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**RESEARCH PAPER**

# Morbidity and mortality among older people admitted to nursing home

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## Abstract

**Background:** the increasing number of multimorbid older people places high demands on future health care systems. To inform the discussion on how to structure future care strategies, we aimed to describe the temporal relationship between admission, and morbidity and mortality in nursing home residents.
**Methods:** data on 5,179 older individuals admitted to 94 Danish nursing homes in 12 municipalities during 2015–2017 were linked to the nationwide Danish health registries to retrieve information on the temporal relation between nursing home admission and morbidity and mortality.
**Results:** at the time of nursing home admission, the majority were women (63%). Male residents were younger than women (median 82 vs 85 years) and had a higher prevalence of comorbidities (median Charlson score 2 vs 1 among women). The median survival after nursing home admission was 25.8 months, with the 3-year survival being 37%. Three-year survival was lower among men (29 vs 43% among women) and among the oldest residents (23% among those aged ≥90 years vs 64% among individuals ≤65 years). In addition to age and sex, predictors of mortality included hospitalisations prior to nursing home admission and a high burden of comorbidity. The rate of hospitalisations, primarily for reasons related to frailty, increased substantially during the 9 months prior to nursing home admission.
**Conclusion:** we provide detailed information on differences in morbidity and mortality across age span and sex at the time of nursing home admission, thereby contributing to the ongoing discussion of how to structure the future health care system.

**Keywords:** *descriptive study*, *epidemiology*, *morbidity*, *mortality*, *nursing home residents*, *older people*

## Key points

- This paper describes the temporal relationship between admission, and morbidity and mortality in nursing home residents.
- Marked sex differences were observed in both morbidity and survival, with men having a worse prognosis than women.
- Age, sex and previous hospitalisations were predictors of post-admission survival.
- Hospitalisations, primarily related to frailty, increased markedly in the months before admission to nursing home.
- Our findings contribute to the ongoing discussion of how to structure the future health care system.

## Introduction

Due to an increasing life expectancy, the older population is expected to expand gradually over the coming years [1]. Although increase in average lifespan is accompanied by improved health at a given age [2], the number of concomitant diseases increases with advancing age, meaning that future health care systems must be prepared for a large number of multimorbid individuals with widespread utilisation of health care services [3]. This likely includes an increasing number of individuals requiring nursing home residency in addition to increasing complexity of diseases handled by health care workers in nursing homes.

Older people admitted to nursing homes represent a frail population with impaired physical function [4, 5]. Compared with the general older population, they use health care services more [6] and experience greater comorbidity and disease complexity [4, 7].

Multimorbidity generally leads to a decreased quality of life and an increased risk of hospitalisations and mortality [8]. To prevent declining quality of life, the optimization of treatment and care is, therefore, a key goal in the management of the ageing population [1]. Though initiatives have been commenced to improve the quality of life among nursing home residents [9, 10], the development of care strategies in this population is complicated by the heterogeneity of the population, in particular the high prevalence of dementia [11].

To inform the ongoing discussion on how to improve upon care strategies in nursing homes in the future, it is essential to obtain detailed information on characteristics and trajectories for the heterogeneous population of nursing home residents. We, therefore, aimed to describe the temporal relationship between admission, and morbidity and mortality overall and across sex and age groups in older nursing home residents.

## Methods

We established a database of 5,179 individuals admitted into 94 nursing homes across 12 Danish municipalities during 2015–2017. The cohort was supplemented with individual-level registry data on hospital admissions and drug dispensing to describe the temporal relationship between nursing home admission and cohort characteristics.

### Study cohort and data sources

During the spring of 2018, 18 Danish municipalities were invited to participate in the study. Of these, 12 agreed to participate and provided personal registration numbers on all individuals moving into a nursing home during 2015–2017, including the date of nursing home admission. The data were reshaped to a common data structure and uploaded to The Danish Health Data Authority. Here, the data were linked via the personal identification number, and a unique identifier assigned to all Danish residents since 1968 [12], to individual-level data on hospital diagnoses and prescription fills covering 1995 through 2018. As practically all medical care in Denmark are provided by the national health authorities, the use of these registries allows virtually complete capture of health care contacts [13].

