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Factors Associated with a High-Risk Profile for Developing Pressure Injuries in Long-Term Residents of Nursing Homes

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Highlights of the Study

- Nursing home residents are at high risk of pressure injuries.
- In older adults, there is an association between the risk of pressure ulcers and dementia.
- Cerebrovascular diseases are related to risk of pressure injuries.

Keywords
Pressure injuries · Pressure ulcers · Norton scale · Nursing homes · Dementia

Abstract
Objectives: Pressure injuries are a health problem of special concern for older adults, and different scales are used to assess the risk of developing these ulcers. We assessed the prevalence of residents at high risk of pressure injuries using a Norton scale and examined its relationships with the most important risk factors in a large sample of Italian nursing homes (NHs). ***Method:*** This was a cross-sectional cohort study in a sample of Italian long-term care NHs with data collected between 2018 and 2020. ***Results:*** We recruited 2,604 NH residents; 1,252 had Norton scale scores, 41 (3.3%) had a diagnosis of pressure injuries, 571 (45.6%) had a Norton score ≤9, and 453 (36.2%) had a score between 10 and 14. The univariate model showed a relationship between female sex, age, dementia, and cerebrovascular disease with a Norton scale score ≤9. The significant associations were confirmed in the multivariate model with stepwise selection. ***Conclusion:*** The prevalence of NH residents at high risk of pressure injuries was very high using the Norton scale, but the percentage of residents who develop these ulcers is lower. Female NH residents with advanced age, dementia, and a history of cerebrovascular disease should be carefully monitored.

Introduction

Pressure injuries are caused by compression of soft tissue between a bony prominence and an external surface for a long time. The consequences of pressure-induced skin and soft tissue injury range from non-blanchable erythema of intact skin to deep ulcers extending to the bone; this imposes a significant burden not only on the patient but also on the healthcare systems [1, 2].

Pressure injuries are caused by a complex range of interacting factors related to the mobility and activity status

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of patients, skin perfusion, nutritional status, and sensory function [3, 4]. Neurologic diseases such as dementia, delirium, or peripheral neuropathy are important risk factors for pressure-induced skin and soft tissue injuries because sensory loss is common among these patients, so they may not perceive pain or discomfort arising from prolonged pressure. Other contributory risk factors include edema, diabetes, reduced subdermal fat, chronic pulmonary disease, erythema, obesity, advanced age, cerebrovascular or cardiovascular disease, recent lower extremity fractures, incontinence, and a number of drugs [5–7]. However, it is still not clear whether these are independent risk factors or whether they simply reflect the high prevalence of immobility among frail older adults [4, 5, 8, 9]. Some classes of medications have also been associated in different settings with an increased risk of pressure injuries because of their effects on mobility or the perfusional state. These medications include sedatives, analgesics, vasopressors, and corticosteroids [10, 11].

Pressure injuries are a health problem that can arise in any healthcare institution and is of particular concern for older adults [3–5]. Nursing home (NH) residents are at high risk of these ulcers because they are older and frailer than noninstitutionalized older adults, and often, they have many comorbidities that result in immobilization and being bedridden. Studies in NH residents have found a prevalence of pressure injuries ranging from 10 to 35% [3, 12–14], but the rates are generally lower (3–12%) among long-term NH residents [10, 15–17]. Although NH residents are at higher risk of pressure injuries, only a few studies on small sample sizes have examined the prevalence and risk factors in this setting, where most residents suffer from dementia and receive psychotropic medications. Therefore, we studied the prevalence and the risk factors for pressure injuries in a large sample of long-term care NHs in Italy.

Subjects and Methods

Data Collection

This cross-sectional cohort study was conducted on a sample of long-term care NHs across Italy. These facilities provide residential care for people with severe disabilities and elderly individuals who cannot care for themselves. All the residents were included in the analysis. No NH resident was excluded. Sociodemographic details, diagnosis, and drug treatments of each NH resident were collected during the study using medical records. Mini Mental Status Evaluation score, Barthel Index score, Norton scale score, and the date of death were also collected.

The Barthel Index is used to assess ability in basic activities of daily living. It considers ten variables and yields scores of 0–100. A high score is associated with a greater likelihood of being able to live at home with a good degree of independence after discharge from hospital. Subjects can be divided into five levels of dependence: total (scores of 0–24), severe (25–49), moderate (50–74), mild (75–90), and minimal impairment (91–100).

The severity of comorbidity was measured with the Charlson's Comorbidity Index (CCI). For this purpose, we used the most recent version of CCI (2008) [18], which added three new classes of diseases to the original items (hypertension, depression, and skin ulcer) and a supplemental condition related to use of warfarin. For each of the 23 classes assessed, weights range from 1 to 6, with no extra point linked to age. To identify patients in severe clinical conditions, we chose the cutoff proposed by the authors: CCI ≥5 for severely affected cases (0 = healthy, 1–2 = mild, 3–4 = moderate).

