

Prevalence and risk factors of dependence-related skin lesions in neonatal units: A multicentre study across Spanish hospitals

Evelin Balaguer López^{a,b,c}, Isabel María Mora Morillo^d, Pablo Buck Sainz-Rozas^{a,e,f,*},
María Carmen Rodríguez Dolz^{a,b,c}, Laura Plá Marzo^{a,b,c}, Pablo García Molina^{a,b,c}

^a Facultad de Enfermería y Podología (Universidad de Valencia). C. de Menéndez y Pelayo, 19, 46010, Valencia, Spain

^b Hospital Clínico Universitario de Valencia. Av. Blasco Ibáñez, 17, 46010, Valencia, Spain

^c Care Research Group. INVESTEN-INCIVA, Spain

^d Hospital Regional Universitario de Málaga. Av. de Carlos Haya, 84, Bailén-Miraflores, 29010, Málaga, Spain

^e Hospital Universitari Vall d'Hebron. Passeig Vall d'Hebron, 119-129, 08035, Barcelona, Spain

^f Facultad de Medicina (Universidad Autónoma de Barcelona). Av. de Can Domènech, Bellaterra, 08193, Barcelona, Spain

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ABSTRACT

Aim: This study aimed to obtain updated epidemiological indicators of dependence-related skin lesions (DRSLs) in neonatal units of Spanish hospitals and to analyze preventive interventions and risk factors associated with DRSL development.

Materials and methods: A multicentre, observational, cross-sectional prevalence study was conducted across three data collection phases in 12 Spanish hospitals with neonatal units, and included 398 hospitalised neonates. Data collection was based on direct observation, clinical record review, and caregiver interviews. The Neonatal Skin Risk Assessment Scale (e-NSRAS) was used to assess DRSL risk. Demographic variables, risk factors, and preventive measures were also analyzed.

Results: DRSL prevalence was 29.4 %. Moisture-related lesions (18.6 %) were the most common, especially in intermediate care, followed by pressure injuries (13.07 %), more prevalent in intensive care, and friction-related lesions (3.02 %). Non-invasive mechanical ventilation and urinary catheterisation were significantly associated with DRSL occurrence. Additionally, 34 % of neonates were classified as at risk of pressure injuries.

Discussion: A high DRSL prevalence was observed among hospitalised neonates, exceeding rates reported in other national and international studies. The e-NSRAS appears unsuitable for assessing all DRSL types. The use of multiple medical devices was associated with higher DRSL rates, and preventive measures were often applied late or inadequately. Study limitations include those typical of cross-sectional studies, such as representativeness, confounding factors, and sample size.

Conclusion: DRSLs are a prevalent issue in Spanish neonatal units. The development and implementation of targeted preventive measures, along with the adaptation of assessment tools, are critical for enhancing the quality of neonatal care.

1. Introduction

In recent years, research examining skin lesions in hospitalised paediatric and neonatal patients has grown significantly. However, published studies have focused on different nosocomial skin lesions separately, without establishing any relationship between them [1–3].

In 2015, a conceptual model was introduced, proposing the

interrelationship between certain skin lesion types by grouping them under the term ‘dependence-related skin lesions’ (DRSLs) [4]. This theoretical framework was required to elucidate the commonalities among these nosocomial skin lesions arising from diverse aetiological factors, irrespective of patient age [4].

DRSLs are defined as damage to the skin and/or underlying tissues affecting individuals with temporary or permanent limitations in

* Corresponding author. Facultad de Medicina (Universidad Autónoma de Barcelona). Av. de Can Domènech, Bellaterra, 08193, Barcelona, Spain.

E-mail addresses: evelin.balaguer@uv.es (E. Balaguer López), isabelm.mora.sspa@juntadeandalucia.es (I.M. Mora Morillo), pablo.buck@vallhebron.cat (P. Buck Sainz-Rozas), laupla4@gmail.com (L. Plá Marzo), pablo.garcia-molina@uv.es (P. García Molina).

@evelin_balop (E. Balaguer López), @IsabelMMora (I.M. Mora Morillo), @pablo_buck (P. Buck Sainz-Rozas), @laurapla09 (L. Plá Marzo), @mactub7 (P. García Molina)

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physical, mental, intellectual, or sensory autonomy due to disability, age, illness, or medical condition, who therefore require assistance with basic activities [4]. These are classified into three main categories: pressure injuries (PIs), moisture-related lesions (MRLs) and friction-related lesions (FRLs). Additionally, the DRSL model recognises the possibility of combined lesions: moisture-pressure, pressure-friction, and moisture-friction lesions.

In particular, neonatal population shows a high degree of dependency related to their physiological immaturity (inversely proportional to their gestational age) and the underlying diseases they present during their hospital stay. Neonatal skin has distinctive characteristics that increase its vulnerability to DRSL [5]: the stratum corneum is composed of fewer layers of corneocytes (neonates between 30 and 24 weeks gestational age may have anywhere from 3 to no layers of corneocytes), the dermo-epidermal junction is fragile and flattened due to the fewer connecting fibers, desmosomes are sparse, and sensory responsiveness to contact is reduced [6]. Moreover, therapeutic interventions, associated techniques, and medical devices used in hospitalised neonates differ significantly from those used in older children or adults, thereby limiting the extrapolation of data across age groups [3, 7].