Data on hospital diagnoses and admissions were obtained from the Danish National Patient Register [14], which contain nationwide data on all non-psychiatric hospital admissions since 1977 as well as both psychiatric and non-psychiatric outpatient contacts since 1995. Discharge/contact diagnoses are assigned to all patients by the discharging physician and have been coded according to ICD-10 since 1994. The validity is generally considered high [14].

Data on prescription fills were obtained from the Danish National Prescription Registry [15], which contain data on all prescription drugs dispensed to Danish citizens since 1995. Unlike many similar registries outside Denmark [15], this registry also covers nursing home residents. Drugs are categorised according to the Anatomic Therapeutic Chemical (ATC) index [16], a hierarchical classification system developed by the WHO [16].

Data on hospital discharge diagnosis codes were used to assess comorbidity. This information was for certain comorbidities combined with individual-level data on drug use (see Appendix A).

### Setting

Individuals with frailty, who need all day care, are eligible for nursing home residency according to Danish law. This contrasts with elder homes, where residency is offered to people with decreased physical or psychological capabilities but who do not require care and assistance. All Danish citizens can apply for nursing home residency. It is, however, up to the local municipalities to appoint residency to individuals with the greatest need. Such prioritisation occurs irrespective of socio-economic status and is purely based on functional capacity [17]. A team of nurses, nurse-assistants and/or therapists with 1½–4 years of basic education support and facilitate the well-being of the residents. At the time of nursing home admission, medical status of each resident is assessed, and individualised care strategies are prepared. These include personal care, the maintenance of functional level and the administration of medication. Residents have access to a doctor whenever needed. The level of services may differ slightly across nursing homes; however, all nursing homes are governed by the Danish Consolidation Act on Social Services [18].

### Analyses

The cohort was described in terms of patient characteristics at the time of nursing home admission. This included sex and age, Charlson Comobidity Index [19], selected baseline comorbidities and the number of hospitalisations during the last year prior to admission.

Next, mortality was described during the first 3 years after nursing home admission, using a Kaplan–Meier approach,

assessing overall survival and age- and sex-adjusted survival stratified by sex and age groups, respectively. Additionally, hazard ratios (HRs) for baseline predictors of one- and 3-year mortality after admission to nursing home were estimated using Cox regression analysis.

Finally, the temporal relation between the progression of severe morbidity and the nursing home admission was evaluated by determining the number of and reasons for hospital admissions from 2 years before to 2 years after admission to nursing home.

### Workshops with municipalities

Interpretation and characterisation of study findings were done during two workshops with representatives from the participating municipalities, these predominantly comprised the heads of nursing homes and people working with quality assurance in the care of older residents within the municipalities.

### Other

According to Danish law, studies based entirely on registry data do not require approval from an ethics review board [13].

## Results

We identified 5,179 residents admitted to nursing homes during the study period (Table 1); of which 63% were female and with a median age of 84 years (interquartile range [IQR] 77–89 years). Male residents were younger than women (median 82 vs 85 years) and had a slightly higher prevalence of comorbidities (median Charlson score 2 (IQR 0–3) vs 1 (IQR 0–2) among women). Furthermore, some comorbidities were more frequent with increasing age (e.g. history of cancer, ischemic heart disease and heart failure), while others showed an inverse relationship (e.g. stroke, COPD, and alcohol and substance abuse). As one exception, dementia was more common among those aged 66–75 years and 75–90 years as compared with those aged ≤65 and ≥90 years (Table 1).

The overall median survival after nursing home admission was 25.8 months. One year after nursing home admission, 70% of residents were still alive, while 37% were alive after 3 years (Figure 1). Post-admission survival was correlated to age at nursing home admission, with a 3-year sex-adjusted survival of 64% among those aged <65 years compared with 23% among those aged ≥90 years ($P_{\text{trend, age}} < 0.001$). Survival was also correlated to sex (when adjusting for age), with women living slightly longer than men (3-year survival 43 vs 29%, $P < 0.001$) corresponding to a median survival of 29.9 months among women vs 20.3 months among men (Figure 1). A *post hoc* analysis excluding patients with a marker of dementia led to virtually identical survival estimates (data not shown). The time-to-event analysis of survival up to 3 years after admission confirmed that men were at higher risk of dying than women (HR 1.37; 95% CI 1.27–1.49) and that increasing age was predictive for mortality (HR 0.52 age < 65 years increasing to HR 1.55 for age >90 years compared with those aged 76–89 years). Similarly, the 3-year survival decreased in the overall population with an increasing pre-admission hospitalisation rate and an increasing Charlson Comorbidity Index (Table 2). When stratifying by sex, the predictive value of the Charlson Comorbidity Index was only apparent for men (e-Table 1). Of single diseases, the strongest predictors of an increased 3-year mortality were cancer (HR 1.36), chronic obstructive pulmonary disease (HR 1.25) and heart failure (HR 1.23) (Table 2). A largely similar pattern of baseline predictors was observed for 1-year survival (e-Table 2).

