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.

INTRODUCTION

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

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, 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. This is surprising because there is evidence that such patterns differ between age groups and sexes in analyses of NHRs.

This is also the case for the epidemiology of hospitalisations of NHRs and there are two older reviews examining articles published until 1995 and 2006. 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 al17 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 data on the prevalence and incidence of hospitalisations in NHRs, particularly focusing on age-specific and sex-specific 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 (e.g., dementia patients) or cause-specific hospitalisations (e.g., 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)34 35 and one study each was from Belgium,36 China,37 Italy38 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 Porell22–24 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
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) or all residents aged 65 years and older (n=7). One study included residents aged 50 years and older and one study included all residents under the age of 106 years. A total of four studies focused on residents newly admitted to the facility and three studies on long-stay residents, while most studies (n=13) included all types of NHRs. One study included residents living in a nursing home at a care level of intermediate I or higher. 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. Hospitalisation measured in person years ranged between 350 and 1100 hospitalisations per 1000 resident years. 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. Overall, most studies showed that newly admitted NHRs are hospitalised more often compared with long-stay residents (in terms of prevalence, incidence or duration).

**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 and 16 conducted multivariate analyses including sex. 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%. Another study found a prevalence of hospitalisations of 47% among male and 45% among female residents. Only female residents from intermediate nursing facilities were more often hospitalised (44%) than men (38%). The rate of hospital days per 1000 resident years was 2960 among female and 3700 among male residents.

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**Figure 1** Flow chart of the literature search.
Table 1  Characteristics of included studies

| Author (year)                      | Country | Data source                                                                 | Year of data | Sample                                                                 | Mean age of residents (% females) |
|-----------------------------------|---------|-----------------------------------------------------------------------------|--------------|------------------------------------------------------------------------|----------------------------------|
| Ackermann and Kemle (1998)¹¹       | USA     | NH and patient records                                                      | 1992–1997    | 250 residents in a 92-bed NH                                            | Ø 81.6 years (75%)               |
| Barker et al (1994)²²              | 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%, 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
| Author (year) | Country | Data source | Year of data | Sample | Mean age of residents (% females) |
|--------------|---------|-------------|--------------|--------|----------------------------------|
| Mor et al (1997) | 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%) and 1993: Ø 81.7 years (76%) |
| O’Malley et al (2011) | 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 | 1998–2004: Ø 76% (69%) |
| Ramroth et al (2005) | 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 | 1999–2001: <70 years: 10.3% 70–79 years: 21.9% 80–89 years: 48.4% 90+ years: 19.4% (66.4%) |
| Ronald et al (2008) | Canada | Administrative data from the British Columbia Linked Health Database (BCLHD) | 1996–1999 | 18 467 residents ≥65 years in BC NHs | 1996–1999: 65–84 years: 48.4% 85+ years: 51.6% (70%) |
| Shapiro et al (1987) | 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 | 1970–1977: 65–84 years: 41.8% 85+ years: 58.3 (69.1%) |
| Suetens et al (2006) | Belgium | Dates and cause of death and hospitalisation were collected every 6 months from the NHs | 2000–2003 | 2814 residents from 23 NHs | 2000–2003: Ø 84.0 years (77%) |
| Tang et al (2010) | 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 | 2001: Ø 83.5 years (68%) |
| Tanuseputro et al (2015) | 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 | 2010–2012: <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.
hospitalisation rate per person year at risk was found to be 1.0 among female NHRs and 1.5 among male NHRs. Also one other study found higher numbers of hospitalisations among men compared with women for all age groups. All multivariate analyses showed a positive, and all but one1 a statistical significant, association between male sex and hospital admission (males: OR 1.67). Two studies found that hospitalised residents were more likely to be younger, while another study reported that age over 85 years is positively associated with an increasing risk of hospitalisation. Two studies found that the probability of being hospitalised increases with age up to 85 years and decreases thereafter and one found no clear trend. 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.

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

Two studies also investigated the main diagnoses for hospitalisation stratified by sex. 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. The other study analysed femur fractures

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### 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| Unclear| Yes| Yes| Yes| Yes|
| Dobalian (2004)23                      | Yes| Yes| Yes| Yes| Yes| Unclear| Yes| Yes|
| Freiman and Murgaugh (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)19                | Yes| Yes| Yes| Yes| Yes| Yes| Yes| Yes|
| Intrator et al (1999)27                | Yes| Yes| Yes| Yes| Yes| Unclear| Yes| Yes|
| Kang et al (2011)28                    | Yes| Yes| Yes| Yes| Yes| Unclear| Yes| Yes|
| Li et al (2016)34                      | 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| Unclear| Yes| 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?
### Table 3  Hospitalisation of nursing home residents