Data collection complied fully with Italian laws on personal data protection, and the study was approved by the Ethics Committee of the IRCCS Carlo Besta Foundation. Drug prescription information, diseases, and sociodemographic characteristics of NH residents were collected 6 times between 2018 and 2020.

Pressure Injuries and Norton Scale

The Norton scale is a commonly used prediction tool to evaluate the individual risk to develop pressure injuries [19]. It takes into account five conditions: mental condition, physical condition, activity, mobility, and incontinence, each of them giving a score between 1 (worst) and 4 (best). The sum is the score and may vary from 5 (maximum risk of pressure injuries) to 20 (minimum risk). Sensitivity typically ranges from 70 to 90% and specificity from 60 to 80% [20]. NH residents at very high risk of pressure ulcers were defined as those with a Norton scale score ≤9 and those at high risk with a score between 10 and 14 [21].

Statistical Analysis

The patients' sociodemographic details were presented using standard descriptive statistics. We tabulated percentages for discrete variables, mean, and standard deviations for continuous variables. Then patients were divided into three comparison groups according to their Norton scale score (very high risk = NS ≤ 9, high risk = 9 < NS ≤ 14, and low risk = NS > 14).

Differences between these groups were first examined using univariate standard tests: χ^2 Pearson's test for discrete variables and *F* test for continuous characteristics. The relation between the Norton score and the risk factors for developing pressure injuries was examined with multinomial logistic regression analysis in a univariate and multivariate model. A multinomial logistic model was developed using the stepwise method for the selection of covariates among all risk factors. Entry and removal criteria for the *p* value evaluation of this procedure were set at 0.25 and 0.15, respectively. All these analyses were repeated using the presence of pressure injuries as the outcome.

Odds ratios (ORs) were calculated for all the models, and confidence intervals (CIs) were calculated using Wald's test. Statistical significance (alpha) was 0.05 for all tests. In accordance with previous studies, the prevalence of patients at risk of pressure injuries ranging from 27% to 33% [6, 13]. A 95% CI would be expected to have a 2.5% margin of error, with a sample of 1,024 NH residents with a Norton score, assuming a reference prevalence of residents at risk around 33%. Analysis was developed using SAS 9.4 statistical software (SAS Institute Inc., Cary, NC, USA).

Table 1. Sociodemographic characteristics, medications, and comorbidities of NH residents included in the analysis

	Norton ≤9 (*N* = 571)	9 < Norton ≤14 (*N* = 453)	Norton >14 (*N* = 228)	*p* value
Age, years (mean±SD)	87.2±8.3	87.0±7.3	83.4±9.7	<0.0001
Women, *n* (%)	474 (83.0)	331 (73.1)	160 (70.2)	<0.0001
Drugs, *n* (mean±SD)	5.8±3.3	7.3±3.5	7.8±3.6	<0.0001
Diagnosis (mean±SD)	10.4±3.0	10.6±3.5	9.4±3.5	<0.0001
Charlson index (mean±SD)	3.2±1.6	3.2±2.0	2.9±1.9	0.06
Score 0, *n* (%)	2 (0.3)	15 (3.3)	15 (6.6)	<0.0001
Score 1–2, *n* (%)	225 (39.4)	172 (40.0)	91 (39.9)	
Score 3–4, *n* (%)	239 (41.9)	160 (35.3)	80 (35.1)	
Score 5+, *n* (%)	105 (18.4)	106 (23.4)	42 (18.4)	
Barthel score (mean±SD)	5.1±7.9	26.6±17.3	69.7±21.4	<0.0001
MMSE (mean±SD)*	8.9±7.9	17.2±7.8	23.2±6.1	<0.0001
Mild 18+, *n* (%)	55 (18.1)	205 (50.6)	176 (82.2)	
Moderate 9–17, *n* (%)	93 (30.6)	148 (36.5)	32 (15.0)	<0.0001
Severe 0–8, *n* (%)	156 (51.3)	52 (12.9)	6 (2.8)	
Class of medications, *n* (%)				
Analgesic	156 (27.3)	164 (36.2)	75 (32.9)	0.0088
Benzodiazepines	244 (42.7)	208 (45.9)	118 (51.7)	0.07
Opioids	71 (12.4)	66 (14.6)	26 (11.4)	0.42
Muscle relaxant	11 (1.9)	5 (1.1)	1 (0.4)	0.12
Antipsychotic	256 (44.8)	187 (41.3)	84 (36.8)	0.11
Antidepressants	97 (17.0)	130 (28.7)	70 (30.7)	<0.0001
Corticosteroids	31 (5.4)	35 (7.7)	15 (6.6)	0.33
Comorbidities, *n* (%)				
Edema	1 (0.2)	–	–	0.55
Diabetes	73 (12.8)	85 (18.8)	50 (21.9)	0.0022
Erythema	–	–	1 (0.4)	0.11
Dementia	492 (86.2)	297 (65.6)	104 (45.6)	<0.0001
Renal disease	57 (10.0)	72 (15.9)	30 (13.2)	0.0182
At least 1 CVD	316 (55.3)	216 (47.7)	97 (42.5)	0.019
Hypotension	2 (0.4)	1 (0.2)	–	0.65
Cerebrovascular disease	288 (50.4)	183 (40.4)	80 (35.1)	<0.0001
Congestive heart failure	52 (9.1)	64 (14.1)	25 (11.0)	0.0408
COPD	67 (11.7)	64 (14.1)	44 (19.3)	0.0206
Infections	32 (5.6)	33 (7.3)	21 (9.2)	0.17
Anemia	75 (13.1)	86 (19.0)	40 (17.5)	0.0322