The rate of hospital admissions increased substantially during the 9 months prior to nursing home admission and peaked at 21 admissions/100 subjects/months in the second-to-last month prior to nursing home admission. Thereafter, it declined rapidly to a rate of about 6 admissions/100/month (e-Figure 1). The same pattern was observed both among the youngest (≤75 years) and the oldest (>75 years) nursing home residents (e-Figure 2–3). More than half of the residents (54%) had one or more hospital admission during the 6 months preceding nursing home admission, while 63% were hospitalised during the last year. The proportion of individuals being hospitalised three or more times within the last year before nursing home admission decreased from 29% among the youngest (<65 years) to 16% among the oldest (≥90 years) (Table 1). The most common reasons for hospital admission were generally similar before and after nursing home admission (e-Table 3) as well as across age groups (e-Table 4–5), and mainly comprised markers of frailty, e.g. unspecified codes, pneumonia and volume depletion.

## Discussion

With this study, we have characterized morbidity and mortality among older people moving into nursing homes. We provide documentation on several aspects, including a strong association between age and post-admission survival, marked sex differences in both morbidity and survival, with men having a worse prognosis than women, an increase in the rate of hospitalisations in the months before admission to nursing home, and that hospital admissions are driven mainly by frailty, both before and after admission to nursing home.

The main strength of the study is the large cohort supplemented by the Danish nationwide health care registries, covering the entire Danish population irrespective of age, sex and socioeconomic status. We were, therefore, able to enrich our nursing home population with information on hospital admissions and drug redemptions without the risk of selection bias and from data sources considered to be of high validity [14, 20]. The main limitations of the study, however, also relate to the data sources used. We did not have information on several markers of frailty, such as the use of

**Table 1**. Baseline characteristics of Danish nursing home residents admitted during 2015–2017. Overall as well as stratified by sex and age groups

