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Pressure ulcer risk profiles of hospitalized patients based on the Braden Scale: A cluster analysis

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Abstract

Aim: The aim of this work is to identify the pressure ulcer risk profiles of hospitalized patients with reference to Braden Scale subscales.

Methods: A total of 2996 hospitalized Portuguese participants were screened using the Braden Scale. A hierarchical and nonhierarchical cluster analysis was conducted, with ethical approval.

Results: Five risk profiles (clusters) based on the first risk assessments were identified. Regarding the Braden Scale total score, two profiles with high risk and three profiles with low risk of pressure ulcer development were identified. All clusters were statistically significantly different in terms of sociodemographic and clinical variables. When the first and the last risk assessments were compared, all the clusters improved the Braden Scale total score on the last risk assessment, except Cluster 4 (low-risk category). Clusters 3, 4 and 5, which were classified as low risk, decreased in several Braden subscales at the last risk assessment.

Conclusions: The classification of low risk may misguide the early identification of patients with individual risk factors. Increasing the awareness of health care professionals for the importance of risk assessment of each Braden subscale is necessary for pressure ulcer prevention. We recommend the implementation of strategies for early identification of patients at risk at local and national levels.

KEYWORDS
cluster analysis, pressure injury, pressure ulcer, prevention, risk factors

Summary statement

What is already known about the topic?

- Pressure ulcers/injuries are one of the most harmful events that can occur in the hospital context.
- Early identification of patients at risk is one of the key steps in pressure ulcer/injury prevention.
- Risk-assessment tools, such as Braden Scale, support health care professionals to assess the risk of pressure ulcer development.

What this paper adds?

- Five different pressure ulcer risk profiles in surgical, medical and orthopaedic hospital wards were identified.
- An increasing awareness of health care professionals is needed, to dedicate the proper attention to patients with high and low risk of pressure ulcer development.
- Although patients can be identified as at low or high risk of developing pressure ulcers, different patterns were identified among these two risk rankings. This reinforces that the subscales should be taken into account by health care professionals when assessing risk, in order to provide and develop better suited intervention plans.

The implications of this paper:

- The classification of low risk of pressure ulcer development may misguide the early identification of patients with important individual risk factors.
- The early identification of at-risk patients should be developed, rather more than relying on risk assessment tools.

1 | INTRODUCTION

Pressure ulcer (PU), also known as pressure injury (Edsberg et al., 2016), is defined as a skin and/or underlying tissue damage, resulting from pressure force or pressure in combination with other forces such as shear; these injuries are generally localized over a bony prominence or related to the pressure caused by medical devices or other objects (EPUAP/NPIAP/PPPIA, 2019). PUs are one of the most harmful adverse events occurring in the clinical context (Lyder et al., 2012; Slawomirski et al., 2017) and are also used as a quality indicator of the care provided (Aydin et al., 2015; Chaboyer et al., 2016). Moreover, there is a negative impact on patients' quality of life (Gorecki et al., 2009) and on health care costs (Lyder et al., 2012; Slawomirski et al., 2017).

The prevalence of PUs in Europe is consistently high with figures around 10.8% across different health care settings, starting from 4.6% up to 27.2% (Moore et al., 2019). These figures ultimately mean that there is a group of patients whose PUs have developed despite the implementation of varied preventive interventions (Gaspar et al., 2019). These data point the need for improved resource allocation and management in order to further enhance PU prevention (Moore et al., 2019).

In the PU context, risk factors are those characteristics that can reduce the tolerance of the tissues to pressure and shear forces, causing pressure ulceration (Vitoriano & Moore, 2017). Therefore, any limitations in activity and mobility may directly expose patients to harmful mechanical loading. There is a plethora of risk factors linked to PU development (Coleman et al., 2013), such as impaired mobility, limited activity and a potential exposure to friction and shear; impaired nutritional status; skin moisture; impaired sensory perception; older age, factors that affect tissue perfusion, circulation and oxygenation, body temperature, among others (EPUAP/NPIAP/PPPIA, 2019; Vitoriano & Moore, 2017).

