



Organizational factors of fall injuries among residents within German nursing homes: secondary analyses of cross-sectional data

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Abstract

The present study explored risk factors for fall injuries among nursing home residents, with a specific focus on the influence of organizational structure within facilities and their environment, which have been insufficiently investigated in the European context. For the analyses, secondary data collected in 2016 from 220 nursing homes across Germany were used. As a risk adjustment, two separate models were calculated for fall injuries among residents without ($N = 7320$) and with cognitive impairment ($N = 8633$). Results showed that residents without cognitive impairment had a decreased risk of fall injuries by 40.1% ($P < 0.01$), while those with cognitive impairment were at an increased risk of 23.8% ($P < 0.05$) when living in facilities that had dementia care units. However, disparities were found between federal states for both groups of residents ($P < 0.05$ vs. $P < 0.01$, respectively). Similarly, a higher proportion of registered nurses were associated with decreased risk of fall injuries among cognitively impaired residents (45.6%), which differed between federal states ($P < 0.01$). Facilities with homelike environments had a 16.7% ($P < 0.05$) lower risk of fall injuries among cognitively impaired residents than did traditionally organized facilities. Further research is needed to explain the disparities between German federal states using representative samples.

Keywords Adverse care outcome · Fall injury · Older adult · Long-term care

Introduction

Falls and fall injuries (FIs) among older adults constitute major healthcare problems, which occur frequently in nursing facilities (Botwinick et al. 2016; Lannering et al. 2016). Older adults living in nursing homes belong to a vulnerable population subgroup, with several individual characteristics identified as risk factors for falls and FIs, including increasing age (Schulz et al. 2017; Mackenzie and Byles 2018),

high care dependency (Seijo-Martinez et al. 2016; Towne et al. 2017), history of previous falls (Ambrose et al. 2013; Bloch et al. 2013), and use of multiple medicines (Bor et al. 2017; Hanlon et al. 2017). Comparing older adults hospitalized owing to falls, nursing home residents experience more in-hospital complications (e.g., pneumonia, sepsis, urinary tract infection) and longer hospital stays than those living at home (Botwinick et al. 2016). Further studies suggest that the most common consequences of FIs among older adults are death (Galet et al. 2018), permanent loss or longer-lasting deterioration of mobility (Hartholt et al. 2011; Botwinick et al. 2016), or increased fear of falling (Iglesias et al. 2009).

Despite widespread research on individual risk factors for falls and FIs (Ambrose et al. 2013; Bloch et al. 2013; Boelens et al. 2013), few recent studies have examined organizational risk factors, including the impact of structural and procedural risk factors for healthcare institutions (Kalisch et al. 2012; Kropelin et al. 2013; Horn et al. 2016; Andersson et al. 2018). According to a literature review by Boelens et al. (2013), unlike the individual risk factors for falling and FIs, the majority of organization-related factors are modifiable (e.g., slippery floors, bad lighting,

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mobile objects, furniture). Additionally, no prior study has investigated risk factors for falls and FIs as related to the organizational environment. Considering falls and FIs as adverse care outcomes, most empirical studies on organizational and environmental factors have been conducted in the USA; European nursing homes remain underexplored in this field (Comondore et al. 2009; Spilsbury et al. 2011; Backhaus et al. 2014). In Germany, few studies have examined organization-related factors associated with adverse care outcomes in nursing homes (Meyer et al. 2009; Rapp et al. 2009, 2012; Büchele et al. 2014; Zimmermann and Pfaff 2018). Thus, the aim of the current study was to contribute to this research area by further investigating organizational and environmental risk factors for FIs among older adults living in nursing homes.

Conceptual framework

To identify relevant FI risk factors, the theoretical *throughput model* from Schrappe and Pfaff (2016) was applied, which is based on the System Theory (Luhmann 1995). The model considers healthcare as a social system comprising diverse elements that are interconnected and interact with the system's environment. Adapting the throughput model to FIs in nursing homes, two kinds of system-related risk factors can be distinguished: input and throughput factors (Fig. 1).

