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ORIGINAL ARTICLE

Independent risk factors for the development of skin erosion due to incontinence (incontinence-associated dermatitis category 2) in nursing home residents: results from a multivariate binary regression analysis

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Elderly; Incontinence-associated dermatitis; Nursing home; Prevention; Risk factors

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Abstract

The aim of this study was to identify characteristics independently associated with a higher risk of developing skin damage because of incontinence [incontinence-associated dermatitis (IAD) category 2] in nursing home residents. As part of a larger randomised controlled trial, IAD incidence was monitored for 1 month in a sample of 381 incontinent residents using a validated IAD Severity Categorisation Tool. Data on demographical, physical, functional and psychological characteristics were collected. The overall IAD incidence (category 1–2) was 30·0%, and 6% of the participants developed skin damage (IAD category 2). Residents who developed IAD category 2 were less mobile [odds ratio (OR) 2·72, 95% confidence interval (CI) 1·06–6·94], had more friction and shear issues (OR 2·54; 95% CI 1·02–6·33) and had more erythema due to incontinence (OR 3·02; 95% CI 1·04–8·73) before IAD category 2 occurrence. Care providers should give full attention to risk factors to both detect residents at risk for IAD development and to start prevention in time.

Introduction

Incontinence is prevalent among elderly in nursing homes. Prevalence rates vary between 30·0% and 65·6% for urinary incontinence and between 22·4% and 55·5% for faecal incontinence (1–3). Incontinent residents were at risk for developing incontinence-associated dermatitis (IAD). IAD is defined as an inflammation of the skin due to prolonged or repeated contact with urine and/or stool (4). Based on the severity of the skin lesion, two categories of IAD can be distinguished: erythema without skin damage [category (cat.) 1] and erythema with skin damage (vesicles, bullae, denudation, skin erosion) (cat. 2) (5). As the prevalence of incontinence rises with ageing, skin structure changes, and barrier function reduces. The skin of elderly is characterised by an increased skin pH, a decreased water volume, loss of elasticity, a decreased turnover rate of epidermal cells, a thinning epidermis and a reduced perfusion (6–10). Consequently, elderly are more susceptible to develop IAD than younger adults (11). The prevalence of IAD in nursing homes is between 3·1% and 6·5% (12,13).

Key Messages

- residents at risk of developing skin erosion because of incontinence [incontinence-associated dermatitis (IAD) category 2] should be detected in time in order to start timely IAD prevention
- resident characteristics independently associated with the development of IAD category 2 were identified using multivariate binary logistic regression analysis
- care providers are recommended to start timely IAD prevention in residents with observed erythema because of incontinence, severe restricted mobility and dependency for repositioning themselves in the bed or chair

Elderly with IAD may experience discomfort because of pain, itching, burning or tingling (14). In addition to these physical complaints, IAD has an impact on the psychological and social functioning (e.g. loss of independence, reduction in social activities) (5,14). Both discomfort and disfunctioning are more distinct if IAD cat. 2 lesions developed (14). Furthermore, IAD is a known risk factor for pressure ulcer development (11).

Prevention of IAD starts with appropriate continence management to avoid or minimise contact of the skin with urine or faeces (e.g. prompt toileting, use of underpads, diapers) (9). In addition, a structured skin care regimen, consisting of gentle skin cleansing, moisturising and skin protecting, is recommended (9,15,16). A wide range of skin care products for the prevention of IAD are available, varying in composition and function (9,16,17).

To improve the (cost) effectiveness of interventions for the prevention of IAD, interventions should be targeted to nursing home residents at high risk of developing IAD. For example, prevalence studies determined that residents with compromised mobility or double incontinence were at higher risk of developing IAD than residents with limited restrictions in mobility or with urinary incontinence only (12,13,18). Current knowledge on IAD risk factors in nursing home residents is limited to prevalence studies using secondary data analysis (12,13,19). Furthermore, one large-scale study demonstrated that, using a multivariate binary logistic regression model, only 8% of variance in IAD prevalence could be explained by the risk factors identified (13). In this study, secondary analyses were performed on a database containing data from two cross-sectional, multicentre prevalence studies in the Netherlands and Austria ($n = 3713$). The study sample consisted of incontinent nursing home residents, hopitalised patients, as well as adults receiving home care. The original prevalence studies were part of an international prevalence study on care problems (20,21). The overall IAD prevalence was 6·1% (category 1 and 2). Using a multivariate binary logistic regression analysis, the authors concluded that an increase in body mass index, being faecal incontinent, having diabetes mellitus and having moisture or friction and shear problems (Braden scale items) were independently associated with the development of IAD.