The early identification of a patient at risk of developing a PU is a key step in clinical practice and preventive programs (EPUAP/NPIAP/PPPIA, 2019; Gaspar et al., 2019). To aid that process, risk assessment (RA) tools were developed to screen at-risk patients and to assist health care professionals in the decision-making/clinical judgement process in a systematic and structured manner (DGS, 2011; EPUAP/NPIAP/PPPIA, 2019; Gaspar et al., 2019). So far, more than 30 RA tools were identified worldwide (Sardo et al., 2015). The Braden Scale (BS) (Bergstrom et al., 1987), is one of the most studied RA tool and widely used in clinical practice (Bergstrom et al., 1987, 1998; Kottner & Dassen, 2008). This tool has demonstrated good validity and reliability in a clinical setting (Kring, 2007; Pancorbo-Hidalgo et al., 2006). Indeed, many countries, such as Portugal, recommend the implementation of BS to assess the risk of PU development as part of structured risk assessment (DGS, 2011).

Notwithstanding, it is widely known that PU risk scales, including the BS, are poor predictors in clinical practice (Kottner & Balzer, 2010). Most RA tools utilize a simple ordinal system to score risk, which limits their ability to differentiate the contribution or importance of one risk factor versus another in the development of PUs (EPUAP/NPIAP/PPPIA, 2019). Because of that, international guideline recommendations explicitly refer that RA total scores should not be exclusively relied on for clinical decision making (EPUAP/NPIAP/PPPIA, 2019). It is also important to consider which risk factors are the basis of PU development in each patient or group of patients. Subscale scores of the RA tools can also be examined to provide in depth information to guide risk-based planning (EPUAP/NPIAP/PPPIA, 2019). Therefore, the aim of this study was to identify the risk profiles of hospitalized patients from the medical, surgical, and

orthopaedic wards with reference to the subscales of the BS, which provide information on the contribution of modifiable individual risk factors.

2 | METHODS

2.1 | Design

Following ethical approval, a retrospective cohort study was performed with data extracted from the electronic health records of patients admitted in one Portuguese hospital between January 1st to 31st December 2016. Confidentiality was assured by anonymizing all participants' data (the electronic health records were extracted anonymously).

2.2 | Sample and procedures

This study is based on nursing electronic health records from hospitalized adult patients (≥18 years) during 2016 after implementation of National Strategy of Patient Safety 2015–2020 (DGS, 2015). Data were collected from 2996 Portuguese hospitalized patients after ethical approval of the commission board and Portuguese National Institute of Data Protection. The patients were screened using the BS (with subscales also recorded) (Bergstrom et al., 1987; DGS, 2011), and the first and last risk assessments (RA) undertaken during their stay on orthopaedic, surgical and medical wards were extracted.

Data included in this study were routinely collected and recorded by the health professionals working at the hospital. The information was then extracted by the informatics department of the hospital and sent to the research team without any patient identification. After receiving the data extracted from available electronic records, the research team recoded the data into a single database in order to proceed with the statistical analysis.

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement reporting guidelines (Elm et al., 2007).

2.3 | Measures

Age, sex, type of ward on admission (surgery, medicine, orthopaedic), length of stay (LOS) and patient disposal (discharge, death, transferred) were collected from the electronic health records. Hospitalized adults (more than 18 years old) were included, with a cut-off point of 65 year-old was used for the description of the percentage of the elderly population in the sample, as this age group are particularly at risk to develop PUs (Ferreira et al., 2007).