Input factors refer to the resources of stakeholders, including characteristics of service providers, patients, and the organizational environment (Schrappe and Pfaff 2016). Previous research revealed that staffing of certified nursing assistants was negatively associated with fall-related fractures (Spector et al. 2007), as well as falls among nursing home residents (Horn et al. 2016). Kimmey and Stearns (2015) reported a lower likelihood of falls within nursing facilities with higher (vs. lower) staffing levels of registered

nurses (RNs). A hospital-based study revealed a negative association between working hours of nursing staff per resident day and frequency of patient falls (Kalisch et al. 2012). Furthermore, previous studies reported high FI occurrence among nursing home residents during the first months after their institutional admission (Rapp et al. 2009; Mackenzie and Byles 2018). Two studies identified mid-morning as the time of the day during which the most falls (Rapp et al. 2012) and FI incidences occurred in German nursing homes (Büchele et al. 2014).

The assumption of the throughput model that the organizational environment (e.g., geographical location, economic conditions, labor market) influences the organizational outcomes is supported by previous nursing home research (Spilsbury et al. 2011; Dellefield et al. 2015). Nevertheless, recent studies on falls and FIs have not yet taken environmental risk factors into account (Kimmey and Stearns 2015; Horn et al. 2016; Mackenzie and Byles 2018). Previous studies focusing on other care outcomes showed that nursing homes located in southern US states received more frequent citations for quality deficiencies when compared to other regions (Mor et al. 2004; Kim et al. 2009). Additionally, there is evidence that nursing facilities located in the US states with lower reimbursement rates of care costs for low-income population (Medicaid payment rate) had higher incidences of pressure ulcers and physical restraints (Grabowski et al. 2004), as well as more health-related deficiency citations (Mor et al. 2004).

Throughput factors were understood as performance components for nursing care involving the application of specific nursing approaches, techniques, and practices. One of the most relevant throughput factors related to falls and FIs is the use of physical restraints (Meyer et al. 2009; Luo et al. 2011; Kropelin et al. 2013), which contributes to the loss of muscle strength, balance, cognitive abilities, and depression (Hamers 2017). Andersson

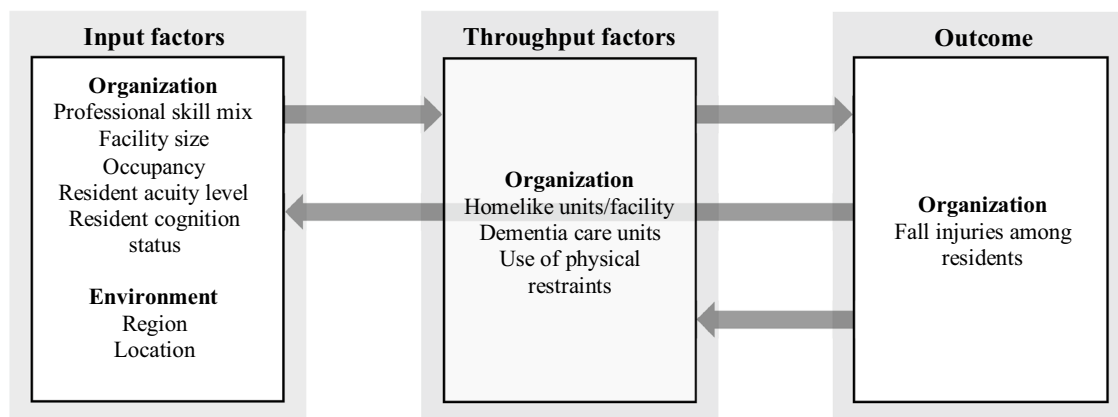


Fig. 1 Throughput model adapted from Schrappe and Pfaff (2016): Organization-related predictors of fall injuries among nursing home residents

et al. (2018) observed that certain nursing processes (e.g., teamwork failure, inadequate communication among staff, insufficient clinical assessment, and mistakes in care documentations) were negatively associated with fall occurrence within Swedish nursing homes. Further studies compared nursing home outcomes for specific care approaches such as delivering dementia care in spatially separated units (dementia care units; DCUs) or providing care in homelike units (HLUs). Two studies, which considered fall rates, reported no statistically significant differences between DCUs and traditional care units (Oppikofer et al. 2005; Nobili et al. 2008). Considering other care outcomes, Kok et al. (2013) identified improved functional abilities and higher quality of life among residents in DCUs, whereas fewer behavior problems were observed in traditional care units. Similarly, the only large-scaled German study revealed lower physical restraint use, more social interactions with personnel, higher participation in activities, as well as lower use of antipsychotics by residents living in DCUs; however, residents in traditional units used fewer antidepressants (Weyerer et al. 2010). Conversely, Meyer et al. (2009) found no association between the presence of DCUs and the use of physical restraints in German nursing homes.