The aim of this study was to identify risk factors associated with the development of skin erosion because of incontinence (IAD cat. 2). In residents who developed IAD cat. 2, prevention has failed or was neglected.

Methods

Study design

This study was part of a multicentre, randomised controlled trial (RCT) (ClinicalTrial.gov registration number: NCT02475512). The RCT examined the effectiveness of using wipes with cleansing, moisturising and skin protecting properties (washing without water) compared to the standard use of soap and water for the prevention of IAD.

Settings and participants

The study was conducted in a convenience sample of 11 nursing homes in Belgium. Nursing homes that introduced washing without water before the start of the study were excluded.

All residents meeting the criteria for inclusion in the selected nursing homes were eligible for participation. Inclusion criteria were: being mostly or always incontinent for urine or stool and requiring partial or full help for washing (both above and below the belt). Eligible residents were selected using the Belgian Evaluation Scale for Activities of Daily Living (BESADL) (22), which is adapted from the Katz Index. (23) Residents with skin damage because of incontinence or pressure/shear, an indwelling device (urinary/faecal catheter), use of incontinence wipes or a skin barrier product in the peri-anal or genital area 2 weeks prior to the start of the study or presence of a bacterial/fungal infection in the peri-anal or genital area were excluded.

Variables

The research group identified possible IAD risk factors through a literature search (IAD prevalence/incidence studies, literature reviews on IAD prevention and treatment, consensus documents). The list of possible risk factors consisted of demographic (e.g. age), physical (e.g. malnutrition, risk of developing pressure ulcers, stool consistency) and functional (e.g. care dependency) characteristics that could be registered using nursing home records and routine observation by nurses. The dependent variable was IAD category 2, defined as erythema with skin erosion (5).

Data collection

Before the start of the study, the researchers instructed the nurses about skin observation (using the diascopy method), classification of IAD and pressure ulcers, risk assessment and risk factor registration. The European Pressure Ulcer Advisory Panel (EPUAP) Pressure Ulcer Classification Set (PUCLAS3) was used to train the nurses (24).

The senior nurses of each ward collected baseline data on demographic, physical and functional characteristics and risk assessment during the week before the start of the study. The ward nurses performed a baseline skin assessment the day before the start of the study.

Skin assessment and risk factor registration were continued on a daily basis by the ward nurses. Skin was assessed using the diascopy method (plastic disk) to make a differential diagnosis between blanchable and non-blanchable erythema. Reliability testing for skin assessment was conducted by one of the researchers on at least a weekly basis and without pre-announcement. Eligible residents were followed-up for 30 days (25). Once IAD category 2 (erythema with skin damage) was observed, residents were excluded from further participation in the study. In this case, the protocol of the nursing home was used. The standard protocols from the participating nursing homes contained the use of soap and water at least once daily. During the day, a product with cleansing and moisturising capacities (foam or milk) was used for incontinence care. Zinc oxide products were used for skin protecting in residents at risk of IAD category 2, as determined by the nurses (e.g. erythema or diarrhoea).

Category	Clinical presentation	Definition	Wound related criteria**
Category 0		No redness and skin intact	Skin is normal as compared to rest of the body (no signs of IAD)
Category 1		Red* but skin intact	Erythema +/- oedema
Category 2		Red* with skin breakdown	As above for Category 1 +/- vesicles/bullae/skin erosion +/- denudation of skin +/- skin infection

* Or paler, darker, purple, dark red or yellow in patients with darker skin tones.
** If the patient is not incontinent, the condition is not IAD.

Figure 1 IAD Severity Categorisation Tool (5).