Patient disposal was presented as discharge, decease or transfer to a different hospital. The patient's admission pathway (emergency or elective admissions), previous hospital stays (Yes/No) and PUs present at admission (Yes/No) were also recorded. BS scores were collected from nursing records. The first and the last risk assessments of BS scores were extracted from electronic health record database, as in previous studies (Sardo et al., 2015). The first risk assessment corresponds to the first risk assessment using BS after admission to the hospital ward and the last assessment corresponds to the last risk assessment before hospital discharge. The BS is composed of six subscales (sensory perception, moisture, activity, mobility, nutrition and friction/shear forces). Each subscale is rated from 1 to 4, except the subscale friction/shear forces which is rated from 1 to 3 (Bergstrom et al., 1987). The total score of BS ranges from 6 to 23, and smaller scores correspond to higher risk of developing PUs. The Portuguese version of BS (DGS, 2011) recommends the patients' categorization as low risk (≥17) and high risk (≤16).

2.4 | Statistical analysis

Descriptive statistics such as frequencies, means and standard deviations were calculated to characterize the participants. Variables of the first risk assessment using the Braden score were standardized using *z*-score (mean = 0, standard deviation = 1) (Marôco, 2018). Patients were grouped/classified through hierarchical and non-hierarchical (Marôco, 2018) cluster analysis concerning the Braden subscales scores of the first risk assessment. First, a nearest neighbour hierarchical cluster analysis was conducted, using the squared Euclidian distance as measure of dissimilarity (Marôco, 2018). The graphical dendrogram analysis (Marôco, 2018) was used as criteria for the retention of the number of clusters at first risk assessment. From this analysis, five clusters from the first risk assessment Braden subscales scores were retained. For validation and classification of the patients in five retained clusters on the first risk assessment, a *k*-means non-hierarchical cluster analysis was conducted. Differences between clusters, for the age and LOS, Braden subscales scores and total score, were tested by the one-way ANOVA test, followed by the Tukey's HSD post hoc test for first and last risk assessments. Differences between clusters and previous living context, admission way, patient discharge, speciality ward and previous hospital stay was tested by chi-square test. Afterwards, first and last risk assessment Braden subscores and total score for each cluster were compared using paired sampled *t*-test. All analyses were performed by the IBM SPSS (v. 24). Significance level was stated at $P < 0.05$.

3 | RESULTS

Table 1 presents the demographic data of the participants. The sample has a mean age of 70.1 ± 18.6 years, with 67.2% ($n = 2012$) of them with 65 years old or over, and 57.5% ($n = 1724$) being female. The participants were admitted to orthopaedic (36.3%, $n = 1089$), surgery (32.5%, $n = 973$) and medicine (31.2%, $n = 934$) speciality wards. According to the Portuguese guidelines (DGS, 2011), 24.6% ($n = 962$) were classified as being at high risk of developing a PU on the first risk

TABLE 1 Participants' characteristics ($n = 2996$)

	Total M ± SD, % (*n*)
Age (years)	70.1 ± 18.6
	Min = 18; max = 118
Age ≥65 years	
≥65 years	67.2 (2012)
<65 years	32.8 (984)
Sex	
Female	57.5 (1724)
Male	42.5 (1272)
Previous living context	
Home with someone	49.5 (1483)
Home alone	11.7 (350)
Nursing home	6.8 (203)
Unknown	32.0 (960)
Admission method	
Emergency	69.9 (2095)
Planned	17.5 (525)
Missing	12.6 (376)
Patient disposal	
Discharge	64.4 (1928)
Transfer	30.6 (917)
Decease	5.0 (151)
Speciality ward	
Surgery	32.5 (973)
Orthopaedics	36.3 (1089)
Medicine	31.2 (934)
Length of stay (days)	9.8 ± 15.9
	Min = 2; max = 357
Previous hospital stays	
Yes	26.5 (793)
No	5.8 (174)
Missing	67.7 (2029)
Braden Scale—First assessment	
Total	18.13 ± 3.71
High risk (≤16)	32.1 (962)
Low risk (≥17)	67.4 (2034)
Braden Scale—Last assessment	
Total	18.38 ± 3.78
High risk (≤16)	27.7 (829)
Low risk (≥17)	72.3 (2167)

Abbreviations: M, mean; PU, pressure ulcer; SD, standard deviation.

assessment. On the last risk assessment, 21.2% ($n = 829$) remained at high-risk of developing a PU.

