Who will be waiting for me in the ward?
Changes in the age and sex composition of hospital patients in Denmark between 2014 and 2050.

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Abstract

Population aging in high-income countries will change the demographic profile of individuals in need of health care within the next decades. This study combines register data for the total Danish population with official population projections of the federal statistical office in Denmark to examine changes in the demographic composition of hospital patients in Denmark up to 2050, using the pattern observed in 2014 as a jump-off year. We found the annual number of hospital days to increase from 8.26 Million in 2014 to 10.91 Million in 2050. This trend will be predominantly driven by the population aged 70+. By 2050, men aged 70+ will be the largest group in Danish hospitals, accounting for 23.2% of all hospital days in 2050 (2014: 13.8%). The projected changes in the age and sex composition of hospital patients will require societal level responses as the preferences, needs and disease patterns of patients vary with age and sex.

Background

Remarkable improvements in life expectancy over the last two centuries in high-income countries resulted in a rapidly growing population of old-aged individuals[1,2]. Currently, in these countries including Denmark, one in four is older than 60 years, and it is projected that, by 2050, one in four will be older than 65 years.[3] Females outlive males, on average. In Denmark, there are twice as many females as males at the age of 85, and at age 100, the male-female ratio is 1:6 in 2018.[4] Previous research has shown that the risk of hospital admission and the duration of stay increases with age.[5] Although

these trajectories point clearly towards a scenario where especially elderly females will be prominent in hospital settings, little research has been done to investigate how the demographic structure of the population requiring hospital treatment will change within the next decades. This is particularly surprising as the demographic profile of patients in hospitals is an important public health issue as the share of the population treated in different contexts, such as hospitals, outpatient clinics, and palliative healthcare settings, and the number of medical doctors needed to provide healthcare services in these settings are central to planning policies for healthcare provision, but also for medical education. Furthermore, studies have shown that disease-specific incidence rates of major non-communicable diseases are highly associated with age and sex, including for example neoplasms,[6] circulatory diseases,[7] and dementia.[8]

Using routinely collected administrative data on all hospital admissions in Denmark we shed light on the age and sex profile of Danish hospital patients up to the year 2050 using the most recent population projections of the Danish federal statistical office, Statistics Denmark.

Methods and Materials

Data

In this study we utilized routinely collected administrative data on the individual level on all inpatient, outpatient and emergency admissions to hospitals in Denmark in 2014. We used the unique personal identification number, which is assigned to all individuals residing in Denmark,[9] to link records from the National Patient Register (NPR) with data of the Central Population Registry (CPR). The CPR contains information on each resident's vital status, sex, and place and date of birth since 1968.[10] The NPR is a population-based register, which contains information on all treatments provided in Danish hospitals since 1977.[11] Reports to the administration are compulsory.[12] Register data in Denmark have high levels of completeness and reliability, making these data a valuable source for research.[13]

Study Population

As 2014 is the last available year in the registers, we used this year as a jump-off year for the projections. In a first step we calculated the total number of hospital days for all inpatient and emergency admissions by single years of age, and separately for men and women. Each day that a patient stayed in the hospital

was counted as one single day. We also estimated the contribution of outpatient treatments, which were provided within the hospital setting. We approximated each outpatient to contribute exactly one days. We used this approximation for outpatient admissions since the registers neither provide the exact number of days an outpatient has spent in the hospital, nor an overview of the provided services. Instead, the information in the registers on outpatient treatments cover the start and the end date of the treatment period for administrative purposes. Using this approximation, we found that inpatient, outpatient and emergency admissions accounted for a total number of 8,259,420 hospital days in 2014. In a second step, we obtained population estimates for the year 2014 from the register. We identified all men and women alive and residing in Denmark who were at risk to be admitted to hospital in 2014 (n=5,627,235). We divided the total number of hospital days by the corresponding population at risk to estimate the average annual number of hospital days for the jump-off year 2014.

Statistical Analysis

We applied the estimated age trajectory of hospital care use to the most recent population projections of the federal statistical office in Denmark. This official projection is deterministic, and based on the assumption that the trend, which has been observed within the last four years will remain stable throughout the projection period.[14] Along with our main findings we provide a sensitivity analysis of the projection in which we use different specifications for the jump-off year in order to examine the impact of obstetrics-related admissions and outpatient treatments, as both might drive the long-term trends predominantly.