Measurement instruments

Validated assessment instruments were used to collect data about nutritional status [revised short form of the Mini-Nutritional Assessment (MNA) (26)], health status [Charlson Comorbidity Index (27)], pressure ulcer risk assessment [Braden scale (28)] and stool consistency [Bristol Stool Chart (29)].

The BESADL, which is adapted from the Katz Index, was used to register the degree of nursing care dependency (22,23,30). The BESADL measures residents' self-care ability on six domains: washing, dressing, transferring, toileting, eating and continence, as well as time perception and spatial perception (22,30). All items were rated on a 4-point Likert scale ranging from 1 (totally independent/continent/oriented) to 4 (totally dependent/incontinent/disoriented). Based on the scores of the individual items, six overall categories of dependency were attributed, O, A, B, C, D, Cd. The categories of dependency were clearly defined by the government in order to control the nurse's assessment of the dependent person by the medical advisors of the social insurance agencies. Residents from category O were independent or at a low dependency level. Residents from category A were dependent for bathing, dressing and transfer or toileting. Residents from category B were dependent for bathing, dressing, transfer, toileting and continence or eating. Residents from category C have the highest score for at least five functions, except continence or eating, which may have a score 3. Residents from category Cd suffer additionally from dementia. The BESADL showed good concurrent validity with the Gerontologic Autonomy ISO Resource Groups system (AGGIR) ($r^2 = 0{\cdot}89$) and is correlated with the time spent for care for Activities of Daily Living (ADL) ($r^2 = 0{\cdot}65$). Cronbach's alpha coefficient is higher than 0·9. Test–retest and external reliability are good (coefficient kappa > 0·7) (31).

The EPUAP classification system for pressure ulcers was used to identify pressure ulcers and to distinguish between four categories of pressure ulcers. Pressure ulcer category (cat.) 1 was defined as blanchable erythema, cat. 2 as partial thickness loss, cat. 3 as full thickness loss and cat. 4 as full thickness loss with exposed bone, tendon or muscle (24,32).

The IAD Severity Categorisation Tool was used to identify IAD and to distinguish IAD lesions into three categories depending on the severity (Figure 1). IAD cat. 0 was defined as being at risk of IAD development without skin abnormalities; IAD cat. 1 was defined as erythema with intact skin; and IAD cat. 2 was defined as erythema with skin damage (5). The IAD Severity Categorisation Tool is currently being validated and compared to the pressure ulcer classification system developed by the National and the EPUAP (32).

Statistical methods/data analysis

Data were analysed using IBM® SPSS® Statistics (Version 23, IBM Corporation, New York, NY). All nominal and ordinal variables were described using frequencies. Normally distributed continuous variables were described using means and standard deviations (SD).

The interrater reliability for skin assessment (IAD category 0, 1, 2) between nurses and researchers was described for 10·0% of the participating residents using the kappa statistic.

The kappa statistic was interpreted according to the guidelines described by Landis and Koch (33).

Risk factors associated with the development of IAD cat. 2 were identified using binary logistic regression analyses. Variables significant at a level of $P < 0{\cdot}1$ in the univariate binary logistic regression were considered to integrate in a multivariate binary logistic regression model. In case of collinearity [$r \geq 0{\cdot}6$ (34)] between two variables, the variable correlating most with the dependent variable was entered into the regression model. Nagelkerke R^2 and Hosmer-Lemeshow statistic were calculated as a measure of model fit (35). The tolerance and variance inflation factor were calculated to determine linear relationships between the variables in the multivariate model (34). Results were significant at a level of $\alpha < 0{\cdot}05$.

Ethical approval and trial registering

The study was performed according to the ethical guidelines of the 1975 Declaration of Helsinki and approved by the Ethics Review Committee of Ghent University Hospital (B670201524231). Written and oral informed consent was obtained from all participating residents or their representatives. The study was registered at ClinicalTrial.gov (NCT02475512).