After the cluster analysis was conducted, five risk profiles (clusters) were identified and their scores are presented in Table 2. According to the Portuguese guidelines (DGS, 2011), and the BS total score at the first and last risk assessments, the cluster analysis conducted identified two clusters (Cluster 1 and 2) in the high-risk category (≤16), and three clusters (Clusters 3, 4 and 5) in low-risk category (>17). However, different patterns emerged when considering the subscales, even within the low and high-risk groups. At first risk assessment, clusters were statistically significantly different from each other regarding sensorial perception, nutrition, friction and shear and BS total score. At the last risk assessment, clusters were statistically significant different from each other regarding activity and mobility. Cluster 2 had the lowest scores on the first risk assessment in all Braden subscales except nutrition. Cluster 3, although being classified as low risk, had the lowest score in the nutrition subscale.

The participants' characteristics by cluster are presented in Table 3. Differences between clusters were found for previous living context, history of previous hospital stays, hospital admission way, speciality ward admission, and LOS. Statistically significant relations were found: (a) among Cluster 1 and previously living in a nursing home, having a previous hospital stay and being admitted through the emergency department (ED); (b) among Cluster 2 and living in a nursing home, being admitted through the ED, mortality and having the highest LOS (in average); (c) among Cluster 3 with previously living in unknown context, being admitted through ED and being admitted to surgery ward; (d) belonging to Cluster 4 and had previous unknown living context, no previous hospital stays, elective admission, being admitted to surgery ward, and having the lowest LOS (in average); and (e) belonging to Cluster 5 and being admitted through the ED.

When the subscales and total score for the first and the last risk assessments were compared (Table 4), it was noted that all clusters improved the BS total score on last risk assessment except for Cluster 4 (low-risk category). Although there was a significant improvement in the BS total score, it was not enough to upgrade Cluster 1 and 2 into the low-risk category. Regarding the subscales, not all of them had an improvement, independently of the BS total score. Indeed, Clusters 3, 4 and 5, classified as low risk, had increased risk in several subscales at the last risk assessment; namely, Cluster 3 had increased risk on the moisture, friction and shear subscales; Cluster 4 had decreased risk in all 6 subscales and Cluster 5 had decreased risk in the sensorial perception, moisture and nutrition subscales.

4 | DISCUSSION

The aim of this study was to identify the risk profiles of hospitalized patients from medical, surgical and orthopaedic wards with reference to the subscales of the BS. Through hierarchical and non-hierarchical cluster analysis, five clusters were retained according to Braden subscales on the patients' first risk assessment. These five clusters showed different patterns of individual risk scores (subscales), even among low and high risk groups. Therefore, besides having information on the stratification in low and high risk given by the total score, it is relevant to have information on subscales related to individual risk factors.