| Author (year) | Prevalence, incidence or number of hospitalisation and follow-up | Age-specific and sex-specific analyses |
|---------------|------------------------------------------------------------------|--------------------------------------|
| Ackerman and Kemle (1998) | 142 residents were hospitalised 298 times during 6-year period (540/1000 resident years) | Prevalence or incidence Regression/model*  |
| | 1727 hospital days (3130/1000 resident years) | Hospital days/1000 resident years |
| | | <65 years: 1300 | Male: 3700 |
| | | 65–74 years: 3720 | Female: 2960 |
| | | 75–84 years: 3790 | |
| | | 85+ years: 2680 | |
| | | | |
| | | | |
| Barker et al (1994) | 892 hospitalisations among the 2120 residents (387/1000 resident years) | Follow-up: 2 years |
| | | Skilled nursing facility: 26.5% (n=451) | Female: 25.4% |
| | | 1 hospitalisation: 18.5% (n=315) | Male: 29.9% |
| | | 2 hospitalisations: 5.6% (n=95) | Intermediate nursing facility: |
| | | 3+ hospitalisations: 2.4% (n=41) | <65 years: 36.7% |
| | | 647 hospitalisations in 1869 resident years (346/1000) | 65–74 years: 52.0% |
| | | Intermediate nursing facility: 41.7% (n=175) | 75–84 years: 42.7% |
| | | 1 hospitalisation: 28.3% (n=119) | 85+ years: 38.9% |
| | | 2 hospitalisations: 10.5% (n=44) | Female: 44.0% |
| | | 3 hospitalisations: 2.9% (n=12) | Male: 37.1% |
| | | 245 hospitalisations in 433 resident years (566/1000) | |
| Carter (2003) | 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) | 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) | 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) | Hospitalisation: 11.6% (n=170) | Mixed-Effects logistic regression |
| | | Follow-up: 1 year | model |
| | | Age >85 years: OR=1.27 (p=0.1688) | |
| | | Male: OR=1.67† (p=0.0058) | |
| Dobalian (2004) | Hospitalisation: 25.0% (n=1559) | Multivariable analysis |
| | | Follow-up: 1 year | 65–84 years: Reference |
| | | Age: OR=1.24 (95% CI 0.97 to 1.60; p=0.091) | |
| | | Male: OR=1.39 (95% CI 1.17 to 1.65) | |
| Freiman and Murtaugh (1993) | Hospitalisation: 30.5% | Multinominal logistic analysis |
| | | Follow-up: 1 year | 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) | Hospitalisation: 25% (n=931) | Multivariate analysis |
| | | Follow-up: 6 months | Age <75 years: OR=1.41 (95% CI 1.15 to 1.73) |
| | | 1 hospitalisation: 83% | Male: OR=1.39 (95% CI 1.17 to 1.65) |
| | | 2 hospitalisations: 13% | |
| | | 3 hospitalisations: 3% (one resident four and one resident five times) | |

**Note:** Continued
| Author (year)          | Prevalence, incidence or number of hospitalisation and follow-up | Prevalence or incidence | Regression/model* |
|-----------------------|---------------------------------------------------------------|------------------------|-------------------|
| Hallgren et al (2016) | Hospitalisation: 45.7% (n=196) Follow-up: 3 years           | Female: 45.1%          | 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) |
|                       | 2 hospitalisations: 17.0% 5 or 6 hospitalisations: 0.02%      | Male: 47.2%            |                   |
| Intrator et al (1999)  | 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)     | 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)       | 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)      | 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) | 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)  | 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)   | 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
(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

### Table 3 Continued

| Author (year)          | Prevalence, incidence or number of hospitalisation and follow-up | Age-specific and sex-specific analyses |
|------------------------|---------------------------------------------------------------|---------------------------------------|
| Shapiro et al (1987)   | Hospitalisation in new admissions after 1 year: 32.1% (n=105)† | Proportion of residents admitted to hospital after 1 year† |
|                        | Hospitalisation in LT residents after 1 year: 17.2% (n=76)†   | 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)   | 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)      | 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)| Hospitalisation: 25.7% Follow-up: 1 year After 12 months: 422.1 per 100 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.
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 rather 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 al19 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,13–15 one showed the opposite effect16 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 life44 and another revealed that NHRs aged 65 years and older had a lower risk than younger residents.50 The study of Becker et al45 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 Litke43 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 al64 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 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 sex46 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 199516 and 200617 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. 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, time frames and estimates (eg, crude or standardised frequencies and multivariate regression models). In addition, 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 tool criteria from the Joanna Briggs Institute. 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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REFERENCES