Results

Participants

A total of 381 nursing home residents participated in the study. The mean age of the participants was 85·3 years (SD 7·55), and 79·5% were female. A total of 49·4% of the participants were incontinent for urine; 0·9% were incontinent for stool; and 49·7% were incontinent for both urine and stool. The incidence of IAD category (cat.) 1 or 2 was 30·0%. The incidence of IAD cat. 2 was 6·0%. The interrater reliability of the identification and categorisation of IAD between nurses and researchers was sufficient [$\kappa = 0{\cdot}65$, 95% confidence interval (CI): 0·40–0·88]. Table 1 provides an overview of the sample characteristics.

Table 1 Characteristics of participants ($n = 381$)*

Females [*n* (%)]	303/381 (79·5)
Age (years) ($n = 346$)	
Mean (SD)	85·3 (7·55)
Range	51–102
BMI (kg/m^2) ($n = 330$)	
Mean (SD)	25·0 (5·40)
Range	13·1–46·0
Braden score ($n = 342$)	
Mean (SD)	15·6 (3·21)
Range	6–23
Risk of pressure ulcers [*n* (%)]†	205/342 (59·9)
Type of incontinence	
Urinary incontinence only [*n* (%)]	174/352 (49·4)
Faecal incontinence only [*n* (%)]	3/352 (0·9)
Urinary and faecal incontinence [*n* (%)]	175/352 (49·7)
IAD incidence (cat. 1 or 2) [*n* (%)]‡, §	96/320 (30·0%)
IAD cat. 2 incidence [*n* (%)]‡	23/381 (6·0)

SD, standard deviation; IAD, incontinence-associated dermatitis; cat., category.

*Data were collected by the head nurses (except for IAD incidence). Not all data were available/obtained from all residents.

†Risk of pressure ulcers: Braden < 17.

‡Cat. 1: erythema with intact skin, cat. 2: erythema with skin damage.

§Residents with IAD cat. 1 at baseline were excluded to calculate IAD incidence.

Risk factors associated with the development of skin erosion (IAD cat. 2)

Univariate binary logistic regression analyses revealed statistically significant associations between the development of IAD cat. 2 and dependency for transferring [odds ratio (OR) 2·402, 95% CI 1·153–5·007], dependency for toileting (OR 3·101, 95% CI 1·137–8·456), risk of developing pressure ulcers (OR 6·497, 95% CI 1·483–28·472), scores on the Braden subscales activity (OR 0·202, 95% CI 0·088–0·465), moisture (OR 0·580, 95% CI 0·355–0·947), mobility (OR 0·206, 95% CI 0·092–0·461) and friction and shear (OR 0·264, 95% CI 0·130–0·537), double incontinence (OR 3·637, 95% CI 1·311–10·090) and IAD cat. 1 (OR 3·783, 95% CI 1·557–9·189) (Table 2).

Multicollinearity ($r \geq 0{\cdot}6$) was determined between the variables 'dependency for transferring' and 'dependency for toileting', between 'dependency for transferring' and the Braden subscale 'mobility', between the Braden subscale 'activity' and the Braden subscale 'mobility' and between the total Braden score and the subscales 'activity' and 'mobility'. The variables 'dependency for toileting' and 'mobility' correlated the most with the dependent variable 'IAD cat. 2' and were selected to enter in the multivariate binary logistic regression model.

Eight risk factors were aggregated into a multivariate binary logistic regression model: 'dependency for toileting'; the Braden subscales 'mobility', 'moisture' and 'friction and shear'; 'incontinence (urine/double)'; 'rate of urine incontinence'; 'loose or liquid stool (Bristol 6 or 7)'; and 'IAD cat. 1' (Table 3). The MNA score was removed from the model because of a high amount of missing data (93/381, 24·4%). The presence of IAD cat. 1 at baseline (OR 3·017, 95% CI 1·043–8·729), a lower (=worse) score on the Braden subscales 'mobility' (OR 0·367, 95% CI 0·144–0·935) and 'friction and shear' (OR 0·393, 95% CI 0·158–0·981) were independently associated with the development of IAD cat. 2. The regression model explained 22·0% of the variance in IAD incidence (Nagelkerke's R^2 0·220). The model prediction was not significantly different from the observed values (Hosemer-Lemeshow 3·172, degrees of freedom 8, $P = 0{\cdot}923$). The tolerance values were above 0·6, indicating acceptable correlations between the independent variables (34).