TABLE 2 Braden subscales of the five clusters at first and last risk-assessment

		Cluster 1 ($n = 464$) M ± SD	Cluster 2 ($n = 247$) M ± SD	Cluster 3 ($n = 257$) M ± SD	Cluster 4 ($n = 1351$) M ± SD	Cluster 5 ($n = 677$) M ± SD	P
First assessment	Sensorial perception	3.13 ± 0.51	1.84 ± 0.57	3.55 ± 0.53	3.92 ± 0.27	3.82 ± 0.39	<0.001[a]
	Moisture	3.00 ± 0.45	2.60 ± 0.84	3.77 ± 0.42	3.93 ± 0.26	3.79 ± 0.41	<0.001[b]
	Activity	1.41 ± 0.69	1.08 ± 0.28	2.13 ± 1.09	3.72 ± 0.49	1.36 ± 0.62	<0.001[c]
	Mobility	2.41 ± 0.56	1.67 ± 0.55	3.09 ± 0.61	3.77 ± 0.42	3.01 ± 0.60	<0.001[b]
	Nutrition	2.61 ± 0.50	1.98 ± 0.64	1.86 ± 0.36	3.12 ± 0.40	3.06 ± 0.23	<0.001[a]
	Friction and shear	1.74 ± 0.50	1.31 ± 0.47	2.56 ± 0.51	2.97 ± 0.17	2.39 ± 0.55	<0.001[a]
	Braden Scale (total score)	14.30 ± 1.30	10.47 ± 1.58	16.95 ± 1.84	21.42 ± 1.02	17.43 ± 1.21	<0.001[a]
Last assessment	Sensorial perception	3.09 ± 0.84	2.28 ± 0.95	3.61 ± 0.67	3.87 ± 0.38	3.73 ± 0.54	<0.001[b]
	Moisture	3.02 ± 0.82	2.75 ± 0.88	3.61 ± 0.67	3.82 ± 0.43	3.64 ± 0.59	<0.001[b]
	Activity	1.93 ± 0.92	1.36 ± 0.62	2.91 ± 1.07	3.33 ± 0.93	2.42 ± 1.05	<0.001[a]
	Mobility	2.51 ± 0.78	1.96 ± 0.73	3.26 ± 0.72	3.61 ± 0.55	3.12 ± 0.67	<0.001[a]
	Nutrition	2.67 ± 0.65	2.43 ± 0.72	2.72 ± 0.64	3.07 ± 0.42	2.99 ± 0.41	<0.001[d]
	Friction and shear	1.93 ± 0.69	1.45 ± 0.59	2.54 ± 0.62	2.87 ± 0.38	2.47 ± 0.62	<0.001[b]
	Braden Scale (total score)	15.14 ± 3.55	12.22 ± 3.14	18.66 ± 3.26	20.57 ± 2.17	18.36 ± 2.66	<0.001[b]

Note: Tested by ANOVA, followed by post hoc Tukey's HSD.

[a]All clusters are statistically different.

[b]Clusters 1, 2 and 4 are statistically different from all the other; clusters 3 and 5 are not statistically different from each other.

[c]Clusters 2, 3 and 4 are statistically different from all the other; clusters 1 and 5 are not statistically different from each other.

[d]Clusters 2, 4 and 5 are statistically different from all the other; clusters 1 and 3 are not statistically different from each other.

Previous results have considered a 3-level risk categorization (high risk, with a total score ≤11; moderate risk, with a total score of 12 to 16; and mild risk, with a total score ≥17) can be more useful and feasible in clinical practice (Chen et al., 2015). However, according to the Portuguese national guidelines, patients are classified has being at high risk or low risk of developing PUs based on the BS total score (DGS, 2011). Following this classification three low risk cluster and two high risk clusters were identified. Notwithstanding, among themselves, these groups of clusters presented significant differences, suggesting that even in low risk and high risk patients there are groups of patients with dissimilar characteristics and with different needs. To address the different needs of patients in each group it is key to have more information on the individual risk factors. For this, the subscales can be used rather than only the total score (EPUAP/NPIAP/PPPIA, 2019). This practice is supported by the international guidelines, that recommend the use of the subscales in order to provide more specific and appropriated care (EPUAP/NPIAP/PPPIA, 2019). These results reinforce the idea that classifying patients as low risk may misguide the early identification of patients with important individual risk factors. It is necessary to be cautious in use of risk assessment tools, because they have not yet proven to be effective for PU prevention (Gaspar et al., 2019). Although the BS is the most widely used risk assessment tool in the world, it has shown low calibration power in predicting PU (Chen et al., 2016; Song et al., 2021).

Besides being statistically different among themselves, the five clusters that resulted from the analysis also presented different associations with selected sociodemographic and clinical risk factors. In a previous Portuguese study, it was found that older age, lower BS scores and admission trough ED were important variables to predict, at least, one PU at the first risk assessment in inpatient setting (Garcez Sardo et al., 2016). In general, this study findings are in accordance with those and strengthen the need for a complete structured risk assessment of the individual risk factors that are behind the complex process of developing PUs (EPUAP/NPIAP/PPPIA, 2019; Gefen et al., 2013; Gefen & Weihs, 2016; Gene Badia et al., 2013).

