alirezaei S, Samani S, Bolagh F, Heydari A, Sarani M, et al. Prevalence of hospital-acquired pressure injuries in intensive care units of the Eastern Mediterranean region: a systematic review and meta-analysis. *Patient Saf Surg.* 2024;18(1):1.
7. Aljezawi Me, Tubaishat A. Nosocomial pressure ulcer risk factors in a relatively young adult population: results from a purposeful selection logistic regression model. *J Dermatol Nurses' Assoc.* 2014;6(5):244–250.
8. Jacq G, Valera S, Muller G, Decormeille G, Youssoufa A, Poiroux L, et al. Prevalence of pressure injuries among critically ill patients and factors associated with their occurrence in the intensive care unit: The PRESSURE study. Aust Crit Care. 2021;34(5):411–418.
9. Serrano ML, Méndez MG, Cebollero FC, Rodríguez JL. Risk factors for pressure ulcer development in Intensive Care Units: A systematic review. Medicina Intensiva (English Edition). 2017;41(6):339–346.
10. González-Méndez MI, Lima-Serrano M, Martín-Castaño C, Alonso-Araujo I, Lima-Rodríguez JS. Incidence and risk factors associated with the development of pressure ulcers in an intensive care unit. *J Clin Nurs.* 2018;27(5,6):1028–1037.
11. Lawrence P, Fulbrook P, Miles S. A survey of Australian nurses' knowledge of pressure injury/pressure ulcer management. *J Wound Ostomy Continence Nurs.* 2015;42(5):450–460.
12. Oner B, Zengul FD, Oner N, Ivankova NV, Karadag A, Patrician PA. Nursing-sensitive indicators for nursing care: A systematic review (1997–2017). *Nurs Open.* 2021;8(3):1005–1022.
13. Saleh MY, Papanikolaou P, Nassar OS, Shahin A, Anthony D. Nurses' knowledge and practice of pressure ulcer prevention and treatment: an observational study. *J Tissue Viability.* 2019;28(4):210–217.
14. Bergstrom N, Demuth PJ, Braden BJ. A clinical trial of the Braden Scale for predicting pressure sore risk. *Nurs Clin North Am.* 1987;22(2):417–428.
15. Veiga TP, Rêgo AS, Montenegro WS, Ferreira PR, Rocha DS, Felipe IMA, et al. Braden scale has low reliability in different patients under care in intensive care unit. *Rev Assoc Méd Bras.* 2022;68:1221–1227.
16. Cox J. Predictive power of the Braden scale for pressure sore risk in adult critical care patients: a comprehensive review. *J Wound Ostomy Continence Nurs.* 2012;39(6):613–621.
17. Mehicic A, Burston A, Fulbrook P. Psychometric properties of the Braden scale to assess pressure injury risk in intensive care: a systematic review. *Intensive Crit Care Nurs.* 2024;83:103686.
18. Rao SJ. *Regression modeling strategies: with applications to linear models, logistic regression, and survival analysis.* Taylor & Francis; 2003.
19. Greenland S. Modeling and variable selection in epidemiologic analysis. *Am J Public Health.* 1989;79(3):340–349.
20. Tubaishat A, Anthony D, Saleh M. Pressure ulcers in Jordan: a point prevalence study. *J Tissue Viability.* 2011;20(1):14–19.
21. Al-Wahsh ZMH, Wahsheh MA. Period prevalence of pressure ulcer in Jordanian intensive care units. *Infect Dis Clin Pract.* 2015;23(2):76–80.
22. Tayyib N, Coyer F. Effectiveness of pressure ulcer prevention strategies for adult patients in intensive care units: a systematic review. *Worldviews Evid-Based Nurs.* 2016;13(6):432–444.
23. Nixon J, Brown S, Smith IL, McGinnis E, Vargas-Palacios A, Nelson EA, et al. Comparing alternating pressure mattresses and high-specification foam mattresses to prevent pressure ulcers in high-risk patients: the PRESSURE 2 RCT. *Health Technol Assess.* 2019;23(52):1.
24. Qaddumi J, Khawaldeh A. Pressure ulcer prevention knowledge among Jordanian nurses: a cross-sectional study. *BMC Nurs.* 2014;13(1):6.
25. Qaddumi J, Almahmoud O, Khurasani A, Alkhawaldeh A, Khraisat O. Incidence of pressure ulcers and its related variables among critically ill adult patients in Palestine. *Pal Med Pharm J.* 2019;4(2):2.
26. Gillespie BM, Walker RM, Latimer SL, Thalib L, Whitty JA, McInnes E, et al. Repositioning for pressure injury prevention in adults. *Cochrane Database Syst Rev.* 2020(6):CD009958.
27. Greenwood C, Nelson EA, Nixon J, Vargas-Palacios A, McGinnis E. Comparative effectiveness of heel-specific medical devices for the prevention of heel pressure ulcers: a systematic review. *J Tissue Viability.* 2022;31(4):579–592.
28. Haesler E. Prevention and Treatment of Pressure Ulcers/Injuries: *Clinical Practice Guideline: The International Guideline| Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline.* Cambridge Media; 2019.
