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Age and sex differences in hospitalisation of nursing home residents: a systematic review

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ABSTRACT

Objectives: Nursing home residents (NHRs) are frequently suffering from multimorbidity, functional and cognitive impairment, often leading to hospital admissions. Studies have found that male NHRs are more often hospitalised. The influence of age is inconclusive. We aimed to investigate the epidemiology of hospitalisations in NHRs, particularly focusing on age-specific and sex-specific differences.

Design: A systematic review was performed in PubMed, CINAHL and Scopus. Quality of studies was assessed.

Setting: Studies conducted in nursing homes were included.

Participants: Nursing home residents.

Primary and secondary outcomes: Outcome measures were the prevalence, incidence or duration of all-cause hospitalisation by age or sex.

Results: We identified 21 studies, 13 were conducted in the USA. The proportion of residents being hospitalised ranged across studies from 6.8% to 45.7% for various time periods of follow-up. A total of 20 studies assessed the influence of sex and found that hospitalisations are more often in male NHRs. A total of 16 studies conducted multivariate analyses and the OR of hospitalisation for males was between 1.22 and 1.67. Overall, 18 studies assessed the influence of age. Some studies showed an increasing proportion of admissions with increasing age, but several studies also found decreasing hospitalisations above the age of about 80–85 years. 8 of 13 studies conducting multivariate analyses included age as a continuous variable. Only 1 study reported stratified analyses by age and sex. 2 studies investigating primary causes of hospitalisation stratified by sex found some differences in main diagnoses.

Discussion: Male NHRs are more often hospitalised than females, but reasons for that are not well investigated. The influence of age is less clear, but there seems to be no clear linear relationship between age and the proportion being hospitalised. Further studies should investigate age and sex differences in frequencies and reasons for hospitalisation in NHRs.

Strengths and limitations of this study

- This review combines current knowledge on age and sex differences in hospitalisation of nursing home residents (NHRs).
- We provide evidence that the prevalence of hospitalisations ranged across studies. All studies found that males are more often hospitalised than female NHRs and that the influence of age is not yet clear.
- There is currently no evidence on reasons for sex differences in hospitalisations of NHRs.
- A clear limitation is that the studies used quite different age groups or that they included age as a continuous variable in regression analyses and that very few studies stratified their results by age and sex.

INTRODUCTION

Nursing home residents (NHRs) are frequently suffering from substantial multimorbidity,[1 2] polypharmacy[3 4] as well as functional and cognitive impairment.[5 6] NHRs also have a higher frequency of emergency department (ED) presentations and hospital admissions when compared with their community-dwelling peers.[7 8] However, hospital transfers in this population are often avoidable,[9 10] frequently result in unintended consequences like greater cognitive and functional decline or hospital-acquired infections[7 11] and lead to a substantial economic burden.[7 12]

Although NHRs represent a wide range of age groups (typically between 65 and 100 years) and about three-quarters are women with an higher proportion in older age classes,[2 4 5 13] data on care needs, chronic medical conditions and service usage are usually presented in aggregate for both sexes and potential differences between age groups are also often not considered.[14] This is surprising because there is evidence that such patterns differ between age groups and sexes in analyses of NHRs.[4 14 15]

This is also the case for the epidemiology of hospitalisations of NHRs and there are two older reviews examining articles published until 1995[16] and 2006.[17] The most recent review revealed that the proportion of

NHRs being hospitalised vary widely between 9% and 59% across studies and concluded that male NHRs are more likely to be hospitalised than females.[17] Reasons for that are not clear. Furthermore, not all studies conducted sex-specific analyses and the influence of age on hospitalisation of NHRs is inconclusive. Although Grabowski *et al*[17] concluded in their review that age is generally positively associated with hospitalisations of NHRs, some studies found decreasing rates above the age of about 80–85 years.[18–20] Another issue is whether there are sex differences by age or in other predictors of hospitalisation. Taken together, of the substantial number of studies on hospitalisations of NHRs included in the earlier review of Grabowski *et al*,[17] only very few present age-specific or sex-specific analyses. Furthermore, these sociodemographic factors are only discussed briefly because the authors focused on facility and policy characteristics associated with hospitalisations of NHRs.

The objective of this systematic review was to investigate data on the prevalence and incidence of hospitalisations in NHRs, particularly focusing on age-specific and sex-specific differences. Analysing age- and sex-dependent patterns is a prerequisite to understand care needs, to identify areas of unmet needs and to optimise care.

METHODS

A systematic literature search was performed on articles published on or before 29 July 2015 (updated on 27 May 2016). Data were identified from three electronic databases: PubMed, CINAHL Ebsco and Scopus. Relevant literature was identified by using MeSH terms and text words in title and abstract. Search terms for *NHR* were combined with terms for *hospitalisation* (see online supplementary appendix for the search strategy). Only articles published in English or German were considered. There was no limitation regarding the time period.