Discussion

This study identified characteristics of nursing home residents associated with a higher risk of developing IAD. The risk factors included physical as well as functional characteristics. Limited mobility, IAD category (cat.) 1 (erythema with intact skin) and friction and shear problems were independently associated with IAD development in a multivariate binary logistic regression model. Our results provide necessary knowledge

Table 2 Univariate binary logistic regression for association between possible risk factor and IAD category 2

	IAD cat. 2 incidence			
	n (%)*	*P* value	OR†	95% CI†
Gender		0·706		
Men	4/78 (5·1%)			
Women‡	19/303 (6·3%)			
Age		0·386		
Dependency (BESADL)§		0·913		
O/A/B/D‡	0/36 (0·0%)			
C	5/62 (8·1%)			
Cd	17/260 (6·5%)			
Dependency for bathing (BESADL)¶		0·998		
3	0/4 (0·0%)			
4	21/325 (6·5%)			
Dependency for dressing (BESADL)¶		0·997		
1	0/1 (0·0%)			
2	0/3 (0·0%)			
3	0/45 (0·0%)			
4	21/317 (6·6%)			
Dependency for transferring (BESADL)¶		0·019	2·402	1·153–5·007
1	0/27 (0·0%)			
2	0/44 (0·0%)			
3	8/149 (5·4%)			
4	12/145 (8·3%)			
Dependency for toileting (BESADL)¶		0·027	3·101	1·137–8·456
1	0/13 (0·0%)			
2	0/25 (0·0%)			
3	4/120 (3·3%)			
4	17/208 (8·2%)			
Continence (BESADL)¶		0·200		
3	10/232 (4·3%)			
4	10/133 (7·5%)			
Dependency for eating (BESADL)¶		0·367		
1	3/37 (8·1%)			
2	7 /169 (4·1%)			
3	6/115 (5·2%)			
4	5/45 (11·1%)			
Time perception (BESADL)¶		0·631		
1	4/40 (10·0%)			
2	1/45 (2·2%)			
3	6/173 (3·5%)			
4	10/108 (9·3%)			
Spatial perception (BESADL)¶		0·830		
1	5/47 (10·6%)			
2	0/42 (0·0%)			
3	7/170 (4·1%)			
4	9/103 (8·7%)			
BMI		0·812		
Medication				
Immunosupressants		0·641		
Yes	1/23 (4·3%)			
No‡	20/290 (6·9%)			
Sedatives		0·890		
Yes	14/216 (6·5%)			
No‡	8/131 (6·1%)			
Corticosteroids		0·163		
Yes	3/20 (15·0%)			
No‡	19/293 (6·5%)			
Laxatives		0·908		
Yes	14/228 (6·1%)			
No‡	8/124 (6·5%)			
Diuretics		0·553		
Yes	10/133 (7·5%)			
No‡	12/204 (5·9%)			
Comorbidities				
Dementia		0·466		
Yes	17/261 (6·5%)			
No‡	5/110 (4·5%)			
Diabetes		0·821		
Yes	4/61 (6·6%)			
No‡	18/310 (5·8%)			

Table 2 Continued

	IAD cat. 2 incidence			
	n (%)*	*P* value	OR†	95% CI†
Cerebrovascular accident		0·677		
Yes	4/56 (7·1%)			
No‡	18/315 (5·7%)			
Heart failure		0·540		
Yes	3/69 (4·3%)			
No‡	19/302 (6·3%)			
Skin pathology		0·645		
Yes	3/64 (4·7%)			
No‡	19/307 (6·2%)			
MNA		0·059		
Undernourished	6/78 (7·7%)			
At risk of undernutrition	7/172 (4·1%)			
No undernutrition	0/38 (0·0%)			
Mobility (MNA)		0·996		
Bed or chair bound	22/246 (8·9)			
Can leave bed or chair independently but doesn't go out	0/95 (0·0)			
Can go out independently	0/18 (0·0)			
Weight loss (MNA)		0·885		
>3 kg	2/26 (7·7)			
Don't know	0/17 (0·0)			
Between 1 and 3 kg	6/84 (7·1)			
No weight loss	13/233 (5·6)			
At risk of pressure ulcers (Braden score < 17)		0·013	6·497	1·483–28·472
Yes	18/205 (8·8%)			
No‡	2/137 (1·5%)			
Sensory perception (Braden)		0·687		
Completely limited	0/25 (0·0%)			
Very limited	5/71 (7·0%)			
Slightly limited	8/113 (7·1%)			
No impairment	8/143 (5·6%)			
Activity (Braden)		<0·001	0·202	0·088–0·465
Bedfast	4/20 (20·0%)			
Chairfast	18/209 (8·6%)			