| | Total ($n = 5179$) | Male | Female | <65 years ($n = 261$) | 66–75 years ($n = 842$) | 76–89 years ($n = 2834$) | 90+ years ($n = 1208$) |
|---|---|---|---|---|---|---|---|
| Sex | | | | | | | |
| Male | 1,920 (37.1%) | 1,920 (100.0%) | - | 162 (62.1%) | 418 (49.6%) | 1,014 (35.8%) | 305 (25.2%) |
| Female | 3,259 (62.9%) | – | 3,259 (100.0%) | 99 (37.9%) | 424 (50.4%) | 1,820 (64.2%) | 903 (74.8%) |
| Age | | | | | | | |
| Median (IQR) | 84 (77–89) | 82 (73–87) | 85 (79–90) | 60 (56–62) | 72 (69–74) | 84 (80–87) | 92 (91–95) |
| <65 years | 295 (5.7%) | 183 (9.5%) | 112 (3.4%) | 261 (100.0%) | – | – | – |
| 66–75 years | 842 (16.3%) | 418 (21.8%) | 424 (13.0%) | – | 842 (100.0%) | – | – |
| 76–89 years | 2,834 (54.7%) | 1,014 (52.8%) | 1,820 (55.8%) | – | – | 2,834 (100.0%) | – |
| ≥90 years | 1,208 (23.3%) | 305 (15.9%) | 903 (27.7%) | – | – | – | 1,208 (100.0%) |
| Charlson Comorbidity Index | | | | | | | |
| Median (IQR) | 1 (1–3) | 2 (1–3) | 1 (0–2) | 1 (0–3) | 2 (1–3) | 2 (1–3) | 1 (0–2) |
| 0 | 1,189 (23.0%) | 363 (18.9%) | 826 (25.3%) | 67 (25.7%) | 159 (18.9%) | 575 (20.3%) | 379 (31.4%) |
| 1 | 1,530 (29.5%) | 520 (27.1%) | 1,010 (31.0%) | 78 (29.9%) | 249 (29.6%) | 833 (29.4%) | 364 (30.1%) |
| 2 | 969 (18.7%) | 354 (18.4%) | 615 (18.9%) | 42 (16.1%) | 139 (16.5%) | 544 (19.2%) | 239 (19.8%) |
| 3+ | 1,491 (28.8%) | 683 (35.6%) | 808 (24.8%) | 74 (28.4%) | 295 (35.0%) | 882 (31.1%) | 226 (18.7%) |
| Medical history of | | | | | | | |
| Cancer | 1,278 (24.7%) | 516 (26.9%) | 762 (23.4%) | 36 (13.8%) | 198 (23.5%) | 719 (25.4%) | 314 (26.0%) |
| COPD | 960 (18.5%) | 383 (19.9%) | 577 (17.7%) | 59 (22.6%) | 180 (21.4%) | 562 (19.8%) | 149 (12.3%) |
| Dementia | 1,681 (32.5%) | 633 (33.0%) | 1,048 (32.2%) | 39 (14.9%) | 281 (33.4%) | 1,085 (38.3%) | 270 (22.4%) |
| Parkinson | 334 (6.4%) | 182 (9.5%) | 152 (4.7%) | 8 (3.1%) | 92 (10.9%) | 204 (7.2%) | 29 (2.4%) |
| Ischemic heart disease | 570 (11.0%) | 259 (13.5%) | 311 (9.5%) | 15 (5.7%) | 74 (8.8%) | 328 (11.6%) | 150 (12.4%) |
| Heart failure | 2,314 (44.7%) | 813 (42.3%) | 1,501 (46.1%) | 75 (28.7%) | 285 (33.8%) | 1,306 (46.1%) | 636 (52.6%) |
| Atrial fibrillation | 1,216 (23.5%) | 517 (26.9%) | 699 (21.4%) | 22 (8.4%) | 125 (14.8%) | 730 (25.8%) | 336 (27.8%) |
| Stroke | 1,512 (29.2%) | 698 (36.4%) | 814 (25.0%) | 86 (33.0%) | 288 (34.2%) | 868 (30.6%) | 258 (21.4%) |
| Diabetes | 945 (18.2%) | 410 (21.4%) | 535 (16.4%) | 52 (19.9%) | 194 (23.0%) | 548 (19.3%) | 143 (11.8%) |
| Alcohol abuse | 292 (5.6%) | 187 (9.7%) | 105 (3.2%) | 73 (28.0%) | 130 (15.4%) | 71 (2.5%) | 6 (0.5%) |
| Substance abuse | 188 (3.6%) | 80 (4.2%) | 108 (3.3%) | 24 (9.2%) | 60 (7.1%) | 85 (3.0%) | 16 (1.3%) |
| Hospitalisations during last year | | | | | | | |
| Median (IQR) | 1 (0–2) | 1 (0–3) | 1 (0–2) | 1 (0–3) | 1 (0–3) | 1 (0–2) | 1 (0–2) |
| 0 | 1,916 (37.0%) | 628 (32.7%) | 1,288 (39.5%) | 89 (34.1%) | 299 (35.5%) | 1,044 (36.8%) | 472 (39.1%) |
| 1–2 | 2,171 (41.9%) | 810 (42.2%) | 1,361 (41.8%) | 97 (37.2%) | 322 (38.2%) | 1,196 (42.2%) | 543 (45.0%) |
| 3+ | 1,092 (21.1%) | 482 (25.1%) | 610 (18.7%) | 75 (28.7%) | 221 (26.2%) | 594 (21.0%) | 193 (16.0%) |
| At least one hospitalisation last 6 months | 2,819 (54.4%) | 1,103 (57.4%) | 1,716 (52.7%) | 144 (55.2%) | 468 (55.6%) | 1,540 (54.3%) | 644 (53.3%) |