Inclusion and exclusion criteria

Studies were included if they reported the prevalence, incidence or duration of all-cause hospitalisation within NHRs and conducted age-specific or sex-specific analyses of hospitalisation or included one of these variables in crude or multivariate models. Studies were excluded if they were restricted to specific groups of NHRs (eg, dementia patients) or cause-specific hospitalisations (eg, femur fractures).

Hospitalisation was defined according to the definition of Castle and Mor. They recommended that studies have to 'include residents discharged from the nursing home to an acute-care hospital for at least 24 hours. This includes emergency and nonemergency transfers but excludes transfers to other long-term or continuing-care facilities such as other nursing homes or rehabilitation hospitals. Furthermore, residents who are discharged to a hospital in a moribund condition or are dead on arrival should be excluded […]'.[16]

Study selection and data extraction

After removing the duplicates, two reviewers (FH and KA) independently identified articles based on title and abstract for inclusion or exclusion. The full text of all articles that met the inclusion criteria were assessed by the same reviewers. Any disagreement was resolved by discussion. In addition, the reference lists of all included articles were screened to identify further articles of relevance. Data extraction was performed by one reviewer (KA) and verified by a second (FH).

Quality assessment

The methodological quality of each study was assessed independently by the two authors using an adapted version of the prevalence critical appraisal instrument from the Joanna Briggs Institute (JBI).[21] Questions 9 and 10 of the instrument (concerning subgroups) were removed as they were not relevant for the systematic review, resulting in a tool of eight quality criteria. Any disagreement between the two authors was resolved by discussion.

RESULTS

Study characteristics

After excluding duplicates, the search strategy resulted in 4515 hits, of which 119 potentially relevant full-text articles were identified and a total of 21 articles satisfied the criteria for inclusion in our review (figure 1). No further studies were found in reference lists of the identified articles. The study characteristics are summarised in table 1.

Most of the studies were conducted in the USA (n=13; 62%),[18 22–33] followed by Canada (n=3)[8 34 35] and one study each was from Belgium,[36] China,[37] Italy,[38] Sweden[39] and Germany.[19] Years of data used ranged from 1982 to 2012 and the articles were published between 1987 and 2016. The studies included data from 1 to 1174 nursing homes with sample sizes ranging from 250 to 687 956 residents. Follow-up periods ranged from 90 days to 6 years. Data on hospitalisations were most commonly obtained from administrative data or Minimum Data Set (n=14). Other sources included nursing home and patient records (n=4) or utilisation reviews (n=1). Two studies did not clearly describe the source of hospitalisation data. The three articles by Carter and Porell[22–24] used the same data set; however, they conducted different analyses or included different subpopulations.

Methodological quality of studies

The quality assessment of all studies is summarised in table 2. The percentage of quality criteria answered with 'yes' varied between 75% and 100% across the studies. The sample was representative of the target population in 90% of studies. Study participants were recruited in an appropriate way in more than 95% of studies. In most studies, hospitalisation was assessed using objective