* MMSE was performed in 923 NH residents, 709 with dementia and 214 without.

Results

Of the 2604 NH residents recruited from 27 NHs, 73 (2.8%) had a diagnosis of pressure injuries. In this cohort, 1,252 had a Norton scale score and were included in this analysis: 41 (3.3%) had pressure injuries, 571 (45.6%) had a Norton score ≤9, and 453 (36.2%) had a Norton score between 10 and 14. Table 1 summarizes the sociodemographic characteristics, medications, and comorbidities of the residents included.

The relations between risk factors for pressure injury and Norton score in the univariate model are reported in Table 2. A significant relationship was found with sex, age, dementia, and cerebrovascular disease; no association was found with medications potentially related to pressure ulcer, such as antipsychotics, benzodiazepines, antidepressants, or opioids. The multivariate model obtained with the stepwise selection (Table 3) confirmed the relationship of Norton score ≤9 with dementia (OR 95% CI: 6.04 [4.19–8.71], $p < 0.0001$), cerebrovascular disease (OR 95% CI: 1.78 [1.27–2.50], $p = 0.0009$), age (OR 95% CI: 1.02 [1.00–1.04], $p = 0.0197$), and female sex (OR 95% CI: 1.81 [1.22–2.69] $p < 0.0001$). Dementia and age were also related to a Norton score between 10 and 14 (OR 95%

Table 2. Unadjusted multinomial logistic model for the relations between the risk factor for pressure injury and the categorical Norton score

	Norton ≤9 OR (95% CI)	*p* value	9 < Norton ≤14 OR (95% CI)	*p* value
Women	2.08 (1.45–2.97)	<0.0001	1.15 (0.81–1.64)	0.43
Age	1.05 (1.03–1.07)	<0.0001	1.05 (1.03–1.07)	<0.0001
Charlson Index	1.08 (0.99–1.18)	0.08	1.11 (1.01–1.22)	0.027
Antipsychotic	1.39 (1.01–1.91)	0.0395	1.21 (0.87–1.67)	0.26
Analgesic	0.77 (0.55–1.07)	0.12	1.16 (0.83–1.62)	0.40
Benzodiazepines	0.70 (0.51–0.95)	0.021	0.79 (0.58–1.09)	0.15
Antidepressants	0.46 (0.32–0.66)	<0.0001	0.91 (0.64–1.29)	0.59
Opioids	1.10 (0.68–1.78)	0.69	1.33 (0.81–2.15)	0.26
Corticosteroids	0.82 (0.43–1.54)	0.53	1.19 (0.64–2.23)	0.59
Dementia	7.43 (5.22–10.57)	<0.0001	2.27 (1.64–3.14)	<0.0001
Cerebrovascular disease	1.88 (1.37–2.59)	<0.0001	1.25 (0.90–1.75)	0.18
Congestive heart failure	0.81 (0.49–1.35)	0.42	1.34 (0.82–2.19)	0.25
Diabetes	0.52 (0.35–0.78)	0.0014	0.82 (0.56–1.22)	0.33
Renal disease	0.73 (0.46–1.17)	0.19	1.25 (0.79–1.97)	0.35
COPD	0.56 (0.37–0.84)	0.0056	0.69 (0.45–1.05)	0.08
Infections	0.59 (0.33–1.04)	0.07	0.77 (0.44–1.37)	0.38
Anemia	0.71 (0.47–1.08)	0.11	1.10 (0.73–1.67)	0.65

The reference group is Norton >14.

Table 3. Adjusted multinomial logistic model for the relations between the risk factor for pressure injury and the categorical Norton score

	Norton ≤9 OR (95% CI)	*p* value	9 < Norton ≤14 OR (95% CI)	*p* value
Age	1.02 (1.00–1.04)	0.0197	1.04 (1.02–1.06)	<0.0001
Women	1.81 (1.22–2.69)	<0.0001	0.95 (0.65–1.37)	0.77
Dementia	6.04 (4.19–8.71)	<0.0001	1.97 (1.41–2.77)	<0.0001
Cerebrovascular disease	1.78 (1.27–2.50)	0.0009	1.17 (0.83–1.64)	0.37
Antidepressants	0.60 (0.41–0.88)		1.06 (0.74–1.53)	

The reference group is Norton >14.

