ISSN 2458-8865 E-ISSN 2459-1505
www.fppc.com.tr
Family Practice & Palliative Care

Research Article

Incidence, prevalence, and risk factors of medical device-related pressure injuries in Türkiye: a systematic review

Türkiye'de tıbbi cihazla ilişkili basınç yaralanmalarının insidansı, yaygınlığı ve risk faktörleri: Sistematik bir inceleme

Cahide Ayık[a], Gizem Göktuna[a], Tayfun Bişgin[b]

[a] Department of Fundamentals of Nursing, Nursing Faculty, Dokuz Eylül University, İzmir, Türkiye

[b] Department of General Surgery, Faculty of Medicine, Dokuz Eylül University, İzmir, Türkiye

Abstract

Introduction: Medical device-related pressure injuries (MDRPIs) tend to occur in hospital settings, negatively impacting patients' quality of life and increasing health care costs. This systematic review aimed to identify the incidence, prevalence, and associated risk factors of MDRPIs in Türkiye based on observational studies.

Methods: From the beginning until October 31, 2024, an extensive electronic literature search was conducted across the Web of Science, PubMed, CINAHL, ScienceDirect, TR Index databases, and Google Scholar. Studies published in Turkish and English that report the incidence or prevalence of MDRPI in Türkiye were incorporated into the review. Two authors independently evaluated the eligibility of studies and extracted the data.

Results: A total of twelve studies, four reporting prevalence and eight reporting incidence, were included in this review, comprising data from 7,067 patients. The estimated pooled incidence and prevalence of MDRPIs were demonstrated at 31.23% (95% CI = 21.96–42.29%) and 26.12% (11.40 – 49.28%), respectively. The predominant classifications of MDRPIs were stage 1 and stage 2 injuries. The occurrence of MDRPI was predominantly observed in the head and facial regions. Respiratory devices, nasogastric tubes, urinary catheters, arterial and venous catheters, thromboembolism stockings, and physical restraint equipment were the most common causative devices for MDRPIs. Risk factors for MDRPIs included length of stay in intensive care or hospital, age, gender, Braden risk score, mechanical ventilation, enteral or parenteral nutrition, skin type, number of medical devices used, fecal incontinence, diet, low albumin and hemoglobin levels.

Conclusion: Despite the significant heterogeneity observed among the included studies, MDRPIs are common among patients receiving critical care and in hospital environments. Additional investigation is required regarding the reporting incidence, prevalence, and risk evaluation of MDRPIs. Future research should include data on MDRPIs stratified by age, gender, devices, and total device days.

Keywords: Incidence, medical device-related, prevalence, pressure injury, risk factors

Öz

Giriş: Tıbbi cihazla ilişkili basınç yaralanmaları (TCİBY) genellikle hastane ortamlarında meydana gelmektedir, hastaların yaşam kalitesini olumsuz etkiler ve bakım maliyetini artırır. Bu sistematik inceleme, gözlemsel çalışmalara dayanarak Türkiye'de TCİBY'lerin insidansını, prevelansını ve ilişkili risk faktörlerini belirlemeyi amaçlamaktadır.

Yöntem: Başlangıç noktasından 31 Ekim 2024'e kadar Web of Science, PubMed, CINAHL, Science Direct ve TR Index veri tabanları ve Google Scholar'da kapsamlı bir elektronik literatür taraması yapıldı. Türkiye'de TCİBY'nin insidansını veya prevelansını bildiren Türkçe ve İngilizce yayınlanmış çalışmalar incelemeye dahil edildi. İki yazar, çalışmaların uygunluğunu bağımsız olarak değerlendirdi ve verileri çıkardı.

Bulgular: Bu inceleme prevalansı bildiren dört ve insidansı bildiren sekiz olmak üzere toplam on iki çalışmadaki 7.067 hastanın sonuçlarını içerdi. TCİBY'lerin kümülatif insidansı ve prevelansı sırasıyla 31.23% (95% CI = 21.96–42.29%) ve 26.12% (11.40 – 49.28%) olarak bulundu. TCİBY'lerin en çok bildirilen sınıflandırmaları evre 1 ve evre 2 yaralanmalardı. TCİBY'lerin oluşumu çoğunlukla baş ve yüz bölgelerinde gözlendi. Solunum cihazları, nazogastrik tüpler, idrar kateterleri, arteriyel ve venöz kateterler, tromboembolizm çorapları ve fiziksel kısıtlama ekipmanları TCİBY'ye en sık neden olan cihazlardı. TCİBY'ler için risk faktörleri arasında yoğun bakımda veya hastanede kalış süresi, yaş, cinsiyet, Braden risk skoru, mekanik ventilasyon, enteral veya parenteral beslenme, cilt tipi, kullanılan tıbbi cihaz sayısı, fekal inkontinans, diyet, düşük albümin ve hemoglobin seviyeleri yer aldı.

Sonuç: Dahil edilen çalışmalar arasında gözlemlenen önemli heterojenliğe rağmen, TCİBY'ler yoğun bakım ve hastane ortamlarında kalan hastalar arasında yaygındır. TCİBY 'lerin insidansı, prevelansı ve risk değerlendirmesiyle ilgili ek araştırmalara ihtiyaç vardır. Gelecekteki araştırmalar, yaşa, cinsiyete, cihazlara ve toplam cihaz günlerine göre değerlendirilen TCİBY'ler hakkında verileri içermelidir.

Anahtar kelimeler: İnsidans, tıbbi cihazla ilgili, prevelans, basınç yaralanması, risk faktörleri

Received	Accepted	Published Online	Corresponding Author	E-mail
December 19, 2024	May 31, 2025	December 22, 2025	Tayfun Bişgin	tayfun.bisgin@deu.edu.tr
Correspondence	Dr. Tayfun Bişgin. Faculty of Medicine, Department of General Surgery, Dokuz Eylül University, 15 Temmuz Sağlık ve Sanat Yerleşkesi / İnciraltı 35340-İzmir, Türkiye			
	https://doi.org/10.22391/fppc.1604346			

Key Points

1. The prevalence and incidence of MDRPIs in intensive care units and hospitals in Türkiye were high.
2. MDRPIs were frequently reported as stage 1 or stage 2.
3. The most common location for MDRPI development was the head and face region, particularly the nose, lips, mouth, and ears.
4. Respiratory devices were the most frequent cause of MDRPIs.

Introduction

Healthcare institutions increasingly recognize MDRPIs as a public health issue [1]. The therapeutic use of medical devices is increasing, resulting in a rise in the prevalence and incidence of MDRPIs and drawing attention to the problem [2–4]. MDRPIs refer to pressure injuries related to the use of devices for preventive, diagnostic, or therapeutic purposes; the resulting injury often conforms to the shape of the device [5]. MDRPIs may develop due to heat, moisture, and pressure caused by medical devices. The etiology of MDRPIs is often affected by various factors, including the properties of the medical device (e.g., hard materials such as rubber, plastic, or silicone; size, shape, configuration, number of devices used), individual patient factors (e.g., age >75, tissue tolerance, skin structure, chronic illnesses, mobility limitations, disruption of the skin microclimate, malnutrition), and care interventions (e.g., repositioning the device, application of protective dressings) [1,6,7].

MDRPIs contribute to increased hospital-acquired pain, morbidity, and mortality. They prolong hospital stays and adversely affect patients' quality of life [1,8,9]. The average length of hospitalization for patients with hospital-acquired pressure injuries is 2.2 days longer than those without such injuries [9]. These prolonged hospital stays are often linked to increased health care costs, hospital-acquired infections, and severe complications such as tissue necrosis, sepsis, and gangrene. The cost of treating pressure injuries is estimated to range from €1.7 to €470.5 per patient per day, whereas the cost of prevention is estimated at €2.6 to €87.6 [10]. However, the exact cost associated with MDRPIs remains unknown.

MDRPIs may also occur in patients admitted to a wide range of healthcare settings, including maternity wards, intensive care units, nursing homes, and rehabilitation facilities [1]. The development of MDRPIs may affect the skin or mucosal tissue, predominantly in the head, neck, sacrum, and heel, while bony prominences are less frequently affected [1–4,6]. MDRPIs on the skin are typically classified according to standardized pressure injury stages; however, this does not apply to MDRPIs that occur on mucosal membranes due to the anatomical and physiological differences. Therefore, they should be classified as mucosal injuries. The risk of MDRPIs among patients is frequently underestimated by existing pressure injury risk assessment instruments, including the Braden scale, Norton scale, and Waterlow score, due to their emphasis on patient immobility instead of the movement of medical devices [11,12]. Consequently, nurses and other healthcare professionals rely on clinical judgment and skin assessment to identify MDRPIs, and such reliance may result in insufficient assessment or documentation of certain cases [7].