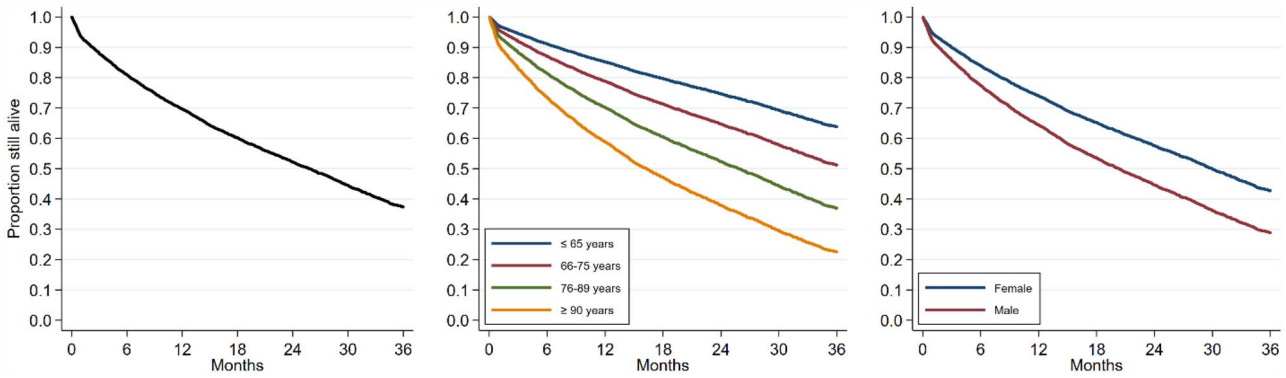


**Figure 1**. Survival among Danish residents moving into a nursing home during 2015–2017 ($n = 5179$) Overall (left panel), age-stratified adjusted by sex (middle panel) and sex-stratified adjusted by age (right panel).

catheters, feeding tubes, weight loss and malnutrition and the measures of physical impairment. These are known to be frequent concerns among nursing home residents [21, 22], and their possible influence on nursing home admission as well as morbidity and mortality is a scope for future research.

In agreement with our findings, multimorbidity and co-existence of several complex diseases are known to be common among nursing home residents, with dementia, depression, stroke and cardiovascular diseases being particularly frequent [7, 21, 23]. The observed prevalence of dementia

**Table 2**. Baseline predictors of three-year mortality after admission to nursing home

| | HR (95% CI) Univariate-adjusted analysis | HR (95% CI) Multivariate-adjusted analysis* |
|---|---|---|
| Sex | | |
| Male | 1.26 (1.17–1.36) | 1.37 (1.27–1.49) |
| Female | 1.00 (ref.) | 1.00 (ref.) |
| Age | | |
| <65 years | 0.52 (0.42–0.64) | 0.52 (0.42–0.65) |
| 66–75 years | 0.73 (0.65–0.82) | 0.70 (0.62–0.79) |
| 76–89 years | 1.00 (ref.) | 1.00 (ref.) |
| ≥90 years | 1.43 (1.31–1.56) | 1.55 (1.41–1.69) |
| Hospitalisations during last year | | |
| 0 | 1.00 (ref.) | 1.00 (ref.) |
| 1–2 | 1.26 (1.15–1.37) | 1.17 (1.07–1.27) |
| 3+ | 1.73 (1.56–1.91) | 1.49 (1.34–1.65) |
| Charlson Comorbidity Index | | |
| 0 | 1.00 (ref.) | 1.00 (ref.) |
| 1 | 1.14 (1.02–1.27) | 1.06 (0.95–1.20) |
| 2 | 1.35 (1.20–1.52) | 1.14 (0.99–1.30) |
| 3+ | 1.51 (1.35–1.68) | 1.16 (1.00–1.34) |
| Medical history of | | |
| Cancer | 1.49 (1.37–1.62) | 1.36 (1.25–1.48) |
| COPD | 1.37 (1.25–1.50) | 1.25 (1.14–1.38) |
| Dementia | 0.91 (0.84–0.99) | 1.00 (0.91–1.09) |
| Parkinson | 1.06 (0.91–1.23) | 1.15 (0.99–1.34) |
| Ischemic heart disease | 1.34 (1.20–1.50) | 1.03 (0.91–1.16) |
| Heart failure | 1.50 (1.40–1.62) | 1.23 (1.13–1.34) |
| Atrial fibrillation | 1.41 (1.29–1.53) | 1.07 (0.98–1.17) |
| Stroke | 1.13 (1.04–1.23) | 1.06 (0.97–1.16) |
| Diabetes | 1.10 (1.00–1.21) | 1.02 (0.91–1.14) |
| Alcohol abuse | 0.74 (0.62–0.89) | 0.90 (0.74–1.09) |
| Substance abuse | 1.17 (0.96–1.43) | 1.17 (0.95–1.43) |