The nursing care approach of homelike organized facilities (or HLUs) differs substantially from traditional care concepts. In German HLUs, care staff live together with a small group of residents (maximum 8–12 persons) and provide person-centered care, which involves stimulating, encouraging, and supporting residents' remaining strengths (Verbeek et al. 2009). Traditional nursing homes mostly employ a "medical care concept" with a focus on disease treatment. Comparing HLUs and common US nursing home units, Horn et al. (2016) observed no significant differences in fall occurrence; however, there were more interactions among staff and greater coverage of certified nursing assistants per resident day in HLUs. Comparing the quality of life in residents with dementia living in HLUs and traditional nursing homes, positive effects of both units were reported by de Rooij et al. (2012), whereas other studies found no differences (Verbeek et al. 2010; Auer et al. 2017). To date, no research on the effects of HLUs has been carried out in German nursing homes.

Considering the latest research evidence, little is known regarding the effect of organizational input and throughput factors on the occurrence of FIs in nursing homes. Therefore, the current study investigated: (1) whether organizational factors (especially staff mix, HLU, and DCU) influence the occurrence of FIs and (2) whether there is an effect of organizational environment (geographical location) on FI occurrence in German nursing homes.

Methods

Data source

Secondary data from the Project "Ergebnisqualität in der stationären Altenhilfe – EQisA" (translated as "quality outcomes in inpatient elderly care") were used. EQisA was a cooperative project of the Diocesan Caritas Association in Cologne (DCA) and the Institute for Nursing Studies at Bielefeld University (INS), which was designed to examine and evaluate quality outcomes within nursing homes. The quality outcome assessment tool used was developed on behalf of the Federal Ministry of Health and the Federal Ministry for Family Affairs, Senior Citizens, Women, and Youth in Germany (Wingefeld et al. 2011). Specially trained nursing staff collected the quality outcomes data, whereas nursing home directors reported on organizational characteristics of the facilities. Standardized questionnaires were used for both. Residents included in the survey had signed a declaration of consent to participate in the EQisA. The evaluation of the quality and traceability of the collected data was carried out through statistical plausibility checks provided by INS and local audits conducted by the project management of the DCA (Kelleter 2017). Moreover, the project was controlled, advised upon, and continuously approved by an external consultant and expert group.

For the present analyses, selected data were available, which were collected in spring 2016. Our study sample included 220 nursing homes with 18,985 residents. All facilities agreed with using their data in aggregated form (at the facility level) for scientific purposes. The data were strictly pseudonymized through the project coordinators.

Model definition

Based on Wingefeld et al. (2011), *FIs* were defined in the EQisA as a proportion of residents who were seriously injured by falling in the nursing home within a 6-month period prior to the reporting date. Similar to other studies (Bücheler et al. 2014; Towne et al. 2017), all fall-related injuries requiring medical treatment, including fractures, wounds, and persistent pain, were considered serious FIs. The German care documentary defines a fall as "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" (World Health Organization 2007, p. 1). Following this definition, residents who could not change their position in bed were excluded from the analyses and, for ethical reasons, residents receiving end-of-life care were not included (Wingefeld et al.

2011). A total of 3032 residents met the exclusion criteria, which means 15,953 residents were assessed for FI occurrence. Following Castle and Engberg (2008, p. 469), we operationalized FIs as “counts of specific negative events per nursing home, each divided by the number of residents at risk for that negative event.” In line with the recent literature (Kropelin et al. 2013), persons with no, or slight, cognitive impairment were regarded as low-risk residents (LRR), and those with at least considerable cognitive impairment were deemed high-risk residents (HRR). Similar to Castle and Engberg (2008), separate analyses were conducted for these two risk groups. For the assessment of cognitive abilities, a tool from Wingenfeld et al. (2008) was used, which served as the conceptual basis for the new definition of care dependency in Germany, introduced on January 1, 2017, as the Second Bill to Strengthen Long-Term Care.