Due to variations in healthcare environments and assessment processes implemented by healthcare professionals, the prevalence and incidence of MDRPIs have been reported inconsistently among studies. A systematic review and meta-analysis [6] reported the estimated pooled incidence of MDRPIs as 12% (95% CI: 8–18) and the estimated pooled prevalence as 10% (95% CI: 6–16). Another systematic review found the incidence of MDRPIs among adults in acute care settings to be 28.1% [4]. Variations in the reported incidence and prevalence across studies, and their confinement to specific regions or countries, make it challenging to understand the epidemiology of MDRPIs [2,4,13]. Therefore, a systematic review is necessary to comprehensively identify, examine, present, and synthesize evidence on MDRPIs in Türkiye. Based on observational studies, this systematic review aimed to identify the incidence, prevalence, and associated risk factors of MDRPIs in Türkiye. This review will provide a robust examination of the available evidence, inform the development of clinical standards and procedures, and highlight areas of uncertainty for future research.

Methods

Study Design

This systematic review adhered to the PRISMA guidelines for systematic reviews and meta-analyses.

Inclusion criteria

The sample's inclusion criteria were determined based on the Population, Intervention, Comparison, Outcome, and Study Types (PICOS) framework, which requires the explicit definition of all components of a clinical question's structure [14] (Table 1).

Inclusion criteria: (1) Observational, cohort, descriptive, or cross-sectional studies reporting the incidence, prevalence, and/or risk factors of MDRPIs in Türkiye; (2) Patients aged 18 years and older in any healthcare setting, without restrictions related to hospital type or department; (3) Relevant data that can be obtained directly or through calculations; (4) Studies published in English or Turkish from the beginning to October 31, 2024 (Table 1).

Exclusion criteria: (1) Experimental studies conducted to test the effectiveness of devices for the prevention or management of MDRPIs (randomized controlled and quasi-experimental), consensus reports, all types of reviews and meta-analyses, case reports, policy reports, and qualitative studies; (2) Inability to obtain the full text; (3) Patients under the age of 18 years and/or those receiving home care services; (4) Duplicate publications (Table 1).

Table 1. Inclusion criteria according to the PICOS framework

Domains	Inclusion criteria	Exclusion criteria
Population	Patients aged 18 years and older All hospitalized patients in Türkiye	Patients under the age of 18 years Patients receiving home care services Studies involving nurses
Intervention	Assessment of MDRPIs incidence or prevalence	Lacking incidence or prevalence reports
Comparison	NA	NA
Outcome	Reporting the incidence or prevalence of MDRPIs Identifying the risk factors associated with MDRPIs	Other hospital-acquired pressure injuries unrelated to devices
Study types	Observational Prospective or retrospective cohort Cross-sectional Descriptive	Experimental studies (RCTs, quasi-experimental) Consensus reports All types of reviews and meta-analyses Case reports Policy reports Qualitative studies
Language	Articles published in English and Turkish	Articles published in other languages

PICOS: Population, Intervention, Comparison, Outcome, and Study types

Search strategy

An extensive electronic literature search was conducted on the Web of Science, PubMed, CINAHL, Science Direct, and TR Index databases, and Google Scholar for this systematic review. In each database, keywords and MeSH terms (“pressure injury*” OR “pressure ulcer*” OR “pressure sore” OR "pressure damage" OR “decubitus” OR “decubitus ulcer” OR “bed sore” OR “mucosal”) AND (“device-related” OR “medical device-related” OR “device associated”) AND (“incidence” OR “prevalence” OR “frequency” OR “occurrence”) were searched in both English and Turkish. The keywords were searched in Turkish in Google Scholar and TR Index databases. No publication date restrictions were applied to our literature search; all electronic sources were searched from the beginning to October 31, 2024, based on title and abstract. Boolean operators and truncation symbols were employed to integrate search terms to achieve a comprehensive search. The reference lists of the included studies were also examined to identify additional relevant research.

Study selection process

The Rayyan program was utilized to to identify duplicate records in the study. Two authors independently assessed the selection and eligibility of the remaining studies, while another author conducted an audit. Both authors independently examined the titles and abstracts of the studies based on the inclusion criteria. The results of the two authors were compared, and in instances of disagreement, critical points were discussed until a consensus was achieved. The data extraction was performed using standardized and predefined forms to ensure the validity and quality of the data. A PRISMA flow diagram was used to document the study selection process, and the diagram in Figure 1 presents the flow of included articles.

Data extraction, synthesis, and quality assessment

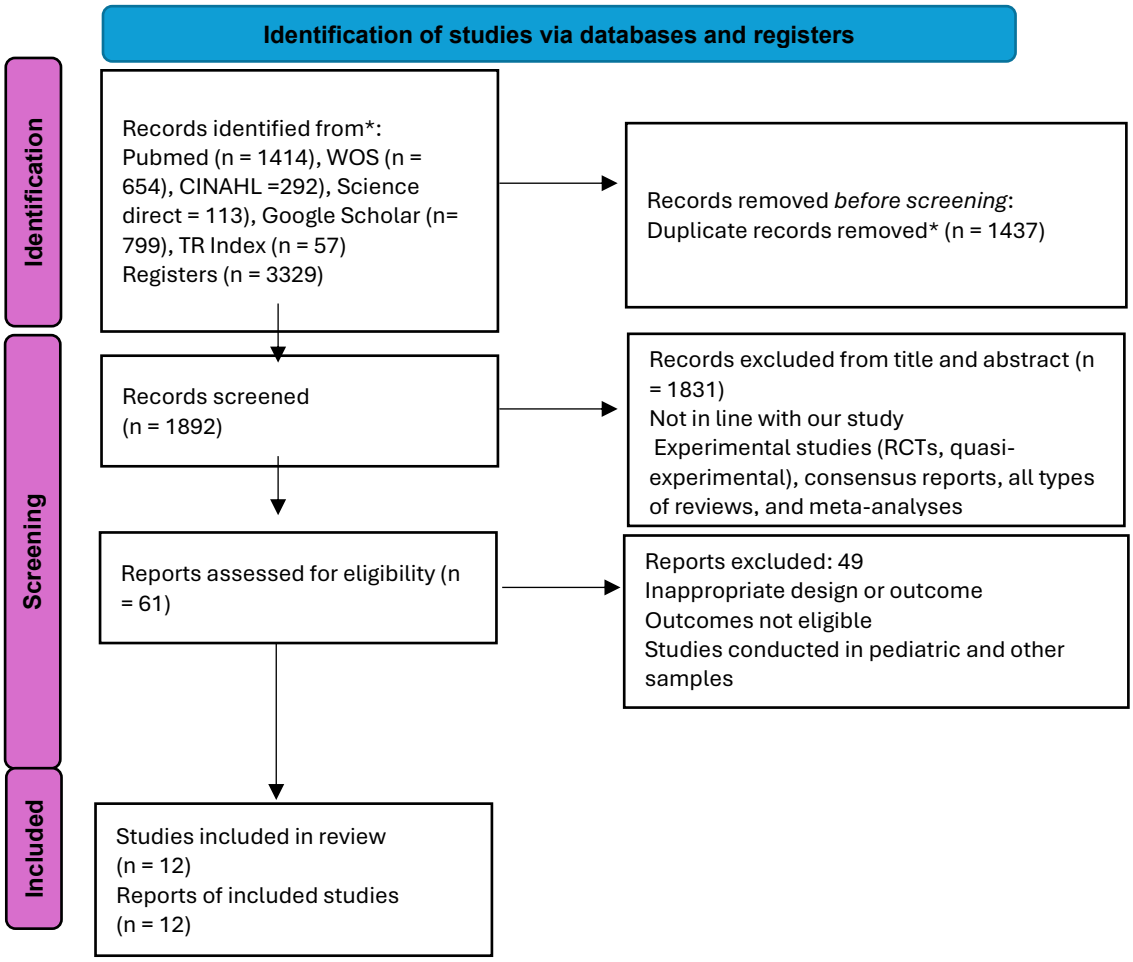
Data was acquired using a standardized extraction form, which comprised details such as author(s), year, country, objective, data collection year, study design, study setting, sample size, data collection tools, results (age, incidence, type of medical device, risk factors), and classification systems. Two authors (CA and GG) independently examined the 12 full-text articles and extracted the data. Summary tables were generated from the extracted data of each included study, accompanied by a narrative synthesis of the findings.