Due to the small percentage of neonatal admissions in some hospitals, the increased survival of extremely preterm neonates, and the unique characteristics surrounding the onset and prevention of DRSLs, it is essential to conduct multicentre studies within a similar healthcare context [8]. Data collection tools must be tailored to these characteristics, as should the variables measured [9,10]. More comprehensive data on the neonatal population are required to understand the scope of the problem, identify risk factors, and determine the most effective preventive measures to reduce skin injuries and minimize practice variations [8].

DRSLs represent a public health issue affecting hospitalised neonates due to their vulnerability at all levels [11]. At the clinical level, they will produce an increased risk of systemic infections from the probable contamination of the lesions [12], as well as a greater risk of skin toxicity derived from the use of antimicrobial treatment products [13]. At the neurophysiological level, the pain generated by skin lesions [14] and the increased manipulations during the healing procedure will lead to a decrease in sleep hours and will result in poorer neurocognitive development [15]. At the healthcare management level, this will lead to longer hospital stays, a heavier workload for healthcare professionals, and increased healthcare costs associated with their care [8,16]. And finally, at the family level, parents will feel a greater level of concern and anxiety when they see their child's suffering and are unable to provide normal care [17].

This study aims to determine the current epidemiological indicators of DRSLs in neonatal units in Spain and to analyze preventive interventions and risk factors influencing the development of DRSLs.

1.1. Study questions

What is the prevalence of DRSLs in hospitalised neonatal patients? How do preventive measures and risk factors influence the occurrence of DRSLs in hospitalised neonates?

2. Material and methods

2.1. Design and setting

This was a multicentre, observational, cross-sectional prevalence study conducted over three distinct data collection periods: 4–8 July 2022, 24–28 October 2022, and 19–23 December 2022. The study was carried out in twelve public hospitals within the Spanish National Health System, located across ten provinces. The neonatal bed capacity of these hospitals ranged from 4 to 61 beds, encompassing a total of 757 neonatal beds assessed during the study. Of these, 401 beds were occupied at the

time of data collection, and 398 neonates met the inclusion criteria.

Hospitals were selected through voluntary participation following the dissemination of the project within the Spanish Society of Neonatal Nursing (SEEN) and Upppediatria scientific group. The methodological design was based on similar prevalence studies conducted in the general [18] and paediatric populations [19], with specific adaptations to neonatal care settings. The STROBE checklist was used to guide the reporting of results.

2.2. Inclusion criteria

According to the World Health Organisation (WHO), a newborn or neonate is defined as a child under 28 days of age [6].

All patients hospitalised on the dates of the three prevalence phases in the neonatal units of the participating hospitals were included in the study, provided that their parents or legal guardians were present, received an explanation of the study objectives, and signed the informed consent form on their behalf.

Neonates admitted to maternity and emergency observation areas were excluded, as were unoccupied beds at the time of the study and those reviewed after the scheduled dates.

2.3. Study team

The main research team comprised two members from the Upppediatria scientific group and the Spanish Society of Neonatal Nursing (SEEN). The study was sponsored by SEEN. Each participating hospital had two designated leading nurses responsible for data collection.

To reduce potential biases and ensure accuracy, consistency, and reliability in the observations, all 30 participating nurse researchers completed a 4-h accredited online standardisation training session prior to each data collection phase. The training focused on the assessment and classification of DRSLs and included practical exercises, which participants were required to pass in order to participate in the study. Additional guidance was provided on the correct use of the data collection form. The final evaluation reported an inter-rater agreement rate of 81.52 %, based on the classification consensus among trained observers.

2.4. Data collection

A data collection form (DCF) was designed based on existing literature [8,16] and clinical practice guidelines used in the study setting [20, 21]. This form includes 12 sociodemographic variables, a questionnaire covering 12 risk factors and 7 preventive measures, calculation of the Neonatal Skin Risk Assessment Scale (e-NSRAS) [9], and the evaluation of existing DRSLs. Lesions were classified in accordance with the theoretical DRSL model and national clinical guidelines, and were grouped as pressure injuries, MRLs (including IAD), and FRLs, with further sub-classification based on stage or severity [22].

The e-NSRAS is a tool for assessing neonates at risk of skin injuries, based on the Braden scale developed by Hufniss & Logsdon (1997) [23], and adapted and validated for use in the Spanish context by García-Molina (2015) [9]. The e-NSRAS comprises six items, each scored from 1 to 4, yielding a total score ranging from 6 to 24 points. In the present study, neonates with a score of 17 or below were classified as 'at risk' of developing pressure injuries.

The DCF was completed through direct observation by two designated nurses, review of clinical records, and interviews with both the family and the healthcare professional responsible for patient care. Observations regarding the type of support surfaces used (e.g., standard vs. pressure-redistributing mattresses), the application of barrier products, the use of hyperoxygenated fatty acids, and other preventive measures were systematically recorded in predefined items of the DCF. This ensured consistency and reproducibility across participating centres. Data were transcribed into Lime Survey®, and the DCFs along with

signed consent forms were securely stored by each healthcare facility.