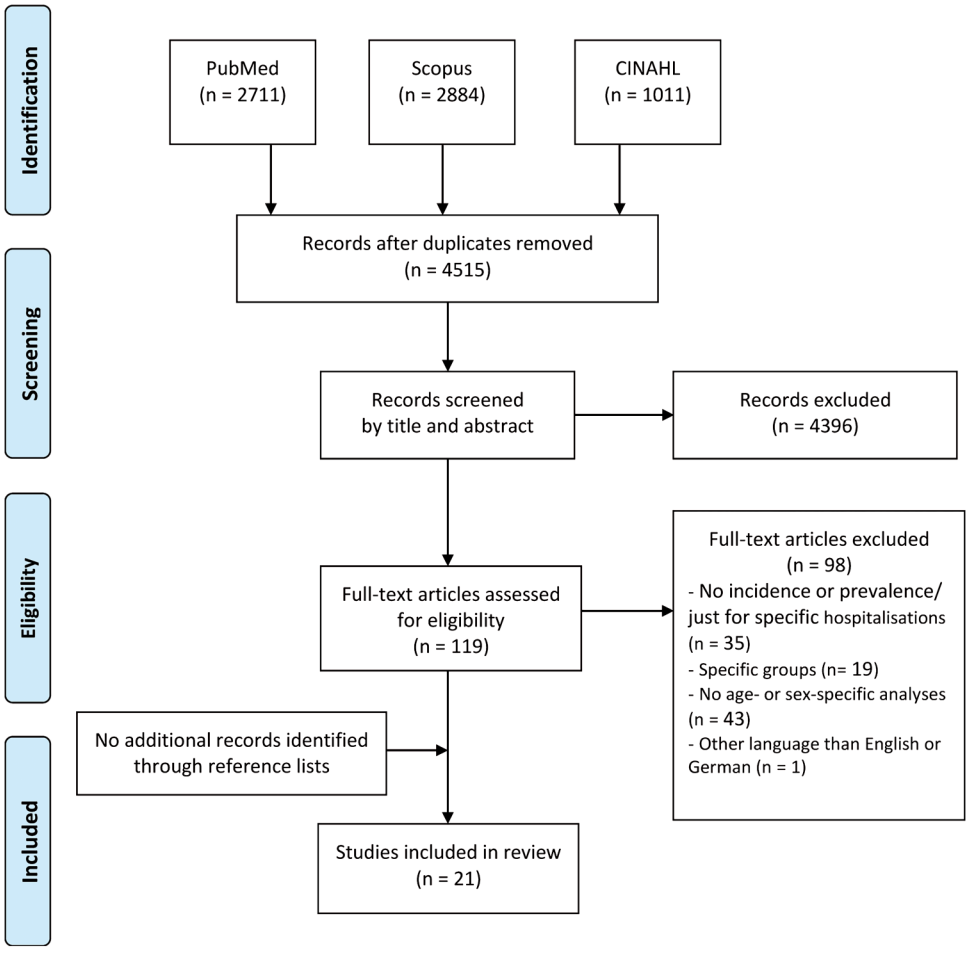

Figure 1 Flow chart of the literature search.

criteria. It was not clear whether the condition was measured in a reliable way for four studies (19%). While appropriate statistical analyses were used in most studies, three studies (14%) did not report CIs or p values.

Resident characteristics

Studies commonly included all residents (n=12)[19 22–25 27 29–32 36 37] or all residents aged 65 years and older (n=7).[8 18 26 33 34 38 39] One study included residents aged 50 years and older[28] and one study included all residents under the age of 106 years.[35] A total of four studies focused on residents newly admitted to the facility[19 30 32 35] and three studies on long-stay residents,[18 33 38] while most studies (n=13) included all types of NHRs.[22–29 31 34 36 37 39] One study included residents living in a nursing home at a care level of intermediate I or higher.[8] The mean age of residents ranged from 81.3 to 85.0 years and 65–79% were females.

Overall hospitalisation

All included studies reported some measure of all-cause hospitalisation (table 3). The reported hospital admissions ranged across studies from 6.8% to 45.7% for various time periods of follow-up.[18 22–30 32 34 37 38] Hospitalisation measured in person years ranged between 350 and 1100 hospitalisations per 1000 resident years.[19 31 32 36] Two studies assessed the exact number of hospitalisations per resident. A total of 68–83% of the hospitalised NHRs were hospitalised once, 13–25% twice and 2–3% three and more times over a period of 6 months to 2 years.[18 32] Overall, most studies showed that newly admitted NHRs are hospitalised more often compared with long-stay residents (in terms of prevalence, incidence or duration).[22–24 26 28 29 31 34]

Hospitalisation by age and sex

A total of 20 studies assessed the influence of sex. We found 6 studies that stratified their results for males and females[8 18 19 31 32 39] and 16 conducted multivariate analyses including sex.[18 22–30 33 35–39] All studies found that male NHRs are more often hospitalised than females. Two studies reported that 30% of the male NHRs were hospitalised, while the prevalence of female NHRs ranged between 23% and 25%.[18 32] Another study found a prevalence of hospitalisations of 47% among male and 45% among female residents.[39] Only female residents from intermediate nursing facilities were more often hospitalised (44%) than men (38%).[32] The rate of hospital days per 1000 resident years was 2960 among female and 3700 among male residents.[31] The