Table 2 Continued

	IAD cat. 2 incidence			
	n (%)*	*P* value	OR†	95% CI†
Walks occasionally	0/79 (0·0%)			
Walks frequently	0/52 (0·0%)			
Moisture (Braden)		0·03	0·580	0·355–0·947
Constantly moist	3/29 (10·3%)			
Very moist	11/99 (11·1%)			
Occasionally moist	3/146 (2·1%)			
Rarely moist	4/85 (4·7%)			
Nutrition (Braden)		0·685		
Very poor	3/15 (20·0%)			
Probably inadequate	3/80 (3·8%)			
Adequate	11/199 (5·5%)			
Excellent	5/67 (7·5%)			
Mobility (Braden)		<0·001	0·206	0·092–0·461
Completely immobile	16/101 (15·8%)			
Very limited	5/152 (3·3%)			
Slightly limited	1/83 (1·2%)			
No limitation	0/26 (0·0%)			
Friction and shear (Braden)		<0·001	0·264	0·130–0·537
Problem	5/32 (15·6%)			
Potential problem	15/175 (8·6%)			
No apparent problem	1/150 (0·7%)			
Incontinence (Urine/double)				
Urine‡	5/174 (2·9%)			
Double	17/175 (9·7%)	0·013	3·637	1·311–10·090
Urine incontinence		0·055		
Never	0/6 (0·0%)			
Sometimes	2/80 (2·5%)			
Mostly	9/152 (5·9%)			
Always	11/125 (8·8%)			
Faecal incontinence		0·124		
Never	2/97 (2·1%)			
Sometimes	10/128 (7·8%)			
Mostly	6/60 (10·0%)			

Table 2 Continued

	IAD cat. 2 incidence			
	n (%)*	*P* value	OR†	95% CI†
Always	4/55 (7·3%)			
Liquid stool (Bristol 7)		0·660		
Yes	7/101 (6·9%)			
No‡	16/280 (5·7%)			
Loose or liquid stool (Bristol 6 of 7)		0·050	2·749	0·999–7·567
Yes	18/221 (8·1%)			
No‡	5/160 (3·1%)			
Fever		0·099		
Yes	3/20 (15·0%)			
No‡	20/361 (5·5%)			
Antibiotics		0·586		
Yes	2/47 (4·3%)			
No‡	21/334 (6·3%)			
IAD cat. 1 at baseline|		0·003	3·783	1·557–9·189
Yes	9/61 (14·8%)			
No‡	14/320 (4·4%)			
Pressure ulcer cat. 1 at baseline|		0·501		
Yes	1/31 (3·2%)			
No‡	22/350 (6·3%)			
Dry skin at baseline		0·937		
Yes	6/101 (5·9%)			
No‡	15/262 (5·7%)			
Wash method		0·148		
Soap and water	8/189 (4·2%)			
Washing without water (wipes)‡	15/192 (7·8%)			

IAD, incontinence-associated dermatitis; Cat., category; OR, odds ratio; 95% CI, 95% confidence interval; SD, standard deviation; BESADL, Belgian Evaluation Scale for Activities of Daily Living; BMI, body mass index; MNA, mini nutritional assessment.

*Not all data were obtained for all participants.

†These fields were only completed if *P* value < 0·05.

‡Reference category.

§According to the BESADL, which is adapted from the Katz Index. (20,21,28) Residents from category A are the least dependent, residents from category C are completely dependent and residents from category Cd suffer additionally from dementia.