2.5. Data analysis

Descriptive statistics (means, frequencies, and percentages) were used to express demographic variables. Normality of the data was tested using the Kolmogorov-Smirnov test (for $N > 50$). Medians and interquartile ranges (IQRs) were calculated given the non-parametric nature of the quantitative variables. Chi-squared tests, Fisher's exact test, and the Mann-Whitney U test were used to explore correlations between variables. Risk factors showing a significant correlation ($p < 0.05$) with the presence of DRSLs were included in logistic regression models. Data analysis was performed using IBM's SPSS 29.0 software.

2.6. Ethical considerations

This study was reviewed and approved by the Research Ethics Committee for the sponsoring hospital (March 10th, 2022, with reference number 2022/037) and by the ethics committees for all participating facilities. Informed consent was obtained, and no data were collected that would enable the subsequent identification of patients. The study was conducted in accordance with the Declaration of Helsinki (1975), good clinical practice (GCP) standards, and the EU General Data Protection Regulation (GDPR) 2016/679.

3. Results

3.1. Demographics

Descriptive characteristics of the neonatal population are presented

Table 1
Descriptive characteristics of the neonatal population by care unit.

Variables	NICU (n)	%	Interm. (n)	%	Total (n)	%
Total number of neonates	176	100	222	100	398	100
Pre-term neonates	141	80.11	144	64.86	285	72
Sex						
Male	102	57.95	118	53.15	220	55
Female	74	42.05	104	46.85	178	45
Medical Devices						
Median number of devices (IQR), [R]	3.7 (1)	[0–10]	1.8 (1)	[0–6]	2.6 (2)	[0–10]
Oxygen saturation probe	170	96.59	194	87.39	364	91
Orogastric tube	79	44.89	13	5.86	92	23
Nasogastric tube	83	47.16	99	44.59	182	46
Urinary catheter	18	10.23	0	0.00	18	5
Peripheral venous catheter	35	19.89	37	16.67	72	18
Central venous catheter	40	22.73	7	3.15	47	12
Epicutaneous venous catheter	45	25.57	5	2.25	50	13
Endotracheal (ET) tube	19	10.80	0	0	19	5
Non-invasive mechanical ventilation (NIMV)	76	43.18	11	4.95	87	22
NIMV nasal interface	50	28.41	3	1.35	53	13
NIMV facemask interface	3	1.70	0	0	3	1
Feeding type						
Enteral	153	86.93	135	60.81	288	72
Total parenteral	44	25	5	2.25	49	12
Suction	35	19.89	176	79.28	211	53
Fasting	16	9.09	5	2.25	21	5
Risk Assessment (e-NSRAS)						
Median Total Score (IQR) [R]	16 (4)	[8–23]	21 (4)	[14–24]	19 (5)	[8–24]
Neonates not at Risk	65	36.93	198	89.19	263	66
Neonates at Risk	111	63.07	24	10.81	135	34
Days of Life	31 (34)	[1–257]	29 (32)	[1–210]	30 (33)	[1–257]
Median (IQR), [R]						
Gestational Weeks at Birth	31.61 (7)	[22–41]	34.12 (8)	[23–42]	33 (8)	[22–42]
Median (IQR), [R]						
Birth weight (kg)	1.7 (1.5)	[0.5–4.2]	2.2 (1.5)	[0.5–5.2]	2 (1.8)	[0.5–5.2]
Median (IQR), [R]						
Length of Stay (days)	29 (30)	[1–255]	27 (31)	[1–210]	27 (31)	[1–255]
Median (IQR) [R]						

Note: Interm. (Intermediate Neonatal Care); NICU (Neonatal Intensive Care Unit); n (count), % (prevalence); IQR (Interquartile Range); R (Range); e-NSARAS (Neonatal Skin Risk Assessment Scale).

in Table 1, stratified by hospital unit (Neonatal Intensive Care Unit [NICU] vs. Intermediate Care Unit).

3.2. Prevalence

Graph 1 illustrates the distribution of DRSL types across the three data collection periods, revealing a consistent pattern over time. Across all cases, MRLs were the most common, followed by PIs and FRLs. The average prevalence was 29.4 %.

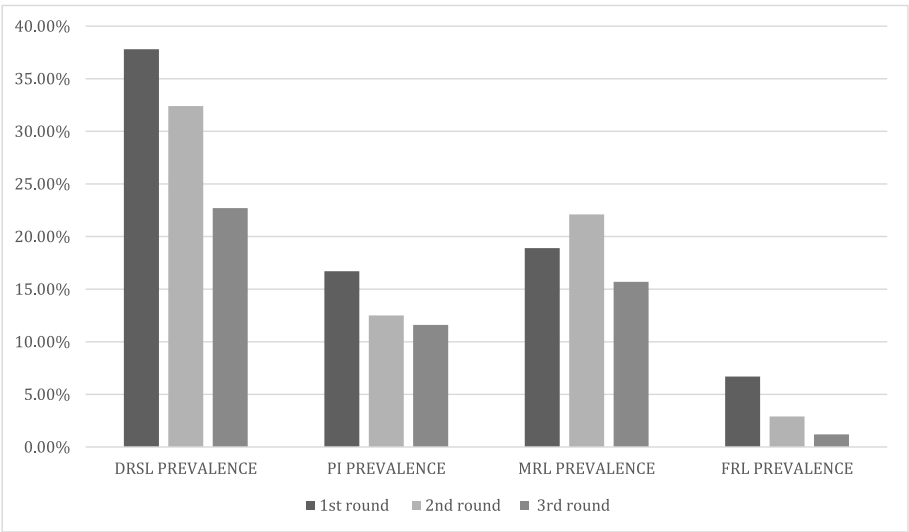
MRLs had the highest prevalence at 18.6 %, rising to 20.7 % in Intermediate Care. PIs affected 13.07 % of neonates, while FRLs had a prevalence of 3.02 %. Table 2 presents the prevalence rates by unit, lesion category, location, and cause.