Table 1 Characteristics of included studies

Author (year)	Country	Data source	Year of data	Sample	Mean age of residents (% females)	
Ackermann and Kemle (1998)[31]	USA	NH and patient records	1992–1997	250 residents in a 92-bed NH	Ø 81.6 years (75%)	
Barker *et al* (1994)[32]	USA	NH utilisation review and hospital discharge data	1982–1984	2120 residents newly admitted in 1982 (1700 from skilled and 420 from intermediate NH facilities)	Skilled NH admissions <65 years: 5.4% 65–84 years: 50.4% 85+ years: 44.2% (74%)	Intermediate NH admissions: <65 years: 7.1% 65–84 years: 47.6% 85+ years: 45.2% (77%)
Carter (2003)[22]	USA	Massachusetts Medicaid data linked with data from the Medicare Provider Analysis and Review file (MEDPAR)*	1991–1994	72 319 person-quarters from 527 NHs	Ø 82.9 years (79%)	
Carter and Porell (2003)[23]	USA	Massachusetts Medicaid data linked with data from the Medicare Provider Analysis and Review file (MEDPAR)*	1991–1994	72 319 person-quarters from 527 NHs	Ø 82.9 years (79%)	
Carter and Porell (2006)[24]	USA	Massachusetts Medicaid data linked with data from the Medicare Provider Analysis and Review file (MEDPAR) and death registry data*	1991–1993	69 119 person-quarters from 527 NHs	Ø 83.0 years (79%)	
Cherubini *et al* (2012)[38]	Italy	Data from the longitudinal observational multicenter, prospective 1-year cohort study U.L.I.S.S.E	2004	1466 long-term residents ≥65 years from 31 NHs	65–84 years: 55.9% 85+ years: 44.1% (71%)	
Dobalian (2004)[25]	USA	Data from the Nursing Home Component of the Medical Expenditure Panel Survey (MEPS-NHC)	1996	5708 residents from 815 NHs	<65 years: 9.1% 65–84 years: 53.3% 85+ years: 37.6% (66%)	
Freiman and Murtaugh (1993)[26]	USA	National Medical Expenditure Survey (NMES), Medicare Automated Data Retrieval System (MADRS)	1987	2790 residents ≥65 years from 744 NHs	Ø 83.1 years (74%)	
Fried and Mor (1997)[18]	USA	Data from regular assessments of NH residents owned by the National Health Corporation (NHC)	1991–1993	3782 long-term residents ≥65 years newly admitted in 1991–1993 from 103 NHs	Ø 83 years (75%)	
Hallgren *et al* (2016)[39]	Sweden	Data from the longitudinal, open cohort, multipurpose Study of Health and Drugs in Elderly living in institutions (SHADES)	2008–2010	429 residents ≥65 years from 11 NHs	Ø 85.0 years (71%)	
Intrator *et al* (1999)[27]	USA	Minimum data Set (MDS) and the Online Survey of Automated Records (OSCAR) from 10 states	1993	2080 residents from 253 NHs	Ø 81 years (76%)	
Kang *et al* (2011)[28]	USA	Data from the 2004 National Nursing Home Survey	2004	12 507 residents ≥50 years from 1174 NHs	Ø 79.9 years (72%)	
Li *et al* (2016)[33]	USA	Data from Maryland nursing home experience with care reports, MDS files, Medicare Provider Analysis and Review (MEDPAR) and linked with several other databases	2007–2008	14 013 long-term residents ≥65 years from 201 NHs	Ø 83.9 years (73%)	

Continued

Table 1 Continued

Author (year)	Country	Data source	Year of data	Sample	Mean age of residents (% females)	
Mor *et al* (1997)[29]	USA	Minimum data Set (MDS), patient records and observation and data from interviews with staff	1990 and 1993	4196 residents (1990: 2118; 1993: 2078) from 268 NHs	1990: Ø 81.3 years (78%)	1993: Ø 81.7 years (76%)
O'Malley *et al* (2011)[30]	USA	Minimum data Set (MDS) and information from the Statewide Planning and Research Cooperative System	1998–2004	687 956 residents newly admitted from 677 NHs	– (69%)	
Ramroth *et al* (2005)[19]	Germany	Data from the German statutory nursing insurance and from the health insurance plans	1999–2001	1926 residents newly admitted in 2000 from 97 NHs	<70 years: 10.3% 70–79 years: 21.9% 80–89 years: 48.4% 90+ years: 19.4% (75%)	
Ronald *et al* (2008)[8]	Canada	Administrative data from the British Columbia Linked Health Database (BCLHD)	1996–1999	18 467 residents ≥65 years in BC NHs	65–84 years: 48.4% 85+ years: 51.6% (70%)	
Shapiro *et al* (1987)[34]	Canada	Data from the Manitoba Longitudinal Study on Aging which combined data from interviews with data from claims field routinely by physicians and hospitals	1970–1977	770 residents ≥65 years newly admitted in 1972–1976 or LT residents	New admissions: 65–84 years: 64.0% 85+ years: 36.1% (66.4%)	LT residents: 65–84 years: 41.8% 85+ years: 58.3 (69.1%)
Suetens *et al* (2006)[36]	Belgium	Dates and cause of death and hospitalisation were collected every 6 months from the NHs	2000–2003	2814 residents from 23 NHs	Ø 84.0 years (77%)	
Tang *et al* (2010)[37]	China	Data were collected from the NHs and from the residents by using the Minimum data Set - Resident Assessment Instrument 2.0 (MDS-RAI 2.0)	2001	1820 residents from 14 NHs	Ø 83.5 years (68%)	
Tanuseputro *et al* (2015)[35]	Canada	Data from the Canadian Continuing Care Reporting System (CCRS) linked with Discharge Abstract Database (DAD) and the Registered Persons Database (RPDB)	2010–2012	53 739 residents ≤105 years newly admitted in 2010–2012 from 640 NHs	<70 years: 11.0% 70–79 years: 20.6% 80–89 years: 47.5% 90+ years: 20.8% (65%)	

*These articles used the same data set.
LT, long term; NH, nursing home; Ø, mean.