Results

Figure 1 shows the average annual number of hospital days per person for men and women, over age, in 2014. For men, the trajectory of hospital care use was consistently U-shaped over the observed age range. At age 0, the average annual number of hospital days was 1.5. It decreased after age 0 and reached the minimum at age 7, at a level of 0.5. Starting from age 8, the level increased slightly until age 14 and plateaued until age 33 on a level of around 0.6. From age 34 onwards, the level of hospital days increased steadily with age, and reached a level of around 5.4 among men aged 90+.

While men showed a consistent U-shaped pattern across the observed age range, we found the tra-

jectory among women to be different. The age-trajectory of women was U-shaped until age 29, and it changed to a J-shaped form thereafter. Although the level among women is very similar to those among men until the age of 13, the average number of days in hospital consistently increased with age among women between age 9 and 29. The level for women reached a local maximum at age 29 and on a level of 1.5. Afterwards the levels started to decline until the age of 41, on a level of 1.0. Starting at age 42, the levels started to steadily increase among women, reaching a level of 4.3 for ages 90+. Women had consistently higher levels of hospital days between age 14 and 66 than men. We found a crossover in the levels between men and women at age 67. After this age, the average annual number of days in hospital was smaller among women than among men.
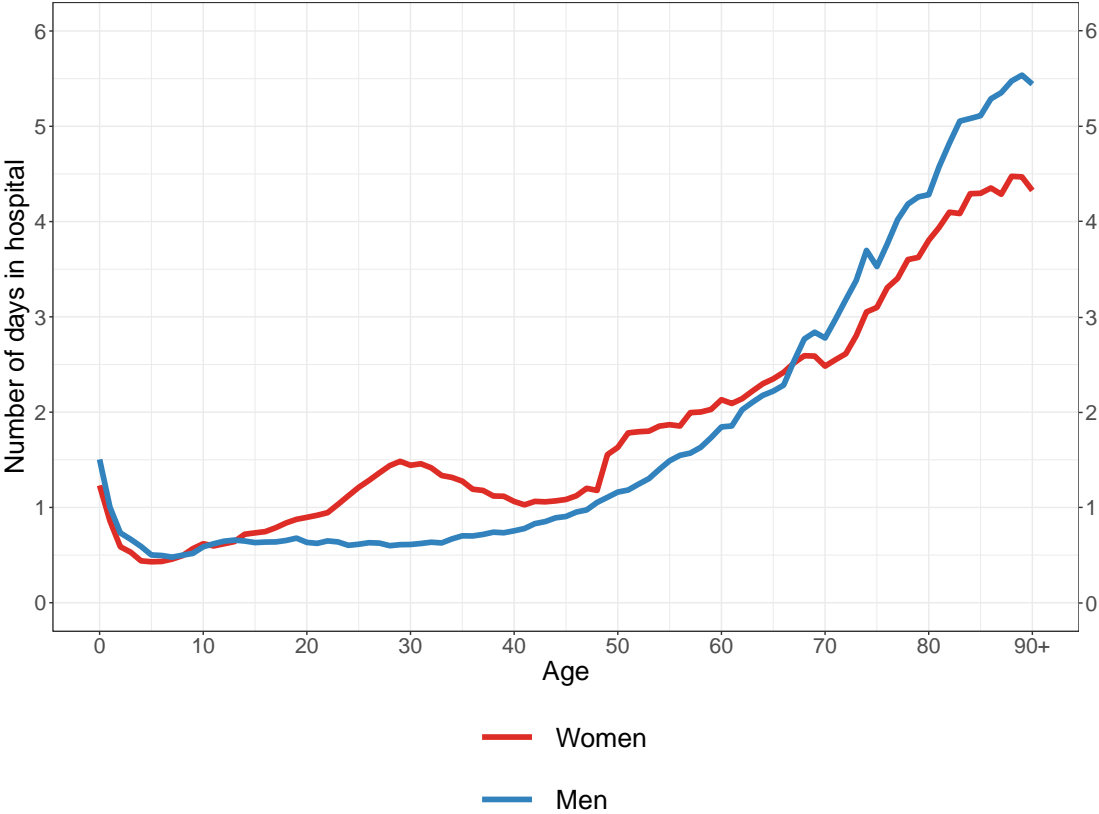

Figure 1: Average annual number of days spend in hospital per person over age in 2014.