¶According to the BESADL, score 1: independent/continent/oriented, score 4: completely dependent/incontinent/disoriented.

|IAD cat. 1: erythema with intact skin (5); Pressure ulcer cat. 1: non-blanchable erythema (22,30).

to guide interventions for preventing IAD in nursing home residents.

The IAD incidence of 30% determined in our study was much higher than in other studies. In a long-term acute care facility, Long, Reed (36) described an IAD incidence of 7·6% using a mixed sample of continent and incontinent patients. Bliss, Zehrer (37) described an incidence of 3·4% in 16 nursing homes using barrier products as part of a standard IAD prevention regimen. A possible explanation for the difference in IAD incidence is the inclusion of the most care-dependent residents who were at the same time mostly or always incontinent for urine or stool in our study. Care dependency was found to be a risk factor for IAD development in two large-scale prevalence studies (12,13). One of these studies also determined the amount of urine loss as a risk factor for IAD development (13). Furthermore, in our study, barrier products (skin protectants) were not used as standard prevention in incontinent residents, but in half of the residents, washing without water was implemented. The high IAD incidence illustrates the need for effective interventions for preventing IAD in incontinent, care-dependent nursing homes residents.

It is known from literature that nurses experience difficulties in distinguishing IAD from pressure ulcers (38,39). In our prospective study, researchers made several attempts to enhance the correct identification of IAD events: use of the IAD Severity Categorisation Tool (5), interactive education in small groups using the EPUAP PUCLAS3 (24), availability of educational documents on the wards, regular ward visits combined with supplementary skin assessments by the researcher and daily reachability of the researcher by e-mail or phone. These attempts may have improved the detection of IAD lesions, contributing to the higher IAD incidence found in our study.

In contrast to the study of Beeckman, Defloor (40), we found no significant differences in IAD outcome between residents being washed without water or with water and pH-neutral soap. A possible explanation could be the difference in study population. In our study, more participants were double incontinent (49·7%) compared to the study of Beeckman, Defloor (40) (10·0%). This finding underpins the need for interventions specifically targeted at residents at a higher risk of IAD development (e.g. residents with double incontinence).

Our results confirm the role of double incontinence in the development of IAD as identified by Bliss, Savik (12) and Kottner, Blume-Peytavi (13). Faeces contain digestive enzymes (lipases and proteases) that break down the intercellular lipids and proteins and disrupt the skin barrier function (4,9). Urine contains urea, which is transformed into ammonium by urease, an enzyme produced by bacteria in faeces. Ammonium causes an increase in skin surface pH (9). The presence of an alkaline pH exacerbates enzymatic activity and irritation of the skin (4). Other studies also identified faecal incontinence only as a risk factor for IAD development (13,41). However, in our study, all but three residents with faecal incontinence were double incontinent, so it was not possible to study the influence of faecal incontinence separately. Faecal and double incontinence are causes of IAD that were easy to observe and should alert care providers to take appropriate preventive measurements.

A systematic review and meta-analysis concluded that IAD was a risk factor for the development of pressure ulcers (11).

Table 3 Multivariate binary logistic regression for associations between possible risk factors and IAD category 2*

	Beta coefficient	Standard error	Wald statistic	OR (95% CI)	*P* value	Tolerance	Variance inflation factor
Dependency for toileting	0·373	0·547	0·465	1·452 (0·497–4·239)	0·495	0·723	1·383
Incontinence (urine/double)	0·705	0·615	1·314	2·025 (0·606–6·766)	0·252	0·742	1·348
Loose or liquid stool	0·358	0·621	0·333	1·431 (0·424–4·831)	0·564	0·856	1·169
IAD cat. 1†	1·104	0·542	4·149	3·017 (1·043–8·729)	0·042	0·965	1·036
Moisture	0·112	0·281	0·158	1·118 (0·644–1·940)	0·691	0·865	1·156
Mobility	−1·001	0·476	4·417	0·367 (0·144–0·935)‡	0·036	0·609	1·643
Friction and shear	−0·933	0·466	4·001	0·393 (0·158–0·981)‡	0·045	0·682	1·466
Rate of urinary incontinence	−0·427	0·413	1·068	0·653 (0·291–1·466)	0·301	0·712	1·405
Constant	−0·474	2·887	0·027	0·623	0·870		

OR, odds ratio; 95% CI, 95% confidence interval; IAD, incontinence-associated dermatitis; cat., category.