3.3. Risk factors/medical devices

The number of medical devices used per neonate and their association with unit type and pressure injuries are summarised in Table 3. A moderate and statistically significant negative correlation was observed between the number of devices and e-NSRAS scores ($\rho = -0.723$; $p = 0.000$).

3.4. Risk detection

Findings regarding e-NSRAS scores, distribution by care unit, risk classification, and association with pressure injuries are presented in Table 3.



Graph 1. Changes in dependence-related skin lesions and their types across the three data collection periods.

Table 2
Characteristics of Dependence-related Skin lesions and prevalence*.

Variables	NICU (n = 176)	Interm. (n = 222)	p
Neonates with DRSLs	33 %	26.6 %	0.165
Neonates with Pressure PIs	21.6 %	6.3 %	0.000
Total number of PIs	50	14	
PI Category: I	64 %	57.14 %	
II	20 %	33.3 %	
III	14 %	6.67 %	
IV	2 %	0 %	
PI Location: Nose	40 %	50 %	
Nasal septum	18 %	7.14 %	
Occiput	12 %	14.29 %	
Face	14 %	7.14 %	
PI Etiology:NIMV	62 %	21.43 %	
Support surface	8 %	7.14 %	
Gastric tube	4 %	21.43 %	
Neonates with MRLs	15.9 %	20.7 %	0.220
Total number of MRLs	34	46	
MRL Category: IA	58.8 %	65.2 %	
IB	14.7 %	21.7 %	
IIA	11.8 %	13 %	
IIB	2.9 %	0 %	
MRL Location: Buttocks	50 %	84.8 %	
Abdomen	35.3 %	2.2 %	
MRL Etiology: Urinary incontinence	44.1 %	89.1 %	
Peristomal dermatitis	23.5 %	2.2 %	
Neonates with FRLs	4.5 %	1.8 %	0.112
Total number of FRLs	8	4	
FRL Category: I	50 %	100 %	
II	50 %	0	
FRL Location: Foot	25 %	0 %	
Groin	0 %	50 %	
FRL Etiology: Restraint measures	37.5 %	25 %	

3.5. Prevention measures

Preventive strategies by e-NSRAS risk showed significant differences in the application of local devices for pressure management, hyperoxygenated fatty acids (HOFAs) and special mattresses. Further details are provided in Table 4.

3.6. Association between DRSL occurrence, risk factors, and preventive measures

Significant associations were identified between the occurrence of DRSLs and several factors, including male sex, use of urinary catheters,

Table 3
Preventive measures according to risk defined by e-NSRAS.

Variable	Comparison Groups	Value/ Direction	p-value
Number of medical devices	NICU vs. Intermediate care	↑ NICU	0.000
	With PI vs. Without PI	↑ With PI	0.000
e-NSRAS score	NICU vs. Intermediate care	↓ NICU	0.000
	With PI vs. Without PI	↓ With PI	0.000
Neonates classified as “at risk” (score <17)	With PI vs. Without PI	↑ With PI	0.000

Note: PI (Pressure Injury), NICU (Neonatal Intensive Care Unit).

Table 4
Preventive Measures by e-NSRAS Risk Classification.

Variables	No Risk (n: 263)	Risk (n: 135)	p
Oxygen saturation sensor change	97.3 %	100 %	0.101
Local pressure relief devices (foam dressing*)	1.5 %	5.9 %	0.019
Local pressure relief devices (occipital cushions)	0.8 %	4.4 %	0.016
Postural change	100 %	98.5 %	0.114
Barrier cream	21.7 %	29.6 %	0.080
HOFAs	10.6 %	19.3 %	0.018
Special Support surfaces	40.3 %	68.2 %	0.002
Reactive static support surface (non-powered)	35 %	66.7 %	0.000
Powered reactive support surface (overlay)	3 %	1.5 %	
Powered reactive support surface (replacement)	2.7 %	0 %	
Conventional hospital mattresses	59.3 %	31.9 %	

N: sample; p: significance; HOFAs: hyperoxygenated fatty acids; *foam dressing: polyurethane heel pads.

NIMV, nasal mask interface, suction feeding, and the application of barrier products.

Analysis of DRSL subtypes revealed that PIs were significantly associated with variables such as hospitalization unit, postnatal age (in days), gestational age, length of stay, and the presence of specific medical devices (e.g. orogastric tubes, peripheral and central venous catheters, and non-invasive mechanical ventilation [NIMV]). Feeding methods and preventive strategies, including the use of HOFAs, were

also significantly related to the development of PIs.