Two authors (CA and TB) independently evaluated the quality of the articles included in the study and then compared their findings to reach a consensus. Any disagreements were resolved through discussion between the authors and a third author (GG). The Joanna Briggs Institute Statistical Assessment and Review Tools Meta-Analysis (JBI–MAStARI) served as the instrument for quality assessment. In cross-sectional studies, data quality was assessed by assigning 1 point for each applicable item, with a total possible score of 8 points. In cohort studies, data quality was evaluated by assigning 1 point for each relevant item, with a possible score of 11 points. Responses to all questions were categorized as 'Yes,' 'No,' 'Unclear,' or 'Not Applicable' (https://jbi.global/critical-appraisal-tools). The score for each article was determined as a percentage, with quality assessed as high (80%-100% score), medium (50%-79%), or low (<50%) (Supplementary Table 1) [15]. The pooled prevalence and incidence were analyzed using Comprehensive Meta-Analysis V4 (CMA) software, with 95% confidence intervals estimated. Statistical significance was determined at $p < 0.05$.

Results

The search strategy generated a total of 3329 records. Throughout the screening process, 1,437 articles were eliminated because of duplication. Following the examination of the titles and abstracts, 1,831 records were excluded because they did not meet the inclusion criteria. Of the 61 studies screened for full-text assessment, 12 were chosen for a thorough eligibility assessment (Figure 1). In conclusion, our review comprised 12 studies involving 7,067 participants. Among the 12 studies, 4 provided prevalence rates, while 8 presented incidence rates (Table 2). The quality of the studies ranged from 81 to 100%.

Among the four studies determining the prevalence of MDRPIs, one was a descriptive, multicenter, prospective, analytical study conducted in all inpatient care and intensive care settings, two were point prevalence studies conducted in intensive care units, and one had a prospective, descriptive study design. Of the 8 studies reporting the incidence of MDRPIs in adult intensive care units, 7 were prospective, descriptive studies, and 1 was a prospective cohort study. Each of the 8 studies evaluated patients during the initial 24 hours following their admission to the intensive care unit. Four of these studies evaluated patients daily until they were discharged from the intensive care unit. One study observed patients twice a day until discharge, two assessed patients every 48 hours until discharge, and one followed the patient daily for 7 days (Table 2).



*
Rayyan identified duplicate publications (https://help.rayyan.ai/hc/en-us).

Figure 1. Flow diagram of search strategies

Table 2. Extracted data for studies of MDRPIs.

First Author (Year)	Study design	Unit where the study was conducted	Sample Size	Data Collection
Erbay Dallı et al. (2022)	Prospective observational cohort study.	Adult Intensive Care Unit	172 intensive care unit patients	Case Report Form, MDRPI Monitoring Form, Braden Scale, and NPIAP Pressure Injury Staging Assessments The data were collected twice daily until discharged from the intensive care unit
Aydım Kudu et al. (2023)	Longitudinal, descriptive/analytical, and cross-sectional study.	Adult Intensive Care Unit	213 patients	Patient Information Form, MDRPI Monitoring Form, the Jackson/ Cubbin Pressure Area Risk Calculator Tool, the NPIAP Pressure Injury Staging System, and the Glasgow Coma Scale. Data was collected every 24 hours until discharge from the intensive care unit
Çelik et al. (2023)	Observational, prospective, and descriptive	Anesthesia-Reanimation ICU	302 patients	Patient Descriptive Characteristics Form, Glasgow Coma Scale (GCS), Medical Device-Related Pressure Injury Diagnosis Form, Braden Scale, and Pressure Injury Staging Form Researchers assessed patients within the first 24 hours and followed up at 48-hour intervals until discharged from the intensive care unit.
Dirgar et al. (2024)	Descriptive/Observational study.	Level 1 and Level 2 Intensive Care Units	A total of 58 patients were included, and 482	Patient Introduction Form, Medical Device-Related Pressure Injury

			patient-days were monitored.	Follow-Up Form, and The Braden Scale. Assessments were conducted daily until discharge from the intensive care unit.
Karacabay et al. (2023)	Descriptive and cross-sectional study.	Neurology and Anesthesia-Reanimation ICU	300 patients	Patient Information Form, Medical Device-Related Pressure Injury Tracking Chart, The Jackson/Cubbin Risk Assessment Scale. Assessments were conducted every 24 hours until discharge from the intensive care unit.
Yiğitoğlu & Aydoğan, (2023)	Observational, prospective, and cross-sectional study.	COVID-19 Intensive Care Unit	132 intensive care unit patients	Patient Characteristics Form, Medical Device-Related Pressure Injury Monitoring Form, Braden Scale, and Pressure Injury Staging Form. Each patient was monitored daily for 7 days.
Temiz et al. (2024)	Descriptive and cross-sectional study	Adult Anesthesia and Reanimation Intensive Care Unit	187 intensive care unit patients	Patient Identification Form, Medical Device-Related Pressure Injury Tracking Form, and Braden Scale Initial assessment was conducted within the first 24 hours, followed by evaluations every 48 hours until discharge from the intensive care unit
Tezcan et al. (2024)	Prospective and descriptive.	Medical and Surgical Intensive Care Unit	138 intensive care unit patients	Intensive Care Patient Information Form, Glasgow Coma Scale, Braden Scale, and Medical Device-Related Pressure Ulcer Identification Form Patients were assessed daily until discharged from the intensive care unit
Hanonu & Karadag (2016)	Prospective, descriptive, prevalence study	Anesthesia and Reanimation, Cardiovascular Surgery, Internal Medicine, Neurosurgery, and Respiratory Intensive Care Units	175 intensive care unit patients	Patient Characteristics Form, Medical Device-Related Pressure Ulcer Form, Braden Scale, and Pressure Ulcer Staging Form (NPUAP-EPUAP) Assessments were conducted between one and six times.
Göçmen Baykara et al. (2023)	Descriptive, multicenter, prospective analytical study Prevalence study	Inpatient and intensive care units (ICUs) were included in 13 hospitals in 12 geographic regions of Türkiye.	A total of 5,088 patients	The Pressure Injury Prevalence Study Tool, Braden Scale Single-time assessment.
Yalçin & Güneş (2023)	Descriptive, cross-sectional, and point prevalence study	Neurology, Neurosurgery, Respiratory, Internal Medicine, Cardiac Surgery, and Anesthesia and Reanimation Intensive Care Units	200 intensive care unit patients	Patient Information Form and Braden Scale Single-time assessment in June
Pamuk Cebeci et al. (2024)	Point prevalence study	Adult Intensive Care Units	102 intensive care unit patients	Patient Information Form, Braden Scale, Pressure Injury Staging Form, and Glasgow Coma Scale Single-time assessment

All the studies were conducted in acute hospital settings, with 11 conducted in intensive care units. In contrast, the remaining study [16] was conducted in all inpatient and intensive care units (Table 3).

Prevalence and Incidence

The estimated pooled prevalence rate of MDRPIs from the 4 included studies [16–19] was 26.12% (11.40 – 49.28%). The highest prevalence was reported at 40% in the anesthesia and critical care, cardiovascular surgery, internal medicine, neurosurgery, and respiratory intensive care units (n=175) [17]. In comparison, the lowest prevalence was reported at 10.7% in all inpatient care and intensive care units (n=5088) [16] (Table 3). The estimated pooled incidence rate of MDRPIs from the 8 included studies was 31.23% (95% CI = 21.96–42.29%). The highest prevalence was reported at 59.10% in the COVID-19 intensive care unit (n=132) [20], while the lowest prevalence was reported at 11.6% in the medical and surgical intensive care units (n=138) [21] (Table 3).

Staging

In many studies (n=6), stage II pressure injuries were reported as the most common type, with their rate ranging between 5.2% and 75% across the included studies [16–18,20–22]. Stage I pressure injuries were reported in three studies, with their prevalence ranging from 10.3% to 90% across the included studies. Mucosal membrane pressure injuries ranged from 1.2% to 32.8% [16,20,24,26] (Table 3).