*Nagelkerke $R^2 = 0{\cdot}220$.

†IAD cat. 1: erythema with intact skin.

‡The Braden subscales (moisture, mobility, friction and shear) range from the worst condition (score 1) to the best condition (score 4). Residents with compromised mobility and residents with more friction and shear problems have a higher risk of developing IAD cat. 2. The inverse OR (95% CI) of 'mobility' is 2·725 (1·070–6·944), the inverse OR (95% CI) of friction and shear is 2·545 (1·019–6·329).

In our study, four of six subscales of the Braden scale (used to identify patients at risk of pressure ulcers) were associated with the development of IAD. In a much larger study, all six Braden subscales were found to be associated with IAD prevalence (13). Furthermore, in our study and in two other studies, the score on the Braden subscale 'friction and shear' was found to be independently associated with IAD incidence and prevalence using a multivariate binary logistic regression model (12,13). According to Luboz, Perrier (42), exposure to moisture and irritants contributes to an increase of the coefficient of friction and to changes in tissue stiffness. In addition, inflammation is associated with a local increase in skin temperature. As a consequence, the cutaneous resistance against tissue deformation is further diminished (42). The findings above illustrated that residents at risk of developing IAD were also likely to be at risk of developing pressure ulcers. However, pressure ulcer risk assessment tools were not recommended to identify residents at risk of IAD (5). When developing and implementing interventions for preventing IAD, particular attention should be paid to incontinent residents at risk of pressure ulcers.

IAD prevalence studies identified body mass index, (13) diabetes (13), score on the Braden subscale 'nutrition' (13), score on the Braden subscale 'sensory perception' (13) and temperature (12) as risk factors for IAD development. However, in our study, these variables were not associated with the development of IAD category 2. A possible explanation is a lack of power because of a smaller sample size. On the other hand, clear differences in study population were determined: in our study, only nursing home residents were included; all participants were incontinent; a higher proportion of incontinent participants were double incontinent (49·7%); and IAD incidence was rather high (30·0%). These differences in study population may have resulted in differences in risk factors identified.

Our study identified a trend ($P = 0{\cdot}059$) towards a significant association between poor nutritional status and IAD category 2. Previous research supported the association of poor nutritional status with IAD development. Junkin and Selekof (25) identified patients with a poor nutritional status, defined as low serum albumin, to be at a higher risk of IAD. In the study of Bliss, Savik (12), residents requiring nutritional support and residents with three or more nutritional problems had a higher risk of developing IAD. In the study of Kottner, Blume-Peytavi (13), elderly persons with IAD had a lower score on the Braden subscale 'nutrition'. A poor nutritional status diminishes tissue tolerance, which increases the likelihood of developing IAD (43). Prevention of malnutrition is a quality improvement issue in nursing homes (44), which also benefits the prevention of IAD.

Results from our multivariate binary logistic regression model and the model from Kottner, Blume-Peytavi (13) suggest the presence of supplementary (unknown) risk factors. Future studies should make attempts to track and study other possible risk factors than the risk factors already known. One of these possible risk factors not studied yet is the ratio of staff to residents. Large-scale studies performed in hospitals indicated an association between the ratio of staff to patients and nursing care left undone (45–47). Other studies determined that a low staff to patient ratio negatively influenced nurses' perceived patient safety and nurses' perceived quality of care (48,49). Prevention of IAD includes regular changes of incontinence pads and diapers to limit the exposure of the skin to urine and stool (9,15). IAD is likely to develop if pad and diaper changes were performed less frequently (e.g. because of inadequate staffing levels).

Conclusion

The risk factors identified in this study can guide care providers to target preventive skin care interventions for residents at high risk of IAD. Particular attention should be paid to residents with severe restrictions in mobility, difficulties with repositioning themselves and the presence of erythema due to incontinence (IAD category 1). Large-scale studies with a priori sample size calculations are needed to identify other existing risk factors. Furthermore, attempts should be made to track and study other possible risk factors than the risk factors already known.

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