CI: 1.97 [1.41–2.77], $p < 0.0001$ and 1.04 [1.02–1.06], $p < 0.0001$, respectively). Finally, the analysis conducted to evaluate the relationship with the diagnosis of pressure injuries found a significant relation only for diabetes (OR 95% CI: 2.06 [1.01–4.22], $p = 0.0483$).

Discussion

Our study found that about 45% of NH residents are at very high risk of pressure injuries and 36% at high risk, but only a small percentage of residents (about 3%) developed pressure injuries. Dementia, cerebrovascular disease, age, and female sex were found to be the main risk factors for a very high risk of pressure ulcers, although only diabetes was found to be related to the diagnosis of pressure injuries.

The prevalence of residents at high risk of pressure injuries in our study is similar or slightly higher than that reported in other studies, which found prevalence between 27 and 47%. Differences in the prevalence of residents at risk of pressure ulcers can be related to the different characteristics of residents and the scales used to assess the risk. A small longitudinal study in a sample of Swedish NHs found about 27% of residents at high risk of pressure injury, but even though the mean age was similar, no information was available for dementia or MMSE scores of residents at the highest risk of ulcers, thus not allowing a direct comparison [6]. Similarly, another large cross-sectional Swedish study found a prevalence of NH residents at high risk of about 33%, but differences in the mean age of that population and in the scale used to assess the risk of pressure injury make comparison difficult [12]. A cross-sectional study in Belgium found a prevalence of

NH residents at high risk of about 32%, and 21% of residents had pressure ulcers [22]; and a German study found 47% of NH residents at risk, with 12% having pressure injuries [14]. These studies used different scales for the assessment of risk of pressure injuries, with different cutoffs (Braden score <17 and <18, respectively), so no direct comparison with our results can be made.

Despite the high number of residents at high risk and very high risk for pressure injuries according to Norton score, only a few had a diagnosis of pressure injuries. The large difference between the prevalence of residents at risk and those with pressure ulcers might be explained by the low sensitivity of the Norton scale or by specific interventions adopted to prevent pressure injuries in NH residents at high risk: these interventions include the optimization of body weight, hydration, use of anti-decubitus pillows and mattresses, unloading of areas with greater body pressure, and the variable postural positioning pattern.

In our study, dementia and cerebrovascular disease were associated with an increased risk of pressure injury, according to the Norton scale score, probably as a consequence of reduced mobility and exercise: immobility is, in fact, the most important host factor that contributes to pressure-induced skin and soft tissue injury [4, 23], and the high percentage of NH residents with dementia and cerebrovascular diseases in our study might explain the high prevalence at risk of pressure injuries. Correlations between pressure injuries and lack of spontaneous nocturnal movements were high in studies that used devices to measure body movement, but since methods to measure immobility in clinical settings are generally not available, clinical characteristics such as a history of cerebrovascular accident or dementia can be used as markers for immobility [24–26].

In critically ill patients, chronic obstructive pulmonary disease (COPD) has been found to be related to the development of pressure ulcers [5, 27–29], owing to immobility and poor perfusion. We found no relationship between COPD and risk of pressure injuries at Norton scale, similarly to the other studies conducted in NHs. However, the small number of NH residents with pressure injuries and COPD in our sample limits the possibility to evaluate this relationship.

A strength of this study is that we examined the relation between risk factors and residents at high risk of pressure ulcers in a larger sample of older adults living in NHs. The lack of information about nutritional status, body mass index, mobility, and bedridden status are among the limitations of the study. Another limitation is the lack of information about the stage of pressure injuries and the correlation of risk factors with the severity of the injuries.

Conclusions

The prevalence of NH residents at risk of pressure ulcers is very high using the Norton scale, but the percentage of residents who develop the ulcers is definitely lower. Female NH residents with advanced age, dementia, and a history of cerebrovascular disease should be carefully monitored.

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Statement of Ethics

The study was approved by the Ethics Committee of the IRCCS Carlo Besta Foundation. All data were anonymous, and informed consent was not required for the purpose of this study.

Conflict of Interest Statement

The authors have no conflicts of interest directly relevant to the content of this manuscript.

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None.

Author Contributions

Chiara Elli and Luca Pasina designed the study, interpreted data, and wrote the manuscript; Alessio Novella conducted and interpreted statistical analyses; Alessandro Nobili and Aladar Ianes made the final critical revision for important intellectual contents. All the authors critically revised the manuscript and approved its final version and approved the final version of the manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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