Anatomic Location

The current systematic review identified ten areas where MDRPIs developed across the included studies: ear (2.8%-20%), nose (6.3%-46.2%), mouth/lips (13.7%-44%), forehead/chin/cheek (1.05%-14.9%), neck (3.15%-14.6%), finger (3.1%-21.1%), leg/inner thigh (0.8%-10.5%), foot (1.2%-6.2%), arm (2%-12.6%), and chest/abdomen (1.5%-7.6%). In four studies [18,19,22,26], MDRPIs most frequently developed on the nose or nasal bridge and in the mouth [17,20,21,23]. In two other studies [24,27], they were reported on the fingers, and in one study [16], they were observed on the leg (Table 3).

Medical Devices

Respiratory devices: Respiratory devices, including endotracheal tubes, nasotracheal tubes, non-invasive ventilation (NIV) masks, CPAP/BiPAP masks, nasal cannulas, simple face masks, SpO2 probes, and tracheostomy tubes, have been reported to cause MDRPIs. A review of the studies revealed that, except for three studies [16,19,22], nine reported respiratory devices were the most common cause of MDRPIs. Among the respiratory devices, endotracheal tubes were most frequently reported as causing MDRPIs in eight studies (10.7%-72.1%) [16–18,20,21,23,25,26], non-invasive ventilation/oxygen masks in two studies (51.2%, 66.7%) [22,27], and SpO2 probes in one study (19.79%) [24] (Table 3).

Gastrointestinal/Genitourinary Devices: Nasogastric tubes, urinary catheters, percutaneous endoscopic gastrostomy (PEG) tubes, adult diapers, and fecal incontinence devices have been reported to cause MDRPIs. Except for one included study [16], the incidence of nasogastric tubes causing MDRPIs ranged from 3.9% to 36.8%. Dirgar et al. (2024) noted that 80% of patients with nasogastric tubes developed nasal injuries [26]. Aydım Kudu et al. (2023) reported that one out of eight patients with percutaneous endoscopic gastrostomy (PEG) tubes (12.5%) developed MDRPI [27], while Çelik et al. (2023) reported that one out of seven patients (14.3%) with the same device developed MDRPI [22]. Among genitourinary devices, urinary catheters were the most frequent cause of MDRPIs, with incidence rates ranging from 0.7% to 49.1% in seven studies [18,19,22–25,27]. Çelik et al. (2023) reported fecal incontinence devices (n=7, 2.3%) [22], and Karacabay et al. (2023) reported adult diapers (12.09%) as causes of MDRPI [24] (Table 3).

Vascular Catheters/lines: Arterial/venous catheters, peripheral venous catheters, and central venous/dialysis catheters have been reported to cause MDRPIs. Aydım Kudu et al. (2023) reported that arterial/venous catheters caused MDRPIs in 4.5% of cases [27], while Çelik et al. (2023) reported that arterial catheters caused MDRPIs in 1.4% of cases [22]. Two studies [21,25] reported that peripheral intravenous catheters caused MDRPIs in 6.2% and 14% of cases, respectively. A study [19] reported that central venous catheters caused MDRPIs in 19.6% of cases (Table 3).

Other devices: Orthopedic devices (62.5%), negative pressure wound therapy equipment (33.3%) [22], adhesive tape (1.4%), drainage tube (100%), chest tube (100%) [27], blood pressure cuffs (15.35%, 42.4%) [23,24], electrocardiography cables/electrodes (0.9%-19.3%) [18,24,25,27] cervical collars (12.3%), airways (7.7%) [18], thromboembolism stockings (2.3%-100%) [16,17,19,22,23,27], and physical restraints (4.39%-51.1%) [16,22–25,27] have been reported to cause the development of MDRPIs (Table 3).

Risk factors

The current systematic review assessed risk factors using regression analysis in 8 studies. The most frequently reported risk factor for MDRPI was the length of stay in the intensive care unit or hospital [16,18,21–23,25,26]. Other commonly reported risk factors included the Braden risk score [16,17,21,22,26], mechanical ventilation [18,21,23,26], enteral or parenteral nutrition [16,17,26], and skin type (dry, moist, edematous) [16,21]. The number of medical devices used [22,27], advanced age [18,26], fecal incontinence, immobility [16], BMI [25], PaCO2 levels, and the duration of aerobic respiration with a positive nasal cannula or mask [21], gender, diet, low albumin and hemoglobin levels [16,18], a history of cardiovascular disease, and vasopressor use [23] were independent risk factors for MDRPIs (Table 3).

Table 3. Extracted data for research reporting incidence, prevalence, and risk factors of MDRPIs

First Author (Year)	Age (Years ± SD)	Incidence % (n)	Region	Medical device type (n)	Risk factors	Classification system
Erbay Dallı et al. (2022)	The average age of patients was 61.1 ± 15.9. Patients who developed MDRPI: 61.3 ± 16.7 Patients who did not develop MDRPI: 56.3 ± 15.3	%48,8 (n=84)	**Head and neck region (62.3%)** Mouth/Lips: 61 (49.2%) Ear: 13 (19.4%) Nasal bridge: 17 (100%) Intranasal: 30 (21.5%) Auricle (outer ear): 9 (28.1%) Neck: 3 (7.7%: tracheostomy) Genitourinary region: 46 (27.2%), Arms: 11 (15.1%) Fingers: 14 (8.1%) Legs: 2 (28.6%)	Endotracheal tube (n=124): 72.1% Face mask (n=67): 38.9% Non-invasive masks (n=17): 9.8% Nasal oxygen (n=32): 18.6% Tracheostomy (n=39): 22.6% Nasogastric tube (n=139): 80.1% Urinary catheter (n=169): 98.2% Blood pressure cuff (n=73): 42.4% SpO2 probe (n=172): 100% Compression stockings (n=7): 4.1% Cervical collar (n=3): 1.7% Physical restraint (n=88): 51.1% *n= According to the device	According to multivariate analysis: Age (46–64 years) (p = 0.008, OR = 12.457), History of cardiovascular disease (p = 0.021, OR = 0.044), Vasopressor use (p = 0.013, OR = 0.089), Length of stay in the intensive care unit (≥22 days, p = 0.048, OR = 0.055), The need for mechanical	NPIAP Nearly half of the medical devices used (48.4%) caused pressure injuries within an average of 1–3 days Stage I: 18.7% Stage II: 13% Stage III: 4.6%