One of the relevant input factors considered was *staff mix* defined as the number of RNs divided by the number of nursing assistants (NAs) and additional care staff (ACS), all measured in full-time equivalents. According to German regulatory requirements, at least 50% of all care and nursing staff in nursing homes must be qualified as RNs. In our study sample, the average RN ratio was 49.60%, comparable to the national average in 2015. German RNs are not required to have an academic education; rather, they must complete a three-year training in theoretical and practical nursing. RNs in leading positions must additionally absolve 460 h advanced training. NAs must be trained in nursing for one year, and ACS does not require any formal nursing training. RNs are responsible for the entire nursing processes and supervision of other nursing and care staff. NAs carry out simple treatments such as changing bandages, assisting with medication intake, or measuring blood pressure. ACS can accompany, support, and facilitate daily life activities for residents. Since the minimum staffing requirements differ between the German federal states, interaction terms of the most represented federal states with a staff mix were included in the analyses (North Rhine-Westphalia (NRW) \times staff mix, Bavaria \times staff mix).

The variable *region* was used to denote the federal state. The majority of nursing homes were located in Bavaria and NRW. Only 10% of the facilities were from other federal states (e.g., Baden-Wuerttemberg, Rhineland-Palatinate, Schleswig-Holstein, Hesse, and Saarland). Therefore, dummy variables were used in the analyses comparing one federal state (e.g., NRW) to all others (e.g., Bavaria, Baden-Wuerttemberg, etc.).

Regarding throughput factors, nursing facilities reported the care concept for dementia care and the availability of *HLUs*. The care of residents with dementia was delivered either 1) in spatially separated units where only residents with dementia lived (*DCUs*) or 2) in traditional care units

where residents with dementia lived together with those without cognitive impairment. The influence of federal state on FIs in nursing homes with *HLUs*, as well as *DCUs*, was explored by including interaction terms (NRW \times *HLUs*, Bavaria \times *HLUs*, NRW \times *DCUs*, and Bavaria \times *DCUs*).

To control for further possible organizational and environmental factors influencing care outcomes (Spilsbury et al. 2011; Dellefield et al. 2015), the analyses included *facility size*, *occupancy rate*, *rural/urban location*, and *resident case mix*. The resident case mix was calculated for each facility as the weighted index of mean resident dependency level defined in the German nursing insurance system. Additionally, the *restraint use ratio* was included as a control variable, which was defined as the ratio of wrist, ankle, and pelvis belt fixations applied to residents with cognitive impairment.

Analyses

The analyses were conducted in SPSS 23.0. First, we calculated descriptive summary measures for the independent and dependent variables (Table 1). In preparation for the planned regression analyses, possible multicollinearity was examined using variance inflation factors (VIFs). None of the VIFs exceeded a threshold of 2, indicating no issues with multicollinearity.

According to the data structure, grouped logistic regression analyses were employed. This was for the organizational level of all measured variables, implying that each facility determined a unique profile of covariates. Moreover, the outcome variables had a character of event counts, including low and zero numbers of observations, which cannot be treated as continuous variables using linear regression models (Long 1997). For each facility, the number of events (FIs) was divided by the number of trials (residents at risk), forming a new outcome variable that measured the percentage of events in each facility. To account for the number of trials, we entered each component of the likelihood function as a weight.

Owing to the grouped data structure, a Pearson's statistic was used as an overall measure of fit. Statistical inference was performed with Likelihood ratio tests and Wald confidence intervals, which followed approximately a Chi square distribution; therefore, its value divided by the number of degrees of freedom should be close to 1. In our case, the resulting values of the model for HRR were slightly above 1, which could indicate a problem of overdispersion due to the correlation of events within facilities. To obtain valid standard errors, the Huber-White cluster robust estimator was applied to this model. The resulting odds ratios were interpreted as approximate relative risks justified by the low incidence of FIs LRR (7.6%) and FIs HRR (13.0%); however, the approximation will be less precise in the latter case. For all tests and confidence intervals, the statistical