MRLs were associated with higher gestational age, greater birth weight, and the presence of pulse oximetry. In contrast, FRLs were linked to lower birth weight.

A detailed summary of all statistically significant associations by DRSL subtype is provided in Table 5.

3.7. Multivariate model

Of the variables collected, non-invasive mechanical ventilation is the factor that most explains the risk of DRSL and PI (see Table 6). 70 % of the risk of developing PI in our sample was attributed to NIMV, enteral

nutrition, parenteral nutrition, peripheral catheter uses and length of stay (see Table 6).

Although considered preventive, certain interventions such as barrier products and hyperoxygenated fatty acids (HOFAs) showed statistically significant associations with DRSL presence. Specifically, barrier products were associated with increased likelihood of MRLs (OR: 7.49; 95 % CI: 4.32–12.99; $p = 0.000$), and HOFAs with PIs (OR: 3.60; 95 % CI: 1.82–7.10; $p = 0.000$). These variables were excluded from the multivariate models due to their statistical behaviour as risk factors.

Table 5

Relationship of descriptive variables with the presence of DRSL and lesion subtype.

Variable	DRSL			PI			MRL			FRL		
	No (n = 281)	Yes (n = 117)	p	No (n = 346)	Yes (n = 52)	p	No (n = 324)	Yes (n = 74)	p	No (n = 386)	Yes (n = 12)	p
Hospitalization unit			0.101			0.000			0.220			0.112
NICU	42 %	0.6 %		39.9 %	73.1 %		45.7 %	37.8 %		43.5 %	66.7 %	
Hospitalization	58 %	50.4 %		60.1 %	26.9 %		54.3 %	62.2 %		56.5 %	33.3 %	
Days of life	28.16 [±32.9]	33.3 [±36.7]	0.221	27.90 [±32.44]	41.46 [±42.39]	0.028	30.23 [±35.27]	27.22 [±28.82]	0.868	28.96 [±33.39]	52.67 [±49.85]	0.129
Gestational weeks at birth	33.03 [±4.83] (n = 276)	32.94 [±4.86] (n = 116)	0.929	33.23 [±4.76] (n = 341)	31.51 [±5.10] (n = 51)	0.018	32.75 [±4.9] (n = 318)	34.09 [±4.32] (n = 74)	0.028	33.06 [±4.77] (n = 380)	31.06 [±6.46] (n = 12)	0.232
Length of stay (days)	26.65 [±33.06]	31.16 [±38.75]	0.335	26.50 [±33.42]	37.77 [±42.23]	0.049	28.27 [±34.64]	26.70 [±35.92]	0.615	27.56 [±34.60]	41.17 [±41.58]	0.282
Birth weight (g)	1946.69 [±1026.9] (n = 225)	2042.16 [±1055.9] (n = 83)	0.453	1981.35 [±1006.6] (n = 271)	1906.97 [±1229.4] (n = 37)	0.337	1926.35 [±1050.7] (n = 251)	2175.28 [±938.3] (n = 57)	0.040	1989.06 [±1027.8] (n = 302)	1134.50 [±1088.6] (n = 6)	0.013
Sex	51.6 %	64.1 %	0.014	52.9 %	71.2 %	0.014	53.4 %	63.5 %	0.114	54.7 %	75 %	0.135
Man	48.4 %	35.9 %		47.1 %	28.8 %		46.6 %	36.5 %		45.3 %	25 %	
Woman												
Presence of therapeutic devices	95 %	93.2 %	0.302	93.6 %	100 %	0.042	95.7 %	89.2 %	0.034	94.3 %	100 %	0.500
Nasogastric tube	46.6 %	43.6 %	0.330	46 %	44.2 %	0.816	45.7 %	45.9 %	0.967	46.1 %	33.3 %	0.381
Orogastric tube	21 %	28.2 %	0.079	19.7 %	46.2 %	0.000	24.4 %	17.6 %	0.210	22.5 %	41.7 %	0.118
Urinary catheter	3.2 %	7.7 %	0.049	4.6 %	3.8 %	0.575	3.7 %	8.1 %	0.096	4.4 %	8.3 %	0.431
Peripheral venous catheter	17.4 %	19.7 %	0.348	16.2 %	30.8 %	0.011	17.9 %	18.9 %	0.837	18.1 %	16.7 %	0.627
Central vascular catheter	10 %	16.2 %	0.058	10.4 %	21.2 %	0.025	10.8 %	16.2 %	0.193	11.7 %	16.7 %	0.425
Epicutaneous catheter	11 %	16.2 %	0.105	11.3 %	21.2 %	0.045	12 %	14.9 %	0.508	12.2 %	25 %	0.181
Pulse-oximeter	92.5 %	88.9 %	0.162	90.8 %	96.2 %	0.149	92.9 %	85.1 %	0.031	91.2 %	100 %	0.337
Nasal prongs	23.8 %	21.4 %	0.346	22.3 %	28.8 %	0.293	24.4 %	17.6 %	0.210	23.2 %	16.7 %	0.449
ECMO	0 %	0.9 %	0.294	0 %	1.9 %	0.131	0.3 %	0 %	0.814	0.3 %	0 %	0.860
IMV	3.9 %	6.8 %	0.161	4.6 %	5.8 %	0.463	4.6 %	5.4 %	0.484	4.4 %	16.7 %	0.107
Fasting	5 %	6 %	0.425	5.5 %	3.8 %	0.466	4.9 %	6.8 %	0.348	5.2 %	8.3 %	0.483
NIMV	18.9 %	29.1 %	0.019	17.1 %	53.8 %	0.000	22.5 %	18.9 %	0.498	21.2 %	41.7 %	0.097
NIMV interface: eartips	11.7 %	11.1 %	0.504	10.7 %	17.3 %	0.164	12.3 %	8.1 %	0.304	11.4 %	16.7 %	0.413
NIMV interface: nasal mask	11 %	18.8 %	0.030	9.5 %	38.5 %	0.000	13.9 %	10.8 %	0.482	13.2 %	16.7 %	0.491
Suction	55.9 %	46.2 %	0.049	57.8 %	21.2 %	0.000	52.8 %	54.1 %	0.843	52.8 %	58.3 %	0.708
Enteral nutrition	71.9 %	73.5 %	0.421	69.4 %	92.3 %	0.001	73.8 %	66.2 %	0.190	72 %	83.3 %	0.310
Total parenteral nutrition	11 %	15.4 %	0.150	10.4 %	25 %	0.003	12 %	13.5 %	0.727	11.9 %	25 %	0.174
Polyurethane foam dressing	3.2 %	2.6 %	0.510	3.2 %	1.9 %	0.520	2.8 %	4.1 %	0.392	3.1 %	0 %	0.689
Occipital cushion	1.4 %	3.4 %	0.181	1.4 %	5.8 %	0.073	1.5 %	4.1 %	0.171	2.1 %	0 %	0.781
Use of SEMP	44.8 %	47.9 %	0.329	45.4 %	48.1 %	0.715	45.4 %	47.3 %	0.764	45.9 %	41.7 %	0.774
HOFAs	12.1 %	17.1 %	0.123	11 %	30.8 %	0.000	13.9 %	12.2 %	0.696	13.5 %	16.7 %	0.501
Barrier products	15.7 %	45.3 %	0.000	24 %	26.9 %	0.646	16.4 %	59.5 %	0.000	24.4 %	25 %	0.592
e-NSRAS Risk	32 %	38.5 %	0.132	30 %	55.8 %	0.000	34.3 %	32.4 %	0.765	33 %	50 %	0.186