Mortality was associated with those patients with the highest PU risk categories according to BS total score (cluster 2). Indeed, both the existence of PUs at baseline assessment and the number of hospital admissions during the year before the study, are variables that independently predicted death in older patients in a nursing home (Gene Badia et al., 2013). In hospital contexts, mortality in patients who develop a PU remains high, and is linked with institutionalization or acquired infections (Khor et al., 2014).

Except for cluster 4 (the lowest risk cluster for PU development), more than 90% of patients from the other clusters were admitted directly from the ED. The admission through the ED represents a high risk of PU development (Dugaret et al., 2014). Therefore, PU risk assessment and prevention planning should be hosted

TABLE 3 Participants' characteristics according to the five clusters

	Cluster 1 ($n = 464$) M ± SD or n(%)	Cluster 2 ($n = 247$) M ± SD or n(%)	Cluster 3 ($n = 257$) M ± SD or n(%)	Cluster 4 ($n = 1351$) M ± SD or n(%)	Cluster 5 ($n = 677$) M ± SD or n(%)	P
Age[a]	71.69 ± 17.81	70.85 ± 19.93	69.81 ± 18.38	69.35 ± 18.38	70.13 ± 18.99	0.194
Sex[b]						0.294
Female	61.0 (283)	60.7 (150)	55.6 (143)	56.0 (757)	57.8 (391)	
Male	39.0 (181)	39.3 (97)	44.4 (114)	44.0 (594)	42.2 (286)	
Living context[b]						<0.001
Home with someone	49.6 (230)	39.3 (97)	45.9 (118)	49.1 (664)	55.2 (374)	
Home alone	9.3 (43)	5.7 (14)	11.7 (30)	12.8 (173)	13.3 (90)	
Nursing home	18.3 (85)[c]	28.3 (70)[c]	4.3 (11)	1.0 (13)	3.5 (24)	
Unknown	22.8 (106)	26.7 (66)	38.1 (98)[c]	37.1 (501)[c]	27.9 (189)	
Admission way[b]						<0.001
Emergency department	94.7 (412)[c]	99.6 (231)[c]	93.3 (208)[c]	61.8 (696)	90.9 (548)[c]	
Programmed	5.3 (23)	0.4 (1)	6.7 (15)	38.2 (431)[c]	9.1 (55)	
Patient discharge[b]						0.382
Discharge	64.9 (301)	65.6 (162)	66.9 (172)	64.8 (876)	61.6 (417)	
Transference	30.2 (140)	20.7 (66)	29.2 (75)	30.4 (411)	33.2 (225)	
Decease	5.0 (23)	7.7 (19)[c]	3.9 (10)	4.7 (64)	5.2 (35)	
Speciality ward[b]						<0.001
Surgery	26.3 (122)	30.4 (75)	38.9 (100)[c]	35.9 (485)[c]	28.2 (191)	
Orthopaedics	38.8 (180)	34.4 (85)	32.7 (84)	35.0 (473)	39.4 (267)	
Medicine	34.9 (162)	35.2 (87)	28.4 (73)	29.1 (393)	32.3 (219)	
Length of stay (days)[a]	10.35 ± 13.50	12.60 ± 32.28	9.77 ± 13.63	9.37 ± 14.45	9.40 ± 11.50	0.048
Previous hospital stays[b]						0.010
Yes	90.5 (152)[c]	86.0 (92)	78.8 (63)	78.6 (327)	81.1 (159)	
No	9.5 (16)	14.0 (15)	21.3 (17)	21.4 (89)[c]	18.9 (37)	

[a]Tested by ANOVA, followed by post hoc Tukey's HSD.
[b]Tested by chi-square.
[c]Adjusted standardized residuals >1.96.

as a priority during the patient's admission process (Cubit et al., 2013). Another important risk factor for PU development is the LOS, as previous studies have shown that prolonged hospitals stays were positively associated with a higher risk of developing a PU (Bereded et al., 2018). Similarly, in this study, it was found that LOS was significantly higher in the highest risk cluster (cluster 2). However, it was also found that patients in the cluster 4, which had a short LOS (in average) and the lowest risk for developing PU, were the only ones presenting an increase in risk from the first to the last risk assessment This finding suggests that even for patients with low risk and short hospital stays, health care professionals should be aware and dedicate focused attention to the probability of PU development on these patients.