			Neck: 1 (33.3%: Cervical collar) Wrists and ankles: 8 (9.1%) *n= According to the device		ventilation (p = 0.028, OR = 10.252)	
Aydım Kudu et al. (2023)	68.02 ± 14.44 Patients who developed MDRPI: 71.54 ± 12.54	%28,6 (n= 61/213 patients)	Mouth/Lips: 13/95, 13.7% Nasal bridge: 6/95, 6.3% Intranasal: 11/95, 11.6% Ears: 2/95, 2.1% Neck: 3/95, 3.15% Wrist/Ankles: 2/95, 2.1% Fingers: 20/95, 21.1% Forearm: 12/95, 12.6% Inner thigh: 10/95, 10.5% Forehead: 1/95, 1.05%	**Respiratory devices: 46 (48.4%)** Endotracheal tube: 13/80 (16.3%) Endotracheal Tube/Tracheostomy tie: 3/81 (3.7%) Non-invasive mask: 2/3 (66.7%) SpO2 probe: 20/213 (9.4%) Face mask: 5/85 (5.9%) Nasal oxygen: 3/65 (4.6%) **Vascular catheters/lines: 12 (12.6%)** Arterial/Venous catheter: 10/210 (4.5%) Central venous/dialysis catheter: 2/29 (6.9%) **Gastrointestinal/Genitourinary: 25 (26.3%)** Nasogastric tube: 10/86 (11.6%) Percutaneous endoscopic gastrostomy: 1/8 (12.5%) Urinary catheter: 14/190 (7.4%) **Others:** Adhesive tape: 3/211 (1.4%) Physical restraint: 1/20 (5%) Electrocardiography cable/electrode: 8/213 (3.7%) Thrombo-embolism stockings: 11/11 (100%) Drainage tube: 30/30 (100%) Chest tube: 3/3 (100%) *n = MDRPIs Development /Medical device	Patients who cannot be fed and those with 5–8 medical devices used	NPIAP
Çelik et al., (2023)	Median: 67 (58–76) 61.9% (n = 187) > 65	27.2% (n = 82)	Nose: 26.8%, n=22 Mouth: 15.9%, n=14 Neck: 14.6%, n=12 Perineum: 9.8%, n=8 Ear: 8.5%, n=7 Arm: 8.5%, n=7 Finger: 7.7%, n=3 Leg: 6.1%, n=5 Foot: 1.2%, n=1	Orthopedic devices: 5/8, 62.5% Restrictors: 8/14, 57.1% Non-invasive ventilation/oxygen masks: 21/41, 51.2% Endotracheal tubes: 13/200, 6.5% Fecal management devices: 7/302, 2.3% IV catheters: n=2/300, 0.7% Foley catheters: n=2/299, 0.7% Pulse oximeters: n=3/299, 1% Arterial catheters: n=4/279, 1.4% Endotracheal tube: n=13/200, 6.5% Nasogastric tube: n=7/179, 3.9% Nasal cannula: n=2/76, 2.6% Anti-embolic stockings: n=2/25, 8% Tracheostomy cannula: n=3/11, 27.3% PEG: n=1/7, 14.3%, Negative pressure wound therapy equipment: n=2/6, 33.3% *n = MDRPIs Development /Medical device	In the regression analysis: The Braden Risk score, The number of medical devices used, The length of stay in the intensive care unit	NPUAP-EPUAP At the time of diagnosis, 65.9% (n = 54) of the patients were at stage II. Stage I = 15.9% (n = 13). A MDRPI diagnosis was made in 29.3% (n = 24) of the patients within 10-14 days (Table 2).
Karacabay et al. (2023)	71.88 ± 14.82 Patients who developed MDRPI: 74.25 ± 15.46	%18 (n = 54)	Mucosal membrane (n=11) 12.08% Skin (n=80) 87.91%	SpO2 probe: 18 (19.79%) Endotracheal tube: 14 (15.35%) Blood pressure cuff: 14 (15.35%) Diaper: 11 (12.09%), Urinary catheter: 7 (7.69%) Nasogastric catheter: 8 (8.79%) Arm/hand restraint: 4 (4.39%) Compression stockings: 3 (3.29%) Nasal cannula: 3 (3.29%), Electrode: 2 (2.19%) Tracheostomy cannula: 2 (2.19%) Oxygen mask: 2 (2.19%), CPAP mask: 1 (1.09%)	*According to univariate analysis:* Low Jackson/Cubbin scores, additionally, it was found that the Jackson/Cubbin score of patients significantly decreased with	Not specifically stated. Stage I (56.25%) Stage II (16.25%) Stage III (11.25%) Deep tissue injury (8.75%) Unstageable (7.5%) The nasal cannula caused

				Catheter: 2 (2.19%) *n= Patient with MDRPI	increasing BMI and age Prolonged hospital stays Low hematocrit and albumin levels Use of respiratory support devices Physical dependence The presence of pressure injuries unrelated to devices	pressure ulcers in the shortest time (6.33 ± 2.88), while the tracheostomy cannulas caused them in the longest time (36.00 ± 19.79).
Dirgar et al. (2024)	73.67 (SD, 18.81) years (range, 21–93 years). 52.5% of the patients who developed MDRPI were in the age range of 81-90 years. Patients who developed MDRPI tended to be older (P = .012).	In 39.7% of the patients (n=23), MDRPI developed within an average of 5 days.	Nose (31.9%) Mouth (21.3%) Cheeks (14.9%) Fingers (11%) Forehead (9%) Other (6%) Neck (4%) Arm (2%)	Among patients who developed MDRPI, 72.7% of those with an endotracheal tube had oral lesions, 80% of those with a nasogastric tube had nasal lesions, 85.7% of those receiving non-invasive positive pressure ventilation had nasal lesions, and 71.4% had cheek lesions. **Distribution of Medical Devices Used** Endotracheal tube (27%) Pulse oximeter (27%) Radial artery catheter (10%) Nasal cannula (10%) Oxygen mask (9%) Foley catheter (7%) Nasogastric catheter (6%) NIMV mask (4%)	Mechanical ventilation (MV), routes other than oral (NG, PEG), elderly patients, low Braden risk scores, and long hospital stays were found to be risk factors.	Not specifically stated. Stage I (10.3%) Stage II (5.2%) Stage III (1.7%) Unstageable mucosal membrane (32.8%)
Yiğitoğlu & Aydoğan, (2023)	Age: 65.45 ± 2.462 MDRPI developed in 65.45 ± 2.462 days.	%59,1 (n = 78)	Nose: 34 (25.8%) Mouth: 34 (25.8%) Ear: 17 (12.9%), Lips: 12 (9.1%) Cheeks: 11 (8.3%) Forehead: 7 (5.3%) Chest: 8 (6.1%) Chin: 4 (3%), Neck: 5 (3.8%) Breast: 2 (1.5%) Abdomen: 2 (1.5%) Legs: 1 (0.8%)	Endotracheal tube (ET): 44 (31.2%) Non-invasive mechanical ventilation: 33 (23.4%) Nasal High Flow: 16 (11.3%) Nasogastric tube: 15 (10.6%) ET connection: 12 (8.5%)	According to univariate analysis: Individuals who received invasive ventilation (51.3%), Enterally fed (46.2%), The prone position (78.2%) and Braden score ≤12 (50%), with an average age of 65.45 ± 2.462.	NPUAP-EPUAP The time to pressure injury was 3 days (25.7%, n = 36). Stage 2 (28.8%, n = 38) Stage 1 (19.7%, n = 26) Stage 3 (9.1%, n = 12), Mucosal membrane injuries (12.9%, n = 17), Suspected deep tissue injuries (9.1%, n = 12).
Temiz et al. (2024)	The average age of the patients was 69.65 ± 14.02. Patients who developed MDRPI: 74 (62–82) Patients who did not develop MDRPI: 70 (58–74)	%30,6 (n=57)	It has not been examined.	Endotracheal tube: 35 (61.4%) Non-invasive ventilation/oxygen mask: 30 (52.6%) Nasal cannula: 8 (14%) Foley catheter: 28 (49.1%) Nasogastric tube: 21 (36.8%) Restrictors: 18 (31.6%) Electrodes: 11 (19.3%) Peripheral venous catheter: 8 (14%) Pulse oximeter: 4 (7%) Central venous catheter: 7 (12.3%) Arterial catheter: 2 (3.5%) PEG tube: 4 (7%) Compression stockings: 3 (5.3%) Tracheostomy cannula: 3 (5.3%) Orthopedic devices (bandages, cervical collar, splint): 1 (1.8%) *n= According to the medical device	According to logistic regression analysis: Skin type (dry, moist, edematous), Length of stay in the intensive care unit, BMI	EPUAP Stage I (73.7%) Stage II (26.3%) Pressure injuries typically developed between the 8th and 11th days in the intensive care unit (36.8%).