Table 2 Summary of quality assessment

Author (year)	1	2	3	4	5	6	7	8
Ackermann and Kemle (1998)[31]	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Barker *et al* (1994)[32]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Carter (2003)[22]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Carter and Porell (2003)[23]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Carter and Porell (2006)[24]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cherubini *et al* (2012)[38]	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes
Dobalian (2004)[25]	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
Freiman and Murtaugh (1993)[26]	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes
Fried and Mor (1997)[18]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hallgren *et al* (2016)[39]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intrator *et al* (1999)[27]	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
Kang *et al* (2011)[28]	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
Li *et al* (2016)[33]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mor *et al* (1997)[29]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
O'Malley *et al* (2011)[30]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Ramroth *et al* (2005)[19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ronald *et al* (2008)[8]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Shapiro *et al* (1987)[34]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Suetens *et al* (2006)[36]	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
Tang *et al* (2010)[37]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tanuseputro *et al* (2015)[35]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Quality appraisal criteria:[21]
1. Was the sample representative of the target population?
2. Were study participants recruited in an appropriate way?
3. Was the sample size adequate?
4. Were the study subjects and setting described in detail?
5. Is the data analysis conducted with sufficient coverage of the identified sample?
6. Were objective, standard criteria used for measurement of the condition?
7. Was the condition measured reliably?
8. Was there appropriate statistical analysis?

hospitalisation rate per person year at risk was found to be 1.0 among female NHRs and 1.5 among male NHRs.[19] Also one other study found higher numbers of hospitalisations among men compared with women for all age groups.[8] All multivariate analyses showed a positive, and all but one[39] a statistical significant, association between male sex and hospital admission (males: OR 1.22–1.67).[18 22–26 28–30 36–38] Time to first hospitalisation and between hospitalisations was also shorter among men.[30] Although 20 studies assessed the influence of sex, only 4 of them (20%) addressed this issue in their discussion but did not present reasons for these findings.[8 19 25 38]

We found 18 studies assessed the influence of age. A total of 6 studies stratified their results by age[8 18 19 31 32 34] and 13 studies conducted multivariate analyses including age.[18 22–26 28 29 33 35 36 38 39] Most studies revealed more hospital admissions with higher age, but several studies also found decreasing hospitalisations above the age of about 80–85 years. However, age categories differed significantly between the studies (table 3). Findings of multivariate analyses varied across studies. Eight of 13 studies used age as a continuous variable, while the other 5 used different categories. One of the studies used age and age squared as variables.[26] One study showed that age at baseline was unrelated to the risk of hospitalisation.[29] Other studies found only a slight or no increase in risk of hospitalisation with each additional year of age.[22–24 33 39] Two studies found that hospitalised residents were more likely to be younger,[18 36] while another study reported that age over 85 years is positively associated with an increasing risk of hospitalisation.[38] Two studies found that the probability of being hospitalised increases with age up to 85 years and decreases thereafter[25 26] and one found no clear trend.[35] Only three studies addressed the influence of age in their discussion and concluded that lower hospitalisation rates in older age reflect a less aggressive treatment approach.[8 19 31]

Two studies reported the length of hospital stay. One study showed that the length of stay decreases with age,[19] while one other study found decreasing hospital days at the age of 85 years and older.[31] Relative time spent in hospital was found to be higher among male NHRs than among females.[19 31]

Two studies also investigated the main diagnoses for hospitalisation stratified by sex.[8 19] One of them assessed 12 categories and the most common reasons for hospital admission among female residents were injuries and poisoning (females: 16.8% vs males: 8.1%), while among male residents, infections (females: 10.0% vs males: 15.6%) were the most common diagnoses leading to hospitalisation.[19] The other study analysed femur fractures