Table 1 Variables used in analyses ($N=220$)

Variable	Operational definition	N (%)	Median (Range)	Mean (SD)
Dependent variables				
Fall injuries LRR	Low-risk residents with fall injuries	553 (7.6) ^a	2 (0; 11)	
Fall injuries HRR	High-risk residents with fall injuries	1121 (13.0) ^b	5 (0; 19)	
Independent variables^c				
Staff mix	Ratio of RNs to NAs plus ACS			1.1 (0.5)
Homelike facilities/units	Presence of small, homelike units	44 (20.0)		
Dementia care units	Presence of separated dementia care units	65 (29.5)		
Region	North Rhine-Westphalia	79 (35.9)		
	Bavaria	119 (54.1)		
	Other federal states	22 (10.0)		
Control variables^c				
Location	Metropolitan	68 (30.9)		
	Urban	56 (25.5)		
	Rural	96 (43.6)		
Facility size	Number of beds			93.6 (35.6)
Occupancy	Occupancy rate			92.9 (11.7)
Resident case mix	Average resident dependency level (DL) per facility (1–5; 1 = no DL, 2 = DL 0, 3 = DL 1, 4 = DL 2, 5 = DL 3)			3.6 (0.3)
Restraint use	Percentage of belt fixations among cognitive disabled residents			3.0 (4.4)

LRR low-risk residents, HRR high-risk residents, RN registered nurse, NA nursing assistant, ACS additional care staff, DL dependency level

^aThe value refers to low-risk residents ($N=7320$)

^bThe value refers to high-risk residents ($N=8633$)

^cThe values are presented at the facility level ($N=220$)

significance level was set at $\alpha=0.05$. No adjustments were made for multiple statistical comparisons. In case of missing data, which occurred in the LRR model within one facility (2.2%), listwise deletion was applied.

As mentioned above, several interaction terms were included in each model and computed separately for the two most represented federal states (NRW and Bavaria). After model selection with respect to the interaction terms, the presented final models achieved the best measure of fit. If a continuous variable was involved (e.g., staff mix), a mean-centered variable was used to simplify the main effect interpretation.

Results

Fall injuries among low-risk residents

Living in nursing homes with DCUs outside Bavaria decreased the risk of FIs LRR by 40.1% ($P=0.003$). This result is significantly different from those in Bavaria ($P=0.017$), where living in a facility with DCUs was estimated to increase the risk of FIs LRR by 3.9% (calculated from regression coefficients of DCU and DCU \times Bavaria). LRR in facilities in rural areas had a significant risk increase

for FIs of 37.1% ($P=0.008$) compared with those located in metropolitan areas. Facility size was significantly associated with higher risk for FIs ($P=0.008$), where a rise of 1 bed in a facility showed an increased risk of FIs by 0.4%. Resident mix showed a significant association with FI risk ($P=0.018$), which was estimated to increase by 53.0% when average dependency level increased by 1 unit (see Table 2 for more details).

Fall injuries among high-risk residents

Outside NRW, an increase of 1 full-time employed RN in proportion to other staff raised the estimated risk of FIs HRR by 16.4%; however, in NRW, there was a decreased risk by 45.6% (calculated from regression coefficients of staff mix and staff mix \times NRW). This difference was significant ($P=0.001$). HRR in facilities with HLUs had a 16.7% ($P=0.033$) lower risk for FIs. Living in a facility with DCUs outside NRW increased the risk of FIs HRR by 23.8% ($P=0.015$). This result differed significantly from facilities in NRW ($P=0.002$), where HRR in facilities with DCUs had a 22.9% decreased risk of FIs (calculated from regression coefficients of DCU and DCU \times NRW). An increase of 1 bed in a facility was estimated to lower the risk of FIs HRR significantly ($P=0.017$) by 0.2% (see Table 3 for more details).