Tezcan et al. (2024)	The average age of patients was 71.41 ± 13.06.	%11,6 (n = 16) MDRPI developed on average in 13.13 ± 6.74 days.	Lips: 6 (37.5%) Nose: 5 (31.3%) Fingers: 3 (18.8%) Foot: 1 (6.2%) Neck: 1 (6.2%) *n= Patient with MDRPI	Nasal cannula: 1 (6.2%) Endotracheal tube: 6 (37.5%) Tracheostomy tube: 1 (6.2%) CPAP mask: 1 (12.5%) Peripheral oxygen saturation probe: 3 (18.8%) Peripheral intravenous catheter: 1 (6.2%) Nasogastric tube: 2 (12.5%) *n= Patient with MDRPI	According to the multinomial logistic regression analysis: The total length of stay in the intensive care unit (β = 0.948, p < 0.01) and PaCO2 levels (β = 0.923, p < 0.01) The duration of aerobic respiration with a nasal cannula or mask (β = -0.920, p < 0.01), The Braden score (β = -0.948, p < 0.01)	EPUAP/NPIAP Stage I (18.8%, n=3) Stage II (75%, n=12) Stage III (6.2%, n=1) MDRPI developed an average of 13.13 ± 6.74 days.
First Author (Year)	**Age (Years ± SD)**	**Prevalence % (n)**	**Region**	**Medical device type (n)**	**Risk factors**	**Classification system**
Hanönü & Karadağ (2016)	The average age of the patients was 62.50 ± 16.67.	%40 (n=70)	Lips: 93 (44.0%) Nose: 33 (15.6%) Fingers: 16 (7.5%) Ears: 13 (6.1%) Others (cheek mucosa, tongue, inner thigh, penis tip, abdominal area): 36 (17.6%)	Endotracheal tube: 95 (45.0%) CPAP masks: 22 (10.4%) SpO2 probes: 17 (8.0%) Oxygen masks: 15 (7.1%) Nasal cannulas: 14 (6.6%) Compression stockings: 5 (2.3%) Electrocardiogram cables: 7 (3.3%) Electrocardiogram electrodes: 2 (0.9%) Blood pressure cuff: 2 (0.9%) Urinary catheter: 6 (2.8%) Nasogastric tube: 10 (4.7%) Arterial catheter: 1 (0.4%) Peripheral intravenous catheter: 1 (0.4%) Central venous catheter: 1 (0.4%) Others (airway, endotracheal tube tie, and plaster): 13 (6.1%) *n = MDRPIs Development /Medical device	The incidence of hospital-acquired pressure injuries related to medical devices was 7 times higher than those unrelated to medical devices (P < 0.05). The risk of pressure injuries increased by 2.12 times in enterally feeding patients, and as the Braden risk score moved from low to high risk, the risk of hospital-acquired pressure injuries related to medical devices increased by 1.81 times (P < 0.05).	NPUAP-EPUAP Stage II (42.6%) Stage I (37.9%) Unstageable (17.5%) Suspected deep tissue injury (1.9%)
Göçmen Baykara et al. (2023)	The average age of the patients was 59 (SD: 17.78) years.	%10,7 (n = 112)	Leg: 75 (7.2%) Scapula: 52 (5.0%) Arm: 42 (4.1%) Trochanter: 33 (3.2%) Ear: 29 (2.8%) Spine: 26 (2.5%) Foot: 26 (2.5%) Scrotum: 20 (1.9%) Ischium: 16 (1.5%) Other: 13 (1.2%)	Compression stockings (28.6%) Endotracheal tube connector (10.7%) Oxygen masks (9.8%)	**Univariate analysis:** low albumin levels (n = 483, 75.8%), fecal incontinence (n = 483, 54.5%), immobility (n = 483, 48.1%), urinary incontinence (n = 483, 38.9%), bed head elevation greater than 30° (n = 483, 30.3%), dry skin (n = 483, 35.9%), wet skin (n = 483, 13.9%), and enteral or parenteral nutrition (n = 483, 30.5% enteral; 18.5% parenteral) **Multivariate analysis:** prolong hospital stays ([OR], 1.006;	NPIAP Stage II (36.2%) Stage I (29.7%) Stage III (11.1%) Stage IV (6.3%) Unstageable (9.8%) Deep tissue injury (5.7%) Mucosal membrane damage (1.2%)

					95% [CI], 1.002-1.010), fecal incontinence (OR, 4.056; 95% CI, 2.687-6.123), immobility (OR, 2.175; 95% CI, 1.590-2.974), parenteral or enteral nutrition (OR, 3.962; 95% CI, 2.804-5.598), having wet or dry skin (OR, 2.631; 95% CI, 1.914-3.615), and low albumin levels (OR, 3.055; 95% CI, 1.914-4.877)	
Yalçin & Güneş (2023)	The average age of the patients was 63.84 ± 15.8.	%32,5 (n=65)	Nose: 30 (46.2%) Mouth: 16 (24.6%) Neck: 7 (10.7%) Chest: 5 (7.6%) Arm: 4 (6.2%) Finger: 2 (3.1%) Lower extremity: 1 (1.6%) *n= Patient with MDRPI	Nasogastric tube: 19 (29.2%) Endotracheal tube: 12 (18.5%) CPAP masks: 10 (15.4%) Tracheostomy cannula: 2 (3.1%) Cervical collars: 8 (12.3%) Airway: 5 (7.7%) Urinary catheter: 4 (6.1%) Blood pressure cuff: 3 (4.6%) Electrodes: 2 (3.1%) *n= Patient with MDRPI	According to the results of the study, the most common risk factors for HAPU were advanced age, gender, length of hospital stay, diet, mechanical ventilation support, albumin, and hemoglobin levels. According to logistic regression analysis, the risk of developing HAPU increased 13.7 times in patients who were hospitalized for 9 to 16 days, and this risk increased 81.9 times in patients who were hospitalized for 17 to 24 days (p = .000). Additionally, in patients on mechanical ventilation, the risk of HAPU increased 13 times (p = .000).	NPIAP EPUAP Stage II (18.5%, n = 12) Stage III (15.4%, n = 10) Stage I (12.3%, n = 8)
Pamuk Cebeci et al. (2024)	The average age of patients was 73.70 ± 12.82.	%29,4 (n=30)	Nose and nasal sides: 11 (36.6%) Ear and surrounding area: 6 (20%) Subclavian region: 6 (20%) Mouth and perioral area: 5 (16.7%) Arm and surrounding area: 2 (6.7%)	Nasal mask: 8 (7.8%), Nasal cannula: 16 (15.7%) ET tube: 3 (2.9%), Tracheostomy: 3 (2.9%) Saturation probe, blood pressure cuff: 18 (17.6%) Saturation probe, BP cuff, ECG: 12 (11.8%) Nasogastric tube and Foley catheter: 10 (9.8%) Central catheter: 20 (19.6%) Peripheral catheter: 4 (3.9%) Compression stockings: 14 (13.6%) Armband: 4 (10.8%), Foot band: 2 (5.4%) *n= According to the device	According to univariate analysis: Albumin levels (z = 3.963; p < 0.001) and Hematocrit (z = 3.316; p < 0.001). In patients who were hospitalized in the intensive care unit for 30 days or more	NPUAP Stage I (90%) Stage II (10%)

SD: Standard Deviation

Discussion

The increasing prevalence and incidence underscore the growing severity of the MDRPI challenge. First, this systematic review aimed to ascertain the incidence of MDRPIs in adults in Türkiye, and the estimated pooled incidence was found to be 31.23% (95% CI = 21.96–42.29%), and the estimated pooled prevalence was 26.12% (11.40 – 49.28%). The twelve included studies varied in evidence hierarchy levels, ranging from III to V. The sample sizes ranged from 58 to 5,088 participants. These findings confirm the results of previous systematic reviews reporting the incidence of MDRPIs in adults [4,28]. However, they were higher than those reported in systematic reviews and meta-analyses involving other adult populations [2,6,29] and pediatric patients [13]. The higher rates observed in Türkiye may be due to the fact that most studies were conducted in intensive care settings. Similarly, the prevalence rate in this systematic review was consistent with some previous studies [2], but higher than others [6,13]. Although the evidence included in this review is valid, the overall results of these studies were heterogeneous, characterized by significant variability in data, especially regarding methodology, study designs, and sample sizes of MDRPI reporting. Prior systematic reviews on the prevalence and incidence of MDRPIs have indicated that, despite the reliability of the primary studies, the results exhibited heterogeneity [4,6]. Despite the heterogeneity of results, this review contributes to understanding the incidence of MDRPIs in intensive care settings and highlights areas for future research in adults. This heterogeneity underscores the need for further research to clarify the factors contributing to these discrepancies. Future research should prioritize the production of high-quality studies and present outcomes with a consistent approach in methodology, study design, sample sizes, and data collection.

This review secondarily aimed to explore the stages, anatomical locations, and devices related to MDRPIs. The review indicated that the predominant stages of MDRPIs were stage 1 or stage 2 injuries in studies. Previous systematic reviews and meta-analyses [3,4] have also documented this trend. Only four of the included studies classified MDRPIs as mucosal injuries. Hence, future studies should classify MDRPIs as mucosal injuries and give more attention to this area.

In this review, the most common location for MDRPI development was the head and face area, specifically the nose, lips, mouth, and ears, consistent with other systematic reviews and meta-analyses [3,4]. This noticeable trend could also stem from the growing number of patients requiring medical devices for therapeutic aims in the lips, mouth, nose, ears, and head [30]. Indeed, this systematic review supports this view, as respiratory devices, such as endotracheal tubes and non-invasive oxygen masks, were found to be the most common causes of MDRPIs. MDRPIs may arise from the nature of respiratory devices (i.e., generic designs that are not aligned with the patient's characteristics) and the patient's ongoing need for oxygen or intubation. However, in this review, nasogastric tubes, urinary catheters, arterial/venous catheters, thromboembolism stockings, and physical restraint equipment were also other common devices causing MDRPIs. Our findings are consistent with those of other systematic reviews [3,4]. Poor application, fixation, adhesive tape friction, and pressure or shear damage may contribute to the development of MDRPIs [7]. When a pressure injury occurs due to a medical device, removing or replacing the device should be considered if it is clinically feasible. In circumstances where the device must stay fixed, it is crucial to adopt methods to alleviate pressure [1]. Therefore, it is recommended that medical device usage and risk assessments be conducted appropriately before using a device.