The previous living context of the patient before hospitalization should also be considered (Gene Badia et al., 2013). Older people living in long-term facilities had lower scores on sensorial perception, moisture, mobility, friction and shear forces and BS total scores (highest-risk clusters 1 and 2). The ageing process brings skin changes and frequently impaired mobility, which can increase the risk to develop a PU (Latimer et al., 2019). These results suggest that those patients already had some level of frailty and dependence. Thus, they need specialized health care, tailored preventive strategies and education to enable better wound care outcomes (Gaspar et al., 2019; Shanley et al., 2020; Vitoriano, 2019).

Using risk assessment tools to guide prevention planning is recommended (DGS, 2011; EPUAP/NPIAP/PPPIA, 2019); however, for clinical judgement, other factors should also be taken into account (DGS, 2011; EPUAP/NPIAP/PPPIA, 2019). Hospitalization stay decreased the risk of PU development for those with the highest initial risk. In fact, the hospitalization period between first and last risk assessment showed a decrease in risk for all BS subscales and total score on patients belonging to the highest risk cluster (cluster 2). Regarding the other high risk cluster (cluster 1), the hospitalization period also was associated with decreasing risk for all BS

TABLE 4 Braden subscales of the five clusters at first and last risk-assessment

	Cluster 1 ($n = 464$) M ± SD	*P*	Cluster 2 ($n = 247$) M ± SD	*P*	Cluster 3 ($n = 257$) M ± SD	*P*	Cluster 4 ($n = 1351$) M ± SD	*P*	Cluster 5 ($n = 677$) M ± SD	*P*
Sensorial perception[a]		0.319		<0.001		0.244		<0.001		<0.001
First assessment	3.13 ± 0.51		1.84 ± 0.57		3.55 ± 0.53		3.92 ± 0.27		3.82 ± 0.39	
Last assessment	3.09 ± 0.84		2.28 ± 0.95		3.61 ± 0.67		3.87 ± 0.38		3.73 ± 0.54	
Moisture[a]		0.645		0.033		<0.001		<0.001		<0.001
First assessment	3.00 ± 0.45		2.60 ± 0.84		3.77 ± 0.42		3.93 ± 0.26		3.79 ± 0.41	
Last assessment	3.02 ± 0.82		2.75 ± 0.88		3.61 ± 0.67		3.82 ± 0.43		3.64 ± 0.59	
Activity[a]		<0.001		<0.001		<0.001		<0.001		<0.001
First assessment	1.41 ± 0.69		1.08 ± 0.28		2.13 ± 1.09		3.72 ± 0.49		1.36 ± 0.62	
Last assessment	1.93 ± 0.92		1.36 ± 0.62		2.91 ± 1.07		3.33 ± 0.93		2.42 ± 1.05	
Mobility[a]		0.003		<0.001		<0.001		<0.001		<0.001
First assessment	2.41 ± 0.56		1.67 ± 0.55		3.09 ± 0.61		3.77 ± 0.42		3.01 ± 0.60	
Last assessment	2.51 ± 0.78		1.96 ± 0.73		3.26 ± 0.72		3.61 ± 0.55		3.12 ± 0.67	
Nutrition[a]		0.082		<0.001		<0.001		0.001		0.004
First assessment	2.61 ± 0.50		1.98 ± 0.64		1.86 ± 0.36		3.12 ± 0.40		3.06 ± 0.23	
Last assessment	2.67 ± 0.65		2.43 ± 0.72		2.72 ± 0.64		3.07 ± 0.42		2.99 ± 0.41	
Friction and shear[a]		<0.001		0.001		0.764		<0.001		<0.001
First assessment	1.74 ± 0.50		1.31 ± 0.47		2.56 ± 0.51		2.97 ± 0.17		2.39 ± 0.55	
Last assessment	1.93 ± 0.69		1.45 ± 0.59		2.54 ± 0.62		2.87 ± 0.38		2.47 ± 0.62	
Braden scale (total score)[a]		<0.001		<0.001		<0.001		<0.001		<0.001
First assessment	14.30 ± 1.30		10.47 ± 1.58		16.95 ± 1.84		21.42 ± 1.02		17.43 ± 1.21	
Last assessment	15.14 ± 3.55		12.22 ± 3.14		18.66 ± 3.26		20.57 ± 2.17		18.36 ± 2.66	