Table 3 Hospitalisation of nursing home residents

Author (year)	Prevalence, incidence or number of hospitalisation and follow-up	Age-specific and sex-specific analyses	
		Prevalence or incidence	Regression/model*
Ackerman and Kemle (1998)[31]	142 residents were hospitalised 298 times during 6-year period (540/1000 resident years) 1727 hospital days (3130/1000 resident years)	Hospital days/1000 resident years <65 years: 1300 65–74 years: 3720 75–84 years: 3790 85+ years: 2680 Female: 2960 Male: 3700	–
Barker *et al* (1994)[32]	892 hospitalisations among the 2120 residents (387/1000 resident years) Follow-up: 2 years Skilled nursing facility: 26.5% (n=451) 1 hospitalisation: 18.5% (n=315) 2 hospitalisations: 5.6% (n=95) 3+ hospitalisations: 2.4% (n=41) 647 hospitalisations in 1869 resident years (346/1000) Intermediate nursing facility: 41.7% (n=175) 1 hospitalisation: 28.3% (n=119) 2 hospitalisations: 10.5% (n=44) 3 hospitalisations: 2.9% (n=12) 245 hospitalisations in 433 resident years (566/1000)	Skilled nursing facility: <65 years: 17.4% 65–74 years: 24.8% 75–84 years: 28.9% 85+ years: 26.2% Female: 25.4% Male: 29.9% Intermediate nursing facility: <65 years: 36.7% 65–74 years: 52.0% 75–84 years: 42.7% 85+ years: 38.9% Female: 44.0% Male: 37.1%	–
Carter (2003)[22]	Hospitalisation: 11% (n=8070) of all resident-quarters (n=73 319)	–	Logistic regression Age: OR=1.01 (p<0.001) Male: OR=1.34 (p<0.001)
Carter and Porell (2003)[23]	Hospitalisation: 11% (n=8070) of all resident-quarters (n=73 319)	–	Logistic regression Age: OR=1.01 (p<0.001) Male: OR=1.36 (p<0.001)
Carter and Porell (2006)[24]	Hospitalisation: 13% of all resident-quarters (n=69 119)	–	Logistic regression Age: OR=1.01 (p<0.001) Male: OR=1.38 (p<0.001)
Cherubini *et al* (2012)[38]	Hospitalisation: 11.6% (n=170) Follow-up: 1 year	–	Mixed-Effects logistic regression model Age >85 years: OR=1.27 (p=0.1688) Male: OR=1.67† (p=0.0058)
Dobalian (2004)[25]	Hospitalisation: 25.0% (n=1559) Follow-up: 1 year	–	Multivariable analysis <65 years: Reference 65–84 years: OR=1.24 (95% CI 0.97 to 1.60; p=0.091) 85+ years: OR=1.22 (95% CI 0.94 to 1.59; p=0.138) Male: OR=1.22 (95% CI 1.03 to 1.44; p=0.021)
Freiman and Murtaugh (1993)[26]	Hospitalisation: 30.5% Follow-up: 1 year	–	Multinominal logistic analysis Age: OR=1.27 (p<0.05) Age squared: OR=1.00 (p<0.05) Male: OR=1.27† (p<0.05)
Fried and Mor (1997)[18]	Hospitalisation: 25% (n=931) Follow-up: 6 months 1 hospitalisation: 83% 2 hospitalisations: 13% 3 hospitalisations: 3% (one resident four and one resident five times)	65–74 years: 33% 75+ years: 23% Female: 23% Male: 30%	Multivariate analysis Age <75 years: OR=1.41 (95% CI 1.15 to 1.73) Male: OR=1.39 (95% CI 1.17 to 1.65)

Continued

Table 3 Continued

Author (year)	Prevalence, incidence or number of hospitalisation and follow-up	Age-specific and sex-specific analyses: Prevalence or incidence	Age-specific and sex-specific analyses: Regression/model*
Hallgren *et al* (2016)[39]	Hospitalisation: 45.7% (n=196) Follow-up: 3 years 2 hospitalisations: 17.0% 5 or 6 hospitalisations: 0.02%	Female: 45.1% Male: 47.2%	Multivariate Cox proportional hazards regression analysing time to hospitalisation Age: HR=1.00 (95% CI 0.99 to 1.02; p=0.902) Male: HR=1.10 (95% CI 0.78 to 1.55; p=0.599)
Intrator *et al* (1999)[27]	Hospitalisation: 15% Follow-up: 6 months	–	Multinominal logistic regression Male: OR=1.49 (95% CI 1.12 to 2.04; p<0.05)†
Kang *et al* (2011)[28]	Hospitalisation: 6.8% Number of hospitalisation: 1.2 (±0.5) Follow-up: 90 days	–	Multilevel analysis Age at admission: OR=0.99 (95% CI 0.98 to 0.99; p=0.001) Male: OR=1.37 (95% CI 1.15 to 1.63; p=0.001)
Li *et al* (2016)[33]	Hospitalisation: 35% Follow-up: 1 year	–	Logistic risk adjustment model Age: OR=1.00 (p=0.478) Male: OR=1.23† (p<0.001)
Mor *et al* (1997)[29]	1018 hospitalisations among 4196 residents 1990: 21.0%; 1993: 16.0% Follow-up: 6 months	–	Polytomous logistic regression Age: OR=1.03 (95% CI: 0.60 to 1.76; p>0.05) Male: OR=1.54 (95% CI: 1.12 to 2.04; p<0.001)†
O'Malley *et al* (2011)[30]	408 534 hospitalisations among 687 956 residents (217 697 were first-time hospitalisations) Hospitalisation: 31.6% (n=217 697) Follow-up: 6 years	–	Accelerated failure time models Time to first hospitalisation: Male: HR=0.81 (p<0.001) Time between hospitalisations: Male: HR=0.82 (p<0.001)
Ramroth *et al* (2005)[19]	2148 hospitalisations within 2049 person years at risk 1.1 hospitalisations per person year Followed for a mean of 388 days	Hospitalisation rate per person-year at risk <70 years: 1.2 70–79 years: 1.2 80–89 years: 1.1 90+ years: 1.0 Female: 1.0 Male: 1.5	–
Ronald *et al* (2008)[8]	6826 hospitalisations among 18 467 residents Follow-up: 3 years	Average annual number of hospitalisations/1000 residents Female 65–69 years: 405.8 70–74 years: 403.6 75–79 years: 366.3 80–84 years: 364.3 85–89 years: 348.8 90+ years: 270.9 Male 65–69 years: 428.1 70–74 years: 465.7 75–79 years: 467.1 80–84 years: 471.1 85–89 years: 449.2 90+ years: 387.7	–