In this systematic review, the risk factors for MDRPIs included length of stay in the intensive care or hospital settings, Braden risk score, mechanical ventilation, enteral or parenteral nutrition, and skin type (dry, moist, or edematous). Endotracheal tubes used in patients receiving invasive positive pressure ventilation are generally secured with adhesive or other commercial medical devices, increasing the likelihood of MDRPIs [31]. At the cellular level, MDRPIs associated with noninvasive ventilation masks occur when soft facial tissues at the nasal bridge undergo direct deformation, leading to cell damage and subsequent tissue breakdown [32].

The number of medical devices used, advanced age, fecal incontinence, gender, diet, and low albumin and hemoglobin levels were also frequently reported as additional risk factors. The review's findings have been supported by similar studies [2,33]. Another notable finding was the variation in risk factors across the included studies. This variation may have several reasons. Despite the emphasis on the importance of risk assessment in NPIAP guidelines (2016) and best practice reports [7], relevant pressure injury risk assessment tools [11,12] are insufficient for assessing the risk of developing MDRPIs. Furthermore, including fixed medical device uses and mucosal pressure injuries in MDRPIs requires more advanced risk assessment strategies [7,34]. These strategies necessitate integrating specific clinical assessment skills and clinical judgments related to MDRPI. Additionally, the fixation of many medical devices on the patient can hinder a thorough skin examination. When assessing MDRPIs, patients who communicate verbally should be asked about decreased sensation or increased pain at the device attachment site. For patients with reduced consciousness, it is essential to closely observe non-verbal responses during skin assessment [7].

The results of this review have significant practical implications, particularly given the growing use of medical devices in patient diagnosis, treatment, and management. Preventing MDRPIs is the most important step. To prevent the development of MDRPIs, standards, procedures, and strategies should be developed and improved for the use of devices [34]. Furthermore, these precautions should follow the NPIAP guidelines and consensus recommendations for preventing MDRPIs in acute and intensive care settings [1,7]. Establishing a constructive event reporting environment for healthcare professionals is crucial for enhancing patient safety, quality of care, and continuous professional development [35]. Moreover, prevention strategies for MDRPIs should encompass the regular repositioning of devices, the application of suitable tapes to minimize movement and friction against the skin, monitoring skin moisture levels, and using protective covers between the skin and devices [36,37]. Emphasizing nursing education and participation in product selection, as well as strategizing quality improvement initiatives, is essential for effectively addressing this issue [36,37]. Reporting devices that cause pressure injuries and informing manufacturers may lead to more effective strategies, potentially resulting in the redesign of these devices. To address this issue with greater attention, nursing education and involvement in product selection should be prioritized, along with establishing initiatives to enhance quality [1,7]. More effective strategies may include reporting devices causing pressure injuries and informing manufacturers, which could lead to the redesign of the devices [7].

Limitations

This systematic review has some limitations. Nearly all studies (except one) were conducted in intensive care units. The clinical care of critical patients is complex, and the therapeutic modalities accessible in intensive care units vary significantly among different hospitals. Therefore, the incidence and prevalence rates may have been higher. Despite the inclusion of numerous studies, publication bias remained unavoidable. Most of the studies presented a variety of MDRPIs. However, studies showed diversity in MDRPI rates, reporting differently depending on the device. This hindered the subgroup analysis's ability to determine the incidence or prevalence of pressure injuries related to each device. Furthermore, all the studies included in this evaluation focused on hospital-based populations, and consequently, this evaluation did not address home care patients with device-related injuries.

However, the fact that the incidence and prevalence rates, anatomical locations, causative medical devices, and risk factors for MDRPIs in Türkiye are being reported nationally for the first time is a strong point of our systematic review. This review is believed to contribute to future studies and prevention strategies in Türkiye on this topic.

Conclusion

Medical devices used for diagnostic, preventive, or therapeutic purposes may result in negative patient outcomes, such as pressure injuries. In Türkiye, the prevalence and incidence of MDRPIs in intensive care units were high, and they were commonly reported as stage 1 or stage 2. This systematic review identified ten regions where MDRPIs developed across the included studies. The most common location for MDRPI development was the head and face region, specifically the nose, lips, mouth, and ears. Respiratory devices were the most frequent cause of MDRPIs. Other causative devices were nasogastric tubes, urinary catheters, arterial/venous catheters, thrombo-embolism stockings, and physical restraint equipment. Risk factors for MDRPIs varied across the included studies. Among the most reported risk factors were the length of stay in the intensive care unit or hospital, Braden risk score, mechanical ventilation, enteral or parenteral nutrition, skin type (dry, moist, edematous), the number of devices used, advanced age, fecal incontinence, gender, diet, and low albumin and hemoglobin levels. MDRPIs are important indicators for the quality of nursing care and patient safety in healthcare facilities. Consequently, additional investigation is required regarding the reporting incidence and risk evaluation of MDRPIs. Future research should include data on MDRPIs stratified by age, gender, devices, and total device days. It is essential to report studies based on the number of patients and the devices utilized.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions		Author Initials
SCD	Study Conception and Design	CA, GG, TB
AD	Acquisition of Data	CA, GG, TB
AID	Analysis and Interpretation of Data	CA, GG, TB
DM	Drafting of Manuscript	CA
CR	Critical Revision	TB, GG

Financial support: The author states that no financial support was obtained from any institution or individual for this research.
Acknowledgments: None.
Prior publication: The author states that this study has not been previously presented as a paper or published in any other journal.

References

1. European Pressure Ulcer Advisory Panel NPIAP and PPPIA. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. (Emily Haesler, ed.). EPUAP/NPIAP/PPPIA; 2019. Accessed November 25, 2024. https://internationalguideline.com/2019
2. Jia YJ, Hu FH, Zhang WQ, et al. Incidence, prevalence and risk factors of device-related pressure injuries in adult intensive care unit: A meta-analysis of 10,084 patients from 11 countries. Wound Repair Regen. 2023;31(5):713-22. https://doi.org/10.1111/wrr.13112
3. Barakat-Johnson M, Lai M, Wand T, Li M, White K, Coyer F. The incidence and prevalence of medical device-related pressure ulcers in intensive care: a systematic review. J Wound Care. 2019;28(8):512-21. https://doi.org/10.12968/jowc.2019.28.8.512
4. Brophy S, Moore Z, Patton D, O'Connor T, Avsar P. What is the incidence of medical device-related pressure injuries in adults within the acute hospital setting? A systematic review. J Tissue Viability. 2021;30(4):489-98. https://doi.org/10.1016/j.jtv.2021.03.002
5. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised national pressure ulcer advisory panel pressure injury staging system. J Wound Ostomy Continence Nurs. 2016;43(6):585-97. https://doi.org/10.1097/WON.0000000000000281
6. Jackson D, Sarki AM, Betteridge R, Brooke J. Medical device-related pressure ulcers: A systematic review and meta-analysis. Int J Nurs Stud. 2019;92:109-20. https://doi.org/10.1016/j.ijnurstu.2019.02.006
7. Gefen A, Alves P, Ciprandi G, et al. Device-related pressure ulcers: SECURE prevention. Second edition. J Wound Care. 2022;31(Sup3a):1-72. https://doi.org/10.12968/jowc.2022.31.Sup3a.S1
8. Dealey C, Posnett J, Walker A. The cost of pressure ulcers in the United Kingdom. J Wound Care. 2012;21(6):261-6. https://doi.org/10.12968/jowc.2012.21.6.261
9. Padula W V., Delarmente BA. The national cost of hospital-acquired pressure injuries in the United States. Int Wound J. 2019;16(3):634-40. https://doi.org/10.1111/iwj.13071
10. Demarré L, Van Lancker A, Van Hecke A, et al. The cost of prevention and treatment of pressure ulcers: A systematic review. Int J Nurs Stud. 2015;52(11):1754-74. https://doi.org/10.1016/j.ijnurstu.2015.06.006
11. Strawn E. An Investigation of Geriatric Nursing Problems in a Hospital. J Gerontol. 1963;18(3):290-1. https://doi.org/10.1093/geronj/18.3.290a