We estimated the total number of hospital days and the underlying proportion of men and women by single years of age. We used register data for estimations of hospital days in 2014 and produced projections for each year between 2018 and 2050. Figure 2 shows the total number of projected hospital

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days broken down by sex and age groups for the period 2018–2050 in 100,000. Throughout all years, boys and girls aged 0–14 contributed the smallest amount of hospital days in relative and absolute terms. Levels in 2014 were 3.3 (4.0%) and 2.9 (3.5%) among men and women, respectively. By 2050 the projected levels have increased to 3.7 (3.3%) for men and to 3.2 (2.9%) for women. The levels of the age group 15–49 are projected to decrease slightly until 2050. The age group 15–49 contributed 9.5 days (11.5%) among men and 14.4 days (17.4%) among women in 2014. By 2050, the contributions in this age group were 9.9 (9.1%) and 15.1 (13.9%) for men and women, respectively. In contrast to the age group 15-49, the levels of the age group 50–69 are projected to decrease slightly until 2050. Levels in 2014 were 13.0 (15.7%) and 15.1 (18.2%) among men and women, respectively. By 2050 the projected levels have decreased slightly to 12.5 (11.5%) for men and to 14.7 for women (13.4%).
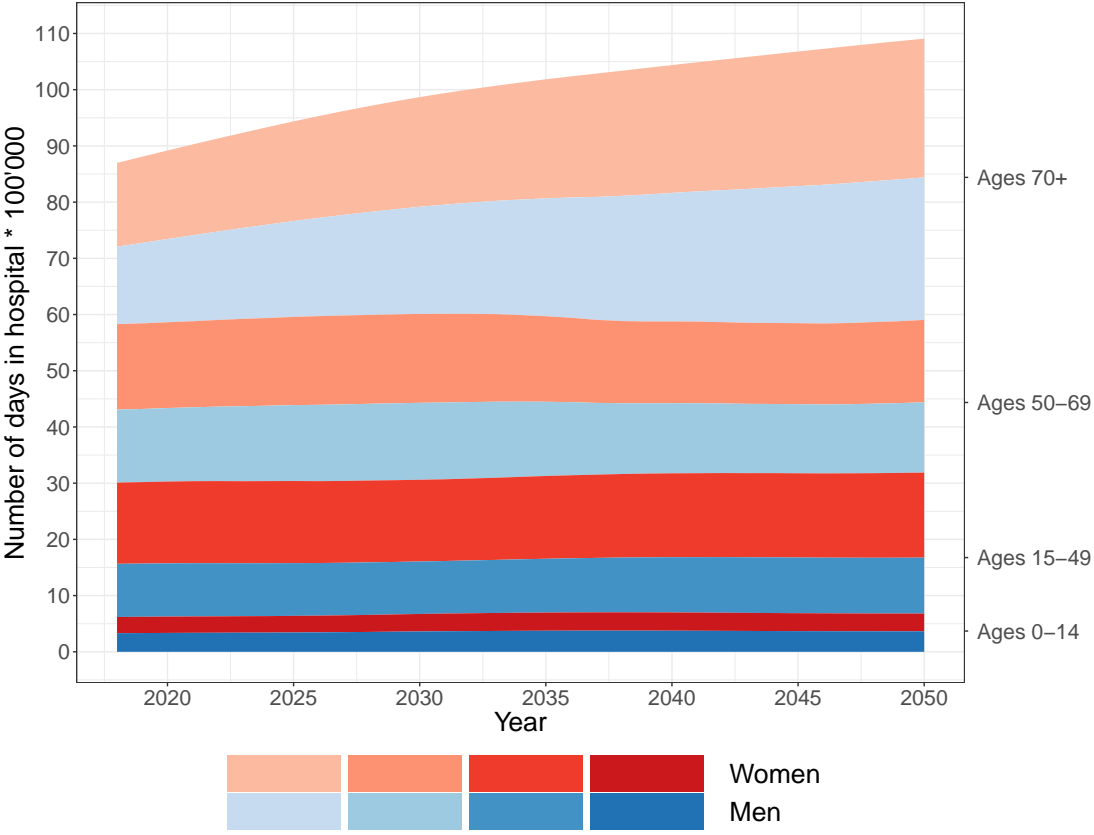

Figure 2: Projected average annual number of days spend in hospital per person 2018-2050.