Continued

Table 3 Continued

Author (year)	Prevalence, incidence or number of hospitalisation and follow-up	Age-specific and sex-specific analyses	
		Prevalence or incidence	Regression/model*
Shapiro *et al* (1987)[34]	Hospitalisation in new admissions after 1 year: 32.1% (n=105)† Hospitalisation in LT residents after 1 year: 17.2% (n=76)† Follow-up: 1 and 2 years	Proportion of residents admitted to hospital after 1 year† New admissions: 65–74 years: 32.1% 75–84 years: 30.8% 85+ years: 33.9% LT residents: 65–74 years: 17.6% 75–84 years: 22.4% 85+ years: 14.3%	–
Suetens *et al* (2006)[36]	1904 hospital admissions in 1083 patients 35 hospital admissions per 100 person-years of follow-up	–	Multiple Poisson regression <70 years: Reference 70–79 years: IRR=0.76 (95% CI 0.63 to 0.91; p=0.003) 80+ years: IRR=0.71 (95% CI 0.60 to 0.85; p<0.001) Male: IRR=1.22 (95% CI 1.10 to 1.35; p<0.001)
Tang *et al* (2010)[37]	Hospitalisation: 24.8% (n=451) in the last 90 days Number of hospitalisation (mean): 1.4 (±0.74)	–	Multiple logistic regression model Male: OR=1.49 (95% CI 1.11 to 2.00; p=0.008)
Tanuseputro *et al* (2015)[35]	Hospitalisation: 25.7% Follow-up: 1 year After 12 months: 422.1 per 1000 person years‡	–	Multivariable model for 12 months after admission‡ 18–49 years: Reference 50–59 years: HR=1.10 (95% CI 0.90 to 1.36) 60–69 years: HR=1.14 (95% CI 0.94 to 1.38) 70–79 years: HR=1.16 (95% CI 0.96 to 1.39) 80–89 years: HR=1.13 (95% CI 0.94 to 1.36) 90+ years: HR=1.07 (95% CI 0.88 to 1.29) Male: 1.25 (95% CI 1.20 to 1.30)†

*p values and CIs whenever reported.
†Calculated from data given in the publication.
‡Data also reported at 3 and 6 months postadmission.
IRR, incident rate ratio; LT, long term.

(females: 16.7% vs males: 8.8%), pneumonia (females: 8.9% vs males: 15.4%) and other heart diseases (females: 10.2% vs males: 8.3%) as the three most frequent primary causes of hospitalisation by sex.[8]

Only one study stratified hospitalisation rates by age and sex.[8] None of the 21 included studies analysed age-specific or sex-specific predictors of hospitalisations in NHRs.

Comparison with community-dwellers and other populations

Two studies from Canada compared hospitalisation rates of NHRs to community-dwelling seniors.[8 34] Ronald *et al* found that hospitalisation rates for femur fractures and pneumonia were higher for NHRs than for the community-dwelling seniors for almost all age groups. In opposite, the community-dwelling population was hospitalised more often for other heart diseases compared with the NHRs in the old age groups. The standardised incidence ratio for all-cause hospitalisation was comparable between the two groups (1.01).[8] However, this measure depends on the choice of the reference population. When the community-dwelling population, which is much younger, is used instead, the standardised incidence ratio shows that hospitalisations occur more frequently for NHRs (1.61; according to own calculation). The second study found that NHRs in older age groups who have been institutionalised for more than 1 year are less frequently

hospitalised than their community counterparts, when age, sex and mortality rate are taken into account.[34]

DISCUSSION

This systematic review provides an overview of hospital admissions of people residing in nursing homes focusing on sex-specific and age-specific differences. The findings show that males are more often hospitalised, which has been shown in all studies with different populations and time frames. However, this finding is only discussed by very few of these studies and reasons are not explored. The influence of age is less clear and studies used different age categories or included age as a continuous variable in multivariate regressions. Evidence suggests that there seem to be no linear relationship between age and the proportion being hospitalised. Only one study reported stratified analyses by age and sex. Two studies investigating main diagnosis stratified by sex found some differences in reasons for hospitalisations between male and female NHRs.