12. Bergstrom N, Braden BJ, LaguzaA A, Holman V. The Braden Scale for predicting pressure sore risk. Nurs Res. 1987;36(4):205-10. https://pubmed.ncbi.nlm.nih.gov/3299278/
13. Şimşek E, Demir AS, Semerci R, Karadağ A. The incidence and prevalence of medical device-related pressure injuries in pediatric patients: Systematic review and meta-analysis. J Pediatr Nurs. 2023;72:e130-8. https://doi.org/10.1016/j.pedn.2023.06.019
14. Eriksen MB, Frandsen TF. The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: A systematic review. J Med Libr Assoc. 2018;106(4):420-31. https://doi.org/10.5195/jmla.2018.345
15. Goldsmith MR, Bankhead CR, Austoker J. Synthesizing quantitative and qualitative research in evidence-based patient information. J Epidemiol Community Health. 2007;61(3):262-70. https://doi.org/10.1136/jech.2006.046110
16. Baykara ZG, Karadag A, Bulut H, et al. Pressure injury prevalence and risk factors: A national multicenter analytical study. J Wound Ostomy Continence Nurs. 2023;50(4):289-95. https://doi.org/10.1097/WON.0000000000000995
17. Hanönü S, Karadağ A. A prospective, descriptive study to determine the rate and characteristics of and risk factors for the development of medical device-related pressure ulcers in intensive care units. Wound Manag Prev. 2016;2(62):12-22. https://pubmed.ncbi.nlm.nih.gov/26901386/
18. Yalçin M, Güneş Ü. A point prevalence study of medical device-associated pressure injuries: A cross-sectional study. J Clin Nurs. 2023;32(19-20):7618-25. https://doi.org/10.1111/jocn.16831
19. Pamuk Cebeci S, Çobanoğlu A, Oğuzhan H. Medical device-related pressure injury development in intensive care patients and affecting factors: point prevalence study [Yoğun Bakım Hastalarında Tıbbi Cihazla İlişkili Basınç Yaralanması Gelişimi ve Etkileyen Faktörler: Nokta Prevalans Çalışması]. SBUHD. 2024;6(1):57-64. https://doi.org/10.48071/sbuhemsirelik.1374543
20. Togluk Yiğitoğlu E, Aydoğan S. Determination of medical device-related pressure injury in COVID-19 patients: A prospective descriptive study. J Tissue Viability. 2023;32(1):74-8. https://doi.org/10.1016/j.jtv.2022.10.004
21. Tezcan B, Ecevit Alpar Ş, Gülseven Karabacak B. Medical device-related pressure injuries in intensive care patients: A prospective and descriptive study. J Tissue Viability. 2024;33(2):275-83. https://doi.org/10.1016/j.jtv.2024.03.003
22. Celik S, Taskin Yilmaz F, Altas G. Medical device-related pressure injuries in adult intensive care units. J Clin Nurs. 2023;32(13-14):3863-73. https://doi.org/10.1111/jocn.16516
23. Erbay Dallı Ö, Ceylan İ, Kelebek Girgin N. Incidence, characteristics and risk factors of medical device-related pressure injuries: An observational cohort study. Intensive Crit Care Nurs. 2022;69:103180. https://doi.org/10.1016/j.iccn.2021.103180
24. Karacabay K, Savci A, Dalkılıç M, Kabu Hergül F. Determining the incidence and risk factors of medical device-related pressure injury in intensive care patients. J Tissue Viability. 2023;32(4):596-600. https://doi.org/10.1016/j.jtv.2023.08.002
25. Temiz Z, Aydın Sayılan A, Sayılan S, Azum E. Incidence, severity and characteristics of medical device-related pressure injuries in adult intensive care patients: A single-centre, cross-sectional study. J Tissue Viability. 2024;33(2):220-24. https://doi.org/10.1016/j.jtv.2024.02.007
26. Dirgar E, Gider NY, Tosun B. determination of incidence and risk factors of medical device-related pressure injury in the ICU: A descriptive study. Adv Skin Wound Care. 2024;37(3):1-6. https://doi.org/10.1097/ASW.0000000000000113
27. Aydım Kudu A, Taşdemir N, Sönmez M. Incidence of medical device-related pressure injuries in the intensive care unit and related risk factors. J Tissue Viability. 2023;32(4):564-71. https://doi.org/10.1016/j.jtv.2023.06.006
28. Coyer F, Barakat-Johnson M, Campbell J, et al. Device-related pressure injuries in adult intensive care unit patients: An Australian and New Zealand point prevalence study. Aust Crit Care. 2021;34(6):561-8. https://doi.org/10.1016/j.aucc.2020.12.011
29. Zhang N, Li Y, Li X, et al. Incidence of medical device-related pressure injuries: a meta-analysis. Eur J Med Res. 2024;29(1):425. https://doi.org/10.1186/s40001-024-01986-2
30. Kim JY, Lee YJ. Medical device-related pressure ulcer (MDRPU) in acute care hospitals and its perceived importance and prevention performance by clinical nurses. Int Wound J. 2019;16(Suppl 1):51-61. https://doi.org/10.1111/iwj.13023
31. Peko Cohen L, Ovadia-Blechman Z, Hoffer O, Gefen A. Dressings cut to shape alleviate facial tissue loads while using an oxygen mask. Int Wound J. 2019;16(3):813-26. https://doi.org/10.1111/iwj.13101
32. Lustig A, Margi R, Orlov A, Orlova D, Azaria L, Gefen A. The mechanobiology theory of the development of medical device-related pressure ulcers revealed through a cell-scale computational modeling framework. Biomech Model Mechanobiol. 2021;20(3):851-60. https://doi.org/10.1007/s10237-021-01432-w
33. Gou L, Zhang Z, Yongde A. Risk factors for medical device-related pressure injury in ICU patients: A systematic review and meta-analysis. PLoS One. 2023;18(6):e0287326. https://doi.org/10.1371/journal.pone.0287326
34. Neill S, Martin D. Nursing care bundles in the prevention of medical device related pressure ulcers: An integrative review. J Tissue Viability. 2024;33(3):376-86. https://doi.org/10.1016/j.jtv.2024.04.003
35. Monarca MC, Marteka P, Breda K. Decreasing incidence of medical device-related pressure injuries in a small community hospital: A quality improvement project. J Wound Ostomy Continence Nurs. 2018;45(2):137-40. https://doi.org/10.1097/WON.0000000000000419
36. Lyu Y, Huang YL, Li ZY, Lin F. Interventions and strategies to prevent medical device-related pressure injury in adult patients: A systematic review. J Clin Nurs. 2023;32(19-20):6863-78. https://doi.org/10.1111/jocn.16790
37. Alshahrani B, Sim J, Middleton R. Nursing interventions for pressure injury prevention among critically ill patients: A systematic review. J Clin Nurs. 2021;30(15-16):2151-68. https://doi.org/10.1111/jocn.15709

Appendix 1.

Quality assessment

Dallı et al., 2022: 9/11 %81,82

Karacabey et al. 2023: 8/8 %100

Kudu et al, 2023: 8/8 %100

Tezcan el, 2023: 8/8 %100

Temiz et al: 8/8 %100

Yiğitoğlu et al.: 8/8 %100

Hanönü et al.: 9/9 %100

Baykara et al.: 9/9 %100

Yalçın et al.: 9/9 %100

Pamuk Cebeci: 9/9 %100

Dirgar et al., 2024: 8/8 %100

Search Strategy

CINAHL: (pressure injury OR pressure ulcer OR decubitus OR decubitus ulcer OR bed sore OR pressure sore OR pressure damage OR mucosal) AND (device related OR medical device related OR device associated) AND (incidence OR prevalence OR frequency OR occurrence)

PubMed: (((pressure injury OR pressure ulcer OR decubitus OR decubitus ulcer OR bed sore OR pressure sore OR pressure damage)) AND ((device related OR medical device related OR device associated))) AND ((incidence OR prevalence OR frequency OR occurrence)) Filters: English, Humans, MEDLINE

Science direct: Title, abstract, keywords: (((pressure injury OR pressure ulcer OR decubitus ulcer OR pressure damage)) AND ((device related OR device associated))) AND ((incidence OR prevalence OR frequency))

Google Scholar: (“pressure injury*” OR “pressure ulcer*” OR “decubitus*” OR “decubitus ulcer*” OR “bed sore*” OR “pressure sore*” OR "pressure damage") AND (“device related” OR “medical device related” OR “device associated”) AND (“incidence” OR “prevalence” OR "frequency" OR "occurrence")

Web of science: https://www.webofscience.com/wos/woscc/summary/8832bfbd-ec7a-4f86-a83e-15e91be423b5-01209e38da/relevance/1