n: sample analyzed; p: significance level; **bold text**: significant differences ($p < 0.005$); ECMO: Extracorporeal Membrane Oxygenation; IMV: Invasive mechanical ventilation; NIMV: Non-invasive mechanical ventilation; e-NSRAS: Spanish version of the Neonatal Skin Risk Assessment; HOFAs: hyperoxygenated fatty acids; SPMS: special pressure management surfaces; NICU: neonatal intensive care unit; [±]: standard deviation of the mean.

Table 6
Regression model for determining factors on dependence-related skin injuries.

Model 1. DRSLs	Score	OR	95 %CI	p
NIMV	5.030	1,82	1.10–3.02	0.018
Urinary catheter	3.856	2,73	1.04–7.12	0.040
Constant	0.538			
R ²	0.032			

Model 2. PIs	Score	OR	95 %CI	p
NIMV	35.829	4.05	2.08–7.89	0.000
Enteral nutrition	11.899	5	1.66–15.0	0.004
Total parenteral nutrition	8.920	2.31	1.05–5.30	0.049
Peripheral venous catheter	6.489	3.12	1.44–6.79	0.004
Length of stay (days)	5.674	1.01	1.00–1.02	0.005
Constant	0.521			
R ²	0.240			

Model 3. MRLs	Score	OR	95 %CI	p
Gestational weeks at birth	4.579	1.060	1.00–1.11	0.033
Constant	–3.395			
R ²	0.019			

OR (Odds Ratio); 95%CI (95 % confidence interval); p (statistical significance); NIMV: non-invasive mechanical ventilation; DRSLs: dependence-related skin lesions; PIs: Pressure Injuries; MRLs: moisture-related lesions.

4. Discussion

This multicentre study is the first nationwide project in Spain to evaluate DRSLs in hospitalised neonates, using a direct data collection method with tools specifically adapted to the neonatal population. The findings confirm that DRSLs are a prevalent issue in neonatal units within the participating hospitals, with 3 in 10 hospitalised neonates showing some form of DRSL. MRLs were the most common, followed by PIs.

4.1. DRSL risk factors

In terms of DRSL risk factors among neonates, the presence of medical devices was a key determinant, as highlighted in previous scientific studies [2,24] in which a higher number of devices was associated with increased clinical dependence, correlating with the presence of DRSL overall, and more specifically with PIs and MRLs. Although medical devices were identified as the main modifiable risk factor in our analysis, they do not fully explain the multifactorial nature of DRSLs. Other contributors -such as clinical severity, length of hospital stay, gestational age, and certain care procedures-may also play a significant role.

4.2. Pressure injuries

Multiple studies have addressed the assessment and prevention PI in neonates using NIMV devices [8,16,20,21]. Our multivariate analysis identified NIMV as the single most influential factor in the risk of DRSLs, particularly due to its strong association with the development of PIs.