1. Schram MT, Fritiers D, van de Lisdonk EH, et al. Setting and registry characteristics affect the prevalence and nature of multimorbidity in the elderly. J Clin Epidemiol 2008;61:1104–12.
2. de Souto Barreto P, Lapeyre-Mestre M, Velias B, et al. Multimorbidity type, hospitalizations and emergency department visits among nursing home residents: a preliminary study. J Nutr Health Aging 2014;18:705–9.
3. Jokanovic N, Tan ECK, Dooley MJ, et al. Prevalence and factors associated with polypharmacy in long-term care facilities: a systematic review. J Am Med Dir Assoc 2015;16:535.e1–535.e12.
4. Dörks M, Herget-Rosenthal S, Schmiemann G, et al. Polypharmacy and renal failure in nursing home residents: results of the Inappropriate Medication in Patients with Renal Insufficiency in Nursing Homes (IMREN) study. Drugs Aging 2015;33:45–51.
5. Gordon AL, Franklin M, Bradshaw L, et al. Health status of UK care home residents: a cohort study. Age Ageing 2014;43:97–103.
6. Hoffmann F, Kaduszewskih H, Glaeske G, et al. Prevalence of dementia in nursing home and community-dwelling older adults in Germany. Aging Clin Exp Res 2014;26:355–9.
7. Deyer R, Gabbie B, Stiel J, et al. A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities. Age Ageing 2014;43:759–66.
8. Ronald LA, McGregor MJ, McGrail KM, et al. Hospitalization rates of nursing home residents and community-dwelling seniors in British Columbia. Can J Aging 2008;27:109–15.
9. Ouslander JG, Lamb G, Perloe M, et al. Potentially avoidable hospitalizations of nursing home residents: frequency, causes, and costs: [see editorial comments by Drs. Jean F. Wyman and William R. Hazzard, pp 760-761]. J Am Geriatr Soc 2010;58:627–35.
10. Renou-Guitaeras A, Uhrenfeldt L, Meyer G, et al. Assessment tools for determining appropriateness of admission to acute care of persons transferred from long-term care facilities: a systematic review. BMC Geriatr 2014;14:80.
11. Pedone C, Ercolani S, Catani M, et al. Elderly patients with cognitive impairment have a high risk for functional decline during hospitalization: the GIFA Study. J Gerontol A Biol Sci Med Sci 2005;60:1576–80.
12. McAndrew RM, Grabowski DC, Dangi A, et al. Potential hospitalizations of nursing home residents: frequency, causes, and costs: [see editorial comments by Drs. Jean F. Wyman and William R. Hazzard, pp 760-761]. J Am Geriatr Soc 2010;58:627–35.
13. Onder G, Carpenter I, Finne-Soveri H, et al. Assessment of nursing home residents in Europe: the Services and Health for Elderly in Long Term care (SHELTER) study. BMC Health Serv Res 2012;12:5.
14. Moore KL, Boscardin WJ, Steinman MA, et al. Age and sex variation in prevalence of chronic medical conditions in older residents of U.S. nursing homes. J Am Geriatr Soc 2012;60:756–64.
15. Richter T, Mann E, Meyer G, et al. Prevalence of psychotropic medication use among German and Austrian nursing home residents: a comparison of 3 cohorts. J Am Med Dir Assoc 2012;13:187.e7–13.
16. Castle NG, Mor V. Hospitalization of nursing home residents: a review of the literature, 1980–1995. Med Care Res Rev 1996;53:123–48.
17. Grabowski DC, Stewart KA, Broderick SM, et al. Predictors of nursing home hospitalization: a review of the literature. Med Care Res Rev 2008;65:3–39.
18. Fried TR, Mor V. Frailty and hospitalization of long-term stay nursing home residents. J Am Med Dir Assoc 1997;45:265–9.
19. Ramoth H, Specht-Leibne B, Brenner H. Hospitalisations before and after nursing home admission: a retrospective cohort study from Germany. Age Ageing 2005;34:291–4.
20. Murtaugh CM, Freiman MP. Nursing home residents at risk of hospitalization and the characteristics of their hospital stays. Gerontologist 1995;35:35–43.
21. Munn Z, Moola S, Rittano D, et al. The development of a critical appraisal tool for use in systematic reviews addressing questions of prevalence. Int J Qual Health Care 2004;16:123–8.
22. Carter MW. Variations in hospitalization rates among nursing home residents: the role of discretionary hospitalizations. Health Serv Res 2003;38:1177–206.
23. Carter MW, Porell FW. Variations in hospitalization rates among nursing home residents: the role of facility and market attributes. Gerontologist 2003;43:175–91.
24. Carter MW, Porell FW. Nursing home performance on select publicly reported quality indicators and resident risk of hospitalization: grappling with policy implications. J Aging Soc Policy 2006;18:17–39.
25. Dobalian A. Nursing facility compliance with do-not-hospitalize orders. Gerontologist 2004;44:159–65.