Table 2 Odds ratio of fall injuries among low-risk residents ($N=7320$)

Risk factors at facility level ($N=219$)	Regression coefficient	Odds ratio ^a	95% CI
Staff mix	0.164	1.179	0.946–1.469
Facilities without homelike units	Reference category		
HLU	0.103	1.109	0.891–1.379
Facilities with traditional care	Reference category		
DCU	−0.459	0.632**	0.465–0.860
Region			
Bavaria	0.223	1.250	0.962–1.623
Remaining federal states	Reference category		
Location			
Metropolitan	Reference category		
Urban	0.225	1.253	0.985–1.592
Rural	0.320	1.377**	1.088–1.743
Facility size	0.003	1.003**	1.001–1.006
Occupancy	0.008	1.008	0.999–1.018
Resident mix	0.415	1.514*	1.073–2.137
DCU × Bavaria	0.497	1.645*	1.093–2.475

HLU facilities with homelike units/based on homelike concept, DCU facilities with dementia care units, CI confidence interval

* $P < 0.05$; ** $P < 0.01$ (in bold)

^aDependent variable was number of fall injuries among low-risk residents divided by number of low-risk residents in a facility. Generalized linear model with binomial probability distribution and logit link (grouped logistic regression) was estimated; Pearson Chi square divided by degrees of freedom: 1.025

Table 3 Odds ratio of fall injuries among high-risk residents ($N=8633$)

Risk factors at facility level ($N=220$)	Regression coefficient	Odds ratio ^a	95% CI
Staff mix (centered)	0.152	1.164	0.993–1.364
Facilities without homelike units	Reference category		
HLU	−0.182	0.833*	0.705–0.985
Facilities with traditional care	Reference category		
DCU	0.213	1.237*	1.043–1.468
Region			
NRW	−0.087	0.917	0.745–1.128
Remaining federal states	Reference category		
Location			
Metropolitan	Reference category		
Urban	0.068	1.070	0.904–1.267
Rural	0.009	1.009	0.849–1.200
Facility size	−0.002	0.998*	0.996–1.000
Occupancy	−0.004	0.996	0.989–1.004
Resident mix	−0.100	0.905	0.729–1.123
Restraint use	0.000	1.000	0.988–1.013
DCU × NRW	−0.473	0.623**	0.464–0.837
Staff mix × NRW	−0.760	0.468**	0.293–0.746

HLU facilities with homelike units/based on homelike concept, DCU facilities with dementia care units, NRW North Rhine-Westphalia, CI confidence interval

* $P < 0.05$; ** $P < 0.01$ (in bold)

^aDependent variable was number of fall injuries among high-risk residents divided by number of high-risk residents in a facility. Generalized linear model with binomial probability distribution and logit link (grouped logistic regression with cluster robust standard errors) was estimated; Pearson Chi square divided by degrees of freedom: 1.104

Discussion

Applying the throughput model, the findings support our assumptions regarding the association between FI occurrence and both input (e.g., staff mix, facility size, resident mix, and region) and throughput factors (DCUs and HLUs). First, we observed a positive impact of a higher proportion of RNs on FI occurrence, which was limited to cognitively impaired residents and NRW facilities. Previous studies showed that inadequate RN staffing and inappropriate delegation of tasks to nursing staff without formal qualifications may increase the risk of errors in nursing processes (Bystedt et al. 2011; Andersson et al. 2018). Our findings may imply that NRW facilities are able to employ better-qualified nursing staff and invest more in their further qualifications, in comparison with those located in other federal states. This explanation would be consistent with results from Grabowski et al. (2004) and Mor et al. (2004), as the prices of NRW facilities are continuously rated as the second highest in Germany (Statistisches Bundesamt 2016, 2017). Thus, NRW facilities have more financial resources available than the majority of facilities in other federal states. Additionally, the association between RN staffing and FIs in NRW nursing homes might be mediated through the processes of delivering nursing care. As Kalisch et al. (2012) observed, the protective effect of higher staffing levels on patient falls was mediated by ambulation, patient assessment, call light response, and toileting assistance.