Comparison with the literature and interpretation

Overall, we found a wide range between 6.8% and 45.7% of NHRs that were hospitalised and even when including the six studies that reported estimates for a follow-up of 1 year, large variations were found (11.6–35%). However, because different time periods and populations (eg, newly admitted or long-term residents, skilled or intermediate facilities) were used, comparisons between studies are difficult. This large variation was also found in the former reviews that used wider inclusion criteria.[16 17] We were interested in age-specific and sex-specific analyses and found that only one study stratified their results by both variables, showing some differences, which were also seen in primary causes of hospitalisations between men and women that were assessed in just two studies. No study analysed age-specific or sex-specific predictors of hospitalisations in NHRs, probably owing to the fact that a large proportion of studies were mainly interested in analysing facility, market or policy characteristics neither than sociodemographic factors. The influence of age is not consistent and age categories differed largely between the studies. Although there is some evidence of a decreasing influence of age above 80–85 years, 8 of 13 studies that conducted multivariate regressions used age as a continuous variable. Taken together, the inconsistent findings on the influence of age in published studies may be due to the fact that age was mostly assessed as a linear variable or with only few categories and not due to different study populations. This is surprising, since the literature on predictors of nursing home placement revealed some evidence for sex-related and age-related differences,[40–42] that might also exist in predictors of hospitalisations in NHRs.

Hospitalisations of NHRs are often deemed to be potentially avoidable.[9 10 12] A recent systematic review published in 2014 including 29 studies found that the proportion of hospital admissions considered as inappropriate ranged from 2% to 77%.[10] However, there is also little research looking at age and sex differences in potentially avoidable or ambulatory care-sensitive hospitalisations. When taking the included articles in the review of Renom-Guiteras *et al*[10] into account, we found that only 10 of 29 studies (34%) analysed sex or age differences and results are inconclusive. Three of these studies found that being male was associated with avoidable hospitalisations of NHRs,[43–45] one showed the opposite effect[46] and six studies revealed no influence of sex.[47–52] Again, the results for age are more difficult to interpret due to different stratifications and are even more inconclusive. Of the nine studies that addressed this question, three saw no influence of age.[47–49] Two found that higher age or age above 85 years is associated with increased ambulatory care-sensitive hospitalisations.[51 52] One study showed continuously decreasing risks above the age of 80 years in the last 90 days of life[44] and another revealed that NHRs aged 65 years and older had a lower risk than younger residents.[50] The study of Becker *et al*[45] is not possible to interpret because the authors state that they used age under 65 years as the reference category in a regression with residents above 65 years.[45] Murtaugh and Litke[43] were the only study presenting analyses stratified by age and sex finding a peak in the age group of 70–74 years for avoidable transitions to hospitals. However, they studied respondents of the National Long Term Care Survey aged 65 years and older including different postacute and long-term care settings.

ED visits are also an increasingly important source of care for NHRs and they often result in hospital stays.[7 53] When compared with the literature on hospitalisations, there has been less research on ED transfers of NHRs and, consequently, age and sex differences have not gained much attention.[53 54] When taking a deeper look at the 12 studies on ED use of NHRs included in the systematic review of Gruneir *et al*[54] published in 2011, just 4 of them (33%) analysed some kind of effects of sex or age, but no conclusions can be drawn from these results. One study assessed ED visits of all persons aged 65 years and older also including those living in the community,[51] one only presented proportions of hospital admissions for NHRs seen in EDs by age and sex,[55] another one, including only urinary and respiratory tract infections, found no influence of sex[56] and the fourth study compared age and sex between residents with appropriate and inappropriate ED presentations.[47]

Taken together, our knowledge on age and sex differences in acute care use of NHRs is quite limited and we strongly encourage further research on the influence of sociodemographic characteristics on hospitalisations and ED visits of NHRs.

Strengths and limitations

We updated the existing reviews examining articles published until 1995[16] and 2006[17] using a more comprehensive search strategy to identify relevant studies from several databases by scanning more than 4500 titles.

When compared with the review of Grabowski *et al*[17] that searched articles until 2006, we were able to include 11 further studies. However, there remains the possibility that relevant studies were not included, particularly those published in languages other than English or German. The extension of our search to other electronic databases might have identified additional studies and we also did not search for grey literature. However, we screened reference lists of all included articles and did not find further relevant studies. This might lead to the conclusion that we did not miss relevant articles.

The interpretation of our findings is hampered by the inclusion of heterogeneous studies in terms of populations, time frames and estimates (eg, crude or standardised frequencies and multivariate regression models). There are also too few studies to assess time trends or differences between countries. Future studies should take comparability of methods already used in the literature into account (eg, on age categories or inclusion criteria).

There is a lack of established and validated critical appraisal tools for studies on prevalence and incidence. We decided to use the prevalence critical appraisal instrument from the Joanna Briggs Institute.[21] However, this is more or less applied to have an overview on the study characteristics than to determine their methodological quality. Further research on tools for quality assessment of studies dealing with prevalence or incidence is clearly needed, since the relevance of such questions for systematic reviews increases.

CONCLUSION

Male NHRs are more often hospitalised than females, but reasons for that are not clear. Findings regarding the influence of age are less consistent. There is also little research looking at age and sex differences in preventable hospitalisations or ED visits of NHRs. More studies are clearly needed, especially outside the USA, investigating age and sex differences in the frequency and reasons for hospitalisation in NHRs to develop person-tailored interventions and to optimise care.

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