29. Nguvulu FN. Incidence and risk factors of pressure ulcer among critically ill patients at Kenyatta National Hospital – Main Critical Care Unit. *Medtigo J Anesth Pain Med.* 2025;1(1):e3067111
30. Sunga MO, Labeau SO, Alfonso E, Benbenishty J. Prevalence, associated factors and outcomes of pressure injuries in adult intensive care unit patients: the DecubICUS Study. J Health Sci. 2023;6(1):1–7.
31. Lichterfeld-Kottner A, Lahmann N, Kottner J. Sex-specific differences in prevention and treatment of institutional-acquired pressure ulcers in hospitals and nursing homes. *J Tissue Viability.* 2020;29(3):204–210.
32. Digesa LE, Baru A, Shanko A, Kassa M, Aschalew Z, Moga F, et al. Incidence and predictors of pressure ulcers among adult patients in intensive care Units at Arba Minch and Jinka Hospitals, Southern Ethiopia. *BioMed Res Int.* 2023;2023(1):9361075.
33. McEvoy NL, Friel O, Clarke J, Browne E, Geoghegan P, Budri A, et al. Pressure ulcers in patients with COVID-19 acute respiratory distress syndrome undergoing prone positioning in the intensive care unit: a pre-and post-intervention study. *Nurs Critical Care.* 2023;28(6):1115–1123.
34. Artico M, Dante A, D'Angelo D, Lamarca L, Mastroianni C, Petitti T, et al. Prevalence, incidence and associated factors of pressure ulcers in home palliative care patients: a retrospective chart review. *Palliat Med.* 2018;32(1):299–307.
35. Hyun S, Li X, Vermillion B, Newton C, Fall M, Kaewprag P, et al. Body mass index and pressure ulcers: improved predictability of pressure ulcers in intensive care patients. *Am J Crit Care.* 2014;23(6):494–501.
36. Alipoor E, Mehrdadi P, Yaseri M, Hosseinzadeh-Attar MJ. Association of overweight and obesity with the prevalence and incidence of pressure ulcers: A systematic review and meta-analysis. *Clin Nutr.* 2021;40(9):5089–5098.
37. Workum JD, van Olffen A, Vaes PJ, van Gestel A, Vos P, Ramnarain D. The association between obesity and pressure ulcer development in critically ill patients: A prospective cohort study. *Obesity Res Clin Pract.* 2022;16(1):56–62.
38. Wu B-B, Gu D-Z, Yu J-N, Feng L-P, Xu R, Zha M-L, et al. Relationship between smoking and pressure injury risk: a systematic review and meta-analysis. *Wound Manag Prev.* 2021;67(9):34–46.
39. Duchesne GA, Waller JL, Baer SL, Young L, Bollag WB. Pressure ulcer diagnosis is associated with increased mortality in patients with end-stage renal disease: a retrospective study. *Life.* 2023;13(8):1713.
40. Nassaji M, Askari Z, Ghorbani R. Cigarette smoking and risk of pressure ulcer in adult intensive care unit patients. *Int J Nurs Pract.* 2014;20(4):418–423.

41. Lu W, Bloom O, Rathgeber M, Maltser S. Pressure injury prevalence and characteristics in patients with COVID-19 admitted to acute inpatient rehabilitation unit. *Front Rehab Sci*. 2023;4:1058982.
42. Gefen A, Brienza DM, Cuddigan J, Haesler E, Kottner J. Our contemporary understanding of the aetiology of pressure ulcers/pressure injuries. *Int Wound J*. 2022;19(3):692–704.
43. Praneetha A, Sathwika MH, Rahimunnisa S, Lokeswari P, Dikshitha A, Ramya S, et al. Pharmacokinetics, disease, and equipment related Factors impacting intensive care unit patient outcomes: comprehensive review. *Indian J Pharm Pract*. 2025;18(3):249–256.
44. Najjar YW, Saleh MY, Hassan ZM. Medical device related pressure ulcers in Jordan: prevalence study among critically ill patients. *Health Sci Rep*. 2022;5(3):e620.
45. Chaboyer W, Coyer F, Harbeck E, Thalib L, Latimer S, Wan CS, et al. Oedema as a predictor of the incidence of new pressure injuries in adults in any care setting: a systematic review and meta-analysis. *Int J Nurs Stud*. 2022;128:104189.
46. Gökdemir S, Aslan M. Main factors regarding pressure injury in intensive care unit patients and the effects of nursing interventions. *Turkish J Intensive Care*. 2024;22(1):31-40.
47. Razi-Chafi Z, Esmaeilpour-Bandboni M, Salmalian Z. Prevalence of pressure ulcer and its related factors in elderly patients hospitalized to teaching hospitals in East Guilan. *J Current Oncology Med Sci*. 2023;3(1):375–381.
48. Mobayen M, Zohrevandi B, Teihou Jorshari S, Salari A. Prevalence of bed sores among patients referring to a medical center in Iran. امورت و یحارج هیرشن. [*J Surg Trauma*] 2021;9(1):17–25.
49. Kayser SA, Phipps L, VanGilder CA, Lachenbruch C. Examining prevalence and risk factors of incontinence-associated dermatitis using the international pressure ulcer prevalence survey. *J Wound Ostomy Continence Nurs*. 2019;46(4):285–290.
50. Beele H, Smet S, Van Damme N, Beeckman D. Incontinence-associated dermatitis: pathogenesis, contributing factors, prevention and management options. *Drugs Aging*. 2018;35(1):1–10.