Taking the throughput factors into account, cognitively impaired residents living in nursing homes with HLUs experienced fewer FIs, regardless of the region of residence. This result may indicate that homelike environments and person-centered care might be more appropriate for residents with mental disorders than traditionally organized care. Previous studies found no association between nursing care outcomes comparing HLUs and traditional care units (Verbeek et al. 2010; Horn et al. 2016; Auer et al. 2017). However, there is evidence that the culture of resident-centered care, small care units for 6–10 residents, as well as the close collaboration of nursing staff with different qualifications decrease fall risk in nursing homes (Horn et al. 2016; Vandenberg et al. 2017). On the other hand, a possible selection bias and the low number of facilities with HLUs should be considered. There is also limited knowledge regarding the implementation of the HLU concept within the facilities as well as their admission criteria. Verbeek et al. (2009) pointed out that some HLUs are specialized for dementia care in Germany, whereas others include mixed resident groups.

Furthermore, the association between FI occurrence among residents without cognitive impairment and the

presence of DCUs significantly differed across federal states. The increased FI risk in Bavarian facilities with DCUs could indicate overstraining and lack of staff competencies to deal with residents with dementia (Kelleter 2017; Andersson et al. 2018). One consequence might be that nursing staff did not have enough time to care for those without cognitive impairment (Zúñiga et al. 2015). This result could be explained in terms of the variability and effectiveness of fall prevention measures applied within nursing facilities. The evaluation of a multifactorial fall and FI prevention program, which was implemented in almost 1000 Bavarian nursing homes, found no significant decline on femoral fractures (Schulz et al. 2017). No effect on hip fracture rate was also reported by Becker et al. (2003) who applied a similar intervention in six German nursing facilities. The authors of both studies argued that the lack of improvements in FI occurrence could be caused by insufficient education or a lack of motivation among nursing staff (Becker et al. 2003; Schulz et al. 2017).

The presence of DCUs lowered the FI risk among residents with cognitive disabilities. Nevertheless, this was only the case in nursing homes located in NRW. Similarly, Selbaek et al. (2008) found that regional disparities in care outcomes (e.g., depression, anxiety, antidepressants use) across Norwegian DCUs were likely to have resulted from differences in the implementation of care processes. This finding could also be in accordance with our assumption regarding better staff skills and qualification in providing dementia-sensitive care and higher effectiveness of fall prevention measures in NRW facilities. Although previous studies comparing DCUs and traditional units found no differences in fall rates and FIs among residents with dementia (Oppikofer et al. 2005; Nobili et al. 2008), there is evidence of higher satisfaction and decreased stress among the staff working in DCUs (Robison and Pillemer 2007). Higher work satisfaction and less work stress are often associated with positive care outcomes (Zúñiga et al. 2015; Berta et al. 2018).

A particular strength of the current study was the use of grouped logistic regression. This method allows for the consideration of all potential and actual FI cases within nursing homes, as facilities with more residents at high risk of falling also have a higher risk for actual FI occurrence. The data set contained very few missing values, even though the data were self-reported by nursing facilities. In addition, computing separate models for residents with and without cognitive impairment revealed that risk factors underlying FIs may differ between these two groups. Finally, the current study is the first in Germany to deal with the organizational and environmental risk factors for FIs in nursing homes.

A few study limitations need to be considered when interpreting the results. First, the use of secondary data, which were primarily collected for other research purposes, limited

the selection of variable we could analyze. In other words, we were not able to include all risk factors for FIs that have been identified as relevant in the literature. Therefore, we cannot exclude the influence of other risk factors (e.g., individual risk factors) on the occurrence of FIs. Second, we could not determine the unit where residents with dementia lived when a facility provided care for people with dementia in traditional units as well as in DCUs/HLUs. Third, since the participation of nursing facilities in the EQisA was voluntary, the possibility of sampling bias exists. All nursing homes were additionally affiliated with the Caritas Association (Catholic welfare organization), which means they must fulfill certain requirements, including following Christian values or providing superior service quality.

Despite these limitations, the present study indicates that FIs among nursing home residents might be associated with organizational risk factors that are avoidable and amendable. For a deeper understanding and a reasonable interpretation of the study results, further research based on representative samples is needed in Germany. Such research should include individual as well as additional organizational and environmental risk factors for falls and FIs. Furthermore, special attention should be paid to older adults with cognitive disabilities, whose numbers are expected to rise in the coming years. Evidence-based knowledge regarding organizational and environmental risk factors may help facility directors, quality managers, and policy-makers improve care quality and patient safety within healthcare facilities.

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Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflicts of interest.

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