*Adjusted for covariates assessed at baseline included in the categories: sex; age; hospitalisation rate within last year; Charlson Comorbidity Index; and medical history of.

is, however, lower than observed in other studies. Rolland *et al.* found a prevalence of dementia of 44% among French nursing home residents [21], and 43% had dementia at the time of nursing home admission in a Belgian study [23]. Since only individuals who have been diagnosed with dementia in a hospital setting or have received treatment for dementia are captured in the Danish health registries, the 32% of nursing home residents with a diagnosis of dementia in our study likely represents an underestimation [10]. Similarly, although the general burden of comorbid diseases is high in our population, this is not directly reflected by a high Charlson Comorbidity Index. The facts that some common diseases among older people, e.g. atrial fibrillation, are not included in the Charlson Comorbidity Index [24] and that not all chronic diseases are captured by discharge diagnoses likely explains this discrepancy.

Whether differences in disease status exist across age and sex in nursing home residents are only sparsely investigated [25]. In a Danish setting, we observed important differences across age span and sex at the time of nursing home admission. Thus, men are generally younger than women and have a shorter post-admission survival as well as a larger burden of comorbidity, including a higher prevalence of stroke, and alcohol and substance abuse in younger male residents. In addition, the predictive value of increasing Charlson Comorbidity Index differed across sex. Furthermore, we found important differences in mortality across sex and age with men and older people having the highest mortality. These findings are in line with a recent German study in which a substantial difference in mortality rate was observed for men and women (429 days median survival vs 824 days) as well as across age groups (decreasing from 841 days in individuals 65–74 years to 467 days in those >95 years) [26]. Altogether, these results highlight that the heterogeneity of this population is an important factor when developing care service strategies for nursing homes residents.

The substantial increase in the hospitalisation rate prior to nursing home admission observed in our study indicates that a recent increase in morbidity and frailty often precedes nursing home admission. This is emphasised by the fact that the majority of hospital admissions seem prompted by measures that indirectly seems to indicate frailty, e.g. unspecified conditions, volume depletion, malaise, fatigue, etc. The marked reduction in the hospitalisation rate following nursing home admission may indicate that a substantial proportion of these hospital admissions is prevented in a nursing home setting. Though this is only sparsely investigated, some studies suggest that nursing home residency reduces the rate of potentially preventable hospitalisations [27, 28]. Whether such reduction is a result of better care

preventing hospitalisation or may be the initiation of early treatment in the nursing home setting remains unknown. It is, however, of note that the vast majority of hospitalisations seem to be related to frailty, even after nursing admission.

Our findings provide an overview of important characteristics of nursing home residents, thereby contributing to the ongoing discussion of how to structure long-term care in the future. The substantial increase in the number of hospitalisations observed in the month leading up to nursing home admission suggests a preventive potential, e.g. through an outreach programme for vulnerable older people. Acknowledging the high burden of comorbidity and complex drug use, it is currently being tested whether having a general practitioner affiliated to each nursing home improves the well-being of the residents to [29]. Given the heterogeneity of the nursing home population, future studies should evaluate whether targeted initiatives are needed.

Though long-term care is structured substantially different across countries [21, 23, 30], the characteristics of nursing home residents in Denmark only seem to differ slightly from what has been reported in other countries [7, 21, 23]. This suggests that our findings are also useful outside Denmark and that approaches to care are potentially feasible in other countries as well, irrespective of differences in health care systems.

In conclusion, this study emphasises that differences in morbidity and mortality exist across age span and sex at the time of nursing home admission. In addition, the increase in hospitalisations, generally related to frailty, leading up to nursing home admission calls for further investigation. Thus, our study contributes to the ongoing discussion of how to structure the future health care system.

**Supplementary data:** Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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