Literature suggests that challenges in adapting the interface to the neonate’s facial anatomy, together with humidified and heated airflow, contribute to the development of skin injuries [9,22]. These lesions often result from a combination of etiological mechanisms, including pressure, friction, and moisture.

However, in this study, researchers were instructed to report only the predominant etiology. Consequently, lesions associated with NIMV were primarily classified as pressure injuries, although some may have involved mixed mechanisms (e.g., pressure–moisture, friction–moisture, or pressure–friction). Future research should aim to explore overlapping etiologies to better understand the pathophysiological mechanisms underlying neonatal skin damage.

4.3. Moisture-related lesion

With regard to gestational age, we observed a significant inverse association between this variable and the presence of both MRLs and PIs. Lower gestational age was significantly associated with PIs, likely due to increased skin immaturity and fragility. Conversely, older gestational age was associated with the presence of MRLs.

This may be explained by the predominance of incontinence-associated dermatitis (IAD) among MRLs, which contributed substantially to their overall prevalence in our cohort.

The vast majority of neonates wear nappies due to physiological incontinence, and prolonged exposure to urine and feces of varying consistencies constitutes the main risk factor for lesion development. Among hospitalised neonates, reported IAD incidence rates vary considerably, ranging from 4.7 % to 60 % [25–29]. In a comparable setting, a longitudinal study conducted in 2024 [1] reported an IAD incidence of 34.7 % among 196 patients—approximately three in ten neonates. That study identified significant associations with an increased frequency of stools per day, administration of oral medications, mixed feeding, and the presence of a collection bag. We consider that the most immature newborns may initially receive parenteral nutrition or tube feeding, leading to reduced stool frequency and, consequently, lower perineal exposure to moisture. Conversely, older newborns are more likely to be started on enteral or full oral feeding, which increases intestinal motility and exposure to urine and feces.

4.4. Friction-related lesions

The low prevalence of FRLs observed in this study coincides with that reported in the literature [8] which underscores the challenges in accurately identifying these injuries. However, it is important to note the absence of diagnostic consensus and unified classification criteria, which may contribute to their underreporting.

Although standardized training and systematic team communication strategies were implemented to reduce diagnostic variability, the potential for misclassification cannot be entirely ruled out. This underscores the need for clearer and more widely accepted definitions to support the accurate recognition and documentation of FRLs in neonatal populations.

4.5. Risk scales use for DRSLs

Analysis of the e-NSRAS scale results suggests that its routine use for DRSL risk assessment should be discouraged [9]. This study found the scale to be effective solely for evaluating PI risk, its original purpose. Modifications or adaptations are needed to incorporate medical devices as risk factors for PIs [30], similar to the Braden QD and Glamorgan scales, which are not yet validated for use in Spain [31]. Additional subscales should also be included to evaluate other DRSL risk factors comprehensively.

At the clinical level, we suggest that healthcare professionals should assess neonatal DRSL risk using validated tools that incorporate key risk factors, thereby guiding the targeted implementation of preventive strategies.

4.6. DRSL preventive measures

Preventive measures were generally under applied [8]. Except for postural changes and rotation of pulse oximetry sensors rotation -both standardized every 3 h as part of neurodevelopmental protection programs-less than half of the neonates identified as at risk received any additional preventive interventions. This under application may stem from various factors related to clinical training, service management, and limited research in the field. Firstly, there remains insufficient awareness of the burden of skin lesions in paediatric and particularly neonatal care. Accurate identification and thorough documentation of

skin lesions by healthcare professionals is essential for their effective prevention and management. In the absence of timely clinical recognition, such lesions may remain undetected and untreated, thereby hindering the implementation of prompt, evidence-based preventive interventions. Secondly—and closely linked to this—is the scarcity of research into preventive interventions for neonates, which results in a lack of robust, high-quality evidence on their effectiveness. As a result, healthcare managers may encounter difficulties in selecting and justifying the procurement of materials specifically adapted to neonatal needs.

In this study, for example, the mattresses used across the participating hospitals were found to be largely unsuitable for neonatal care, consistent with previous findings [2]. Nearly half of the surfaces used—irrespective of the neonate's risk level—were standard mattresses lacking features such as pressure redistribution or adequate breathability. Notably, those few surfaces with redistribution capabilities (whether powered or non-powered) were often allocated to low-risk patients, highlighting the absence of standardized assignment protocols. From a managerial standpoint, it is essential to procure and assign support surfaces in accordance with individual risk stratification, ensuring they incorporate features that promote pressure redistribution, safety, optimal positioning, and breathability.

An inverse relationship was observed between the application of preventive measures and the presence of DRSLs, as in other studies [1, 32]. However, due to the cross-sectional design of the study, preventive measures were recorded at a single time point, frequently after lesions had already developed. For instance, the use of barrier products was more common among neonates with MRLs than among those without. Similarly, HOFAs and pressure-redistributing support surfaces were more frequently observed following the appearance of PIs.

The statistical association between these products and increased DRSL incidence suggests their therapeutic rather than preventive use, as they behaved as apparent risk factors in our analysis. The likelihood of developing an MRL was up to seven times higher when barrier products were applied, and nearly four times higher for PIs when HOFAs were used.