[a]Tested by *t*-test to paired samples.

subscales, with exception of the sensorial perception subscale, and total score. On the other hand, for the lowest risk cluster (cluster 4), hospitalization increased the risk of PU development in all BS subscales and total score. Perhaps this is due to the individual characteristics of the patients who did not show a potential for improvement regardless of the interventions applied. Another possibility may be due to the simple fact that the risk assessments are not accurate enough tools to identify at-risk patients (Chen et al., 2016; Moore & Patton, 2019; Song et al., 2021). This finding is important as it shows that even patients scored at low risk of developing PU can worsen their health status. Thus, a focused attention is needed with all patients apparently without PU risk development, as they may in the future become at risk patients who can develop a PU. In particular, health care professionals should pay particular attention to patients who have limited sensory perception, mobility limitations, and/or when moisture status is less than optimal (Chen et al., 2017).

One major concern among the lowest risk patients (cluster 4) was the identified increase in some specific risks, such as activity and mobility. These are two concepts that appear similar, but in PUs prevention they measure different things. Activity is measured in a macro level (bedfast, chairfast, walking) and mobility is measured in terms of frequency and magnitude of movement (Coleman et al., 2013). Activity is significantly associated with PU development (Bereded et al., 2018), namely patients who had impaired activity (chairfast and bedfast) were respectively 11 times and 7.58 times more likely to develop a PU (Bereded et al., 2018). This limitations on activity are related to prolonged exposure to pressure on bony prominences, which are conducive to impaired perfusion and oxygenation of the underlying skin (Bereded et al., 2018), and consequently the development of a PU. Nutrition also seems to be a particular problem of patients admitted with low risk, as its score was significantly lower in these patients admitted with low risk. Although it is not clear that nutrition is a primary risk factor of PU development (Coleman et al., 2013), this result needs to be reflected by the health care providers regarding the attention given and care provided to the lower risk patients.

4.1 | Study limitations

This study had some limitations that should be acknowledged. First, this study only shows the reality at local level from one hospital. Second, the use of retrospective data from electronic health records limits the full understanding of the processes, as it only takes into account registered records from the health professionals which could be lacking (e.g., records of clinical judgement regarding PU risk assessment) or incomplete (e.g., records regarding skin inspection). Third, the study design is only based on the analysis of the BS subscales risk factors and not in the complete structured risk assessment, which also includes skin assessment. Nonetheless, the study identified the risk profiles of hospitalized patients from medical, surgical and orthopaedic wards with reference to the subscales of BS. A prospective multicentre study and/or studies which consider more specifics settings and subgroup analysis would be beneficial in the future to better understand the PU risk assessment.

5 | CONCLUSION

The cluster analysis of this study suggests the need of increasing awareness of health care professional to dedicate a focused attention to patients in both high and low risk of PU development. The classification as low risk may misguide the early identification of patients with important individual risk factors. The cluster with the lowest PU risk on the first risk assessment was the only cluster where patients increased the BS subscales risks, which impacted on their overall BS score. Also, it was reinforced that early identification of at-risk patients should be performed rather than relying solely on risk assessment tools. We recommend that at micro and macro levels, policies that aim to tailor strategies to patient's specific risk factors are developed.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interests.

AUTHORSHIP STATEMENT

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DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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