Our study was not designed to assess the therapeutic efficacy of these products; therefore, definitive conclusions regarding their effectiveness as treatments cannot be drawn. Nonetheless, these products are commonly used in clinical practice for early-stage skin lesions, such as category I pressure injuries. Future longitudinal studies should evaluate their preventive and therapeutic effectiveness more rigorously.

These findings support the hypothesis that products such as barrier creams and HOFAs were often applied after lesion onset, which would explain their paradoxical association with higher DRSL prevalence. Their use, therefore, reflects reactive therapeutic interventions rather than proactive preventive strategies.

Additionally, the e-NSRAS scale used in this study—although suitable for assessing pressure injury risk—does not incorporate device-related factors, which were identified as key contributors to DRSLs. Future adaptations of this tool should integrate these variables, as observed in other models like the Braden QD or Glamorgan scales.

The results of this study reveal a high prevalence of dependence-related skin lesions in hospitalised neonates, exceeding figures reported in previous national studies [33]. Methodological differences, particularly in sample classification, variable selection, and data collection methods, may explain this disparity. The lack of specific risk assessment tools and the underuse of preventive strategies reflect shortcomings in the implementation of evidence-based care. These may be due to the limited availability of suitable materials or a lack of awareness regarding their clinical significance. However, the consistency of our findings with international literature underscores the clinical relevance of this issue and reinforces the need to strengthen care protocols and training aimed at preventing neonatal skin injuries.

4.7. Study limitations

The limitations of this study are inherent to cross-sectional designs. Although we conducted three data collection points across the year to minimize seasonal bias, and used a multicentre approach, causality between risk factors and preventive measures cannot be established. The study primarily focused on risk factors and preventive measures for PI, without evaluating more specific variables for MRLs and FRLs. This likely affects the multivariate models for MRLs and FRLs, meaning that caution should be exercised when interpreting the results. Additionally, no national sample size calculation was performed due to the voluntary nature of the study, and not all Spanish Autonomous Communities were represented, which may have influenced prevalence estimates. Only the four PI categories were assessed, excluding deep tissue injuries and unstageable lesions. MRL were categorised uniformly, and FRLs did not include tear injuries or medical adhesive-related skin injuries (MARSIs). Future studies should incorporate these categories to enable better comparisons with other research.

Since most international studies [2,16,32] focus on describing nosocomial pressure injuries, our research team designed a study aimed at evaluating known risk and preventive factors for these conditions. As a result, the assessment of variables related to other types of DRSLs was limited. Future research should address this gap by identifying additional factors that may contribute to the onset or prevention of other DRSL subtypes, such as MRLs and FRLs.

Moreover, this study concentrated mainly on medical devices as risk factors, excluding potentially relevant variables like clinical severity, treatment protocols, or perinatal history.

This focus narrows the scope of the risk factor analysis and should be considered when interpreting the reported associations.

Despite these limitations, this study provides a descriptive snapshot of DRSL prevalence in 2022 across various hospitals, facilitating future interhospital comparisons. Establishing a stable network of trained investigators across national hospitals could pave the way for the creation of a national observatory on neonatal skin care. Such an initiative would monitor the epidemiological status of DRSLs, their risk factors, and preventive measures in hospitalised neonates.

5. Conclusion

Dependence-related skin lesions (DRSLs) are a prevalent issue in the participating units and require continuous monitoring. This study observed a higher incidence of DRSLs compared to previous national and international reports. Approximately 30 % of neonates developed DRSLs, with moisture-related lesions -particularly incontinence-associated dermatitis (IAD)- being the most common subtype.

Each lesion type was associated with specific risk factors. Clinical device use, prematurity, and prolonged hospitalization emerged as major contributors to the development of pressure injuries. While higher birth weight and gestational age were associated with MRLs, lower gestational age was linked to the occurrence of FRLs.

Preventive measures targeting the reduction of pressure injuries were inconsistently applied and frequently not aligned with individual risk stratification. Nearly all neonates received enteral or parenteral nutrition, regular repositioning, and pulse oximetry sensor rotation every 3 h. The use of pressure-relieving support surfaces, barrier creams, and HOFAs was limited and typically initiated following the onset of injury.

Premature neonates undergoing NIMV and those with vascular access devices, urinary catheters, enteral nutrition, or prolonged hospitalization may benefit from intensive assessment, priority care, and tailored preventive strategies.

CRedit author statement

Evelin Balaguer López: Conceptualisation, Methodology, Validation,

Formal analysis, Investigation, Data Curation, Writing - Review & Editing, Supervision. Isabel María Mora Morillo: Conceptualisation, Methodology, Validation, Investigation, Resources, Funding acquisition. Pablo Buck Sainz-Rozas: Software, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualisation, Project administration. María Carmen RodríguezDolz: Conceptualisation, Methodology, Investigation, Writing - Review & Editing, Project administration. Laura Plá Marzo: Software, Investigation, Writing - Review & Editing, Project administration. Pablo García Molina: Conceptualisation, Methodology, Investigation, Resources, Data Curation, Writing - Original Draft, Supervision.

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Conflict of interest

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