The largest increase between 2014 and 2050 was observed among the age group 70+. In 2014, the levels were 11.4 (13.8%) among men and 13.1 (15.9%) among women. We found the levels to in-

crease steadily until 2050, reaching levels of 25.4 (23.2%) among men and levels of 24.7 (22.6%) among women. Mainly driven by increases among men and women aged 70+, we found the overall level of hospital days to steadily increase in Denmark between 2014 (8.26 Million) and 2050 (10.91 Million).

Sensitivity Analysis

We examined the robustness of the presented findings (Setting A) by controlling separately for the impact of obstetrics-related admissions (Setting B), outpatient admissions (Setting C), and a combination of both (Setting D). We first compared different specifications for the jump-off year 2014 (see Figure 3). The exclusion of outpatient treatments roughly halved the levels of average hospital days among men and women in the jump-off year 2014. As expected, the removal of all admissions related with obstetrics reduced the levels among women of age 15-49 significantly, but it had no impact on the levels at higher ages among men and women. We then used the different specifications of the jump-off year for the forecast (see Figure 4). Although the absolute levels differ based on the choice of a setting, men aged 70+ always remained the largest patient group in 2050, followed by women aged 70+.

Discussion

Principle Findings

In this study, we investigated changes in the age and sex composition of hospital patients in Denmark up to the year 2050 using data on all types and all causes of admission to hospital. We used the age trajectory of the annual hospital care use in 2014 as a jump-off. We then projected the total number of hospital days in Denmark taking age and sex into consideration. Our analysis revealed a substantial increase of hospital care use as a result of population aging with the age group 70+ being the most important driver, accounting for nearly 1 in 2 hospital days in 2050. By 2050, men aged 70+ are projected to be the largest group treated in Danish hospitals.

Strengths and Limitations

This study utilizes Danish register data. The data provide nationwide coverage and are representative of the total Danish population. In contrast to survey data, register data suffer less in terms of non-response and loss to follow-up.[15] We used register data on hospital care use, which are routinely collected in hospitals and reports to the administration are compulsory. This eliminates recall biases and problems regarding the under- or overstatement of the health care use – problems, which often affect studies which are based on self-reports.[16] In Denmark, hospital care is financed through taxes and the access to health care services is free and universal for all residents with GP's having an essential gate-keeping role regarding the use of hospital care.[17] We expect that the tax-financed healthcare provision substantially reduces socioeconomic inequalities in the access of health care. Nevertheless, potential hurdles in accessing health care services might still exist in Denmark and it cannot be ruled out that the propensity of health care use is shaped by social, economic, and geographic factors, or by mechanisms of the inverse care law, meaning i.e. that groups who need health care most utilize the least.[18,19]

One limitation of this study is the lack of information from general practitioners and specialist doctors working in settings outside the hospital, in which women in Denmark have contact more often than men.[20] Furthermore, forecasting is by nature uncertain, as are the future hospitalization patterns. In this study, we used a deterministic population projection and assumed future hospitalization rates to remain stable within the next decades. The freezing of age and sex-specific rates is one of the easiest forecasting methods. However, it has been shown that freezing rates might consistently outperform statistically sophisticated techniques and is among the methods of highest accuracy.[21] In addition to the distribution of risk factors and diseases within a population, structural factors including admission strategies and the efficiency of primary health care are important determinants of the hospital care use.[22,23]

Interpretation in Light of Previous Findings

Our findings indicate population aging to be an important driver for two important features: first, the amount of health care provided, and, second, the demographic composition of people in need of hospital care. The official population projections of the federal statistical office in Denmark assume the life expectancy of men and women to further narrow within the next decades. Results of our projection therefore indicate men aged 70+ will be the fasted growing group to be treated in Danish hospitals

by 2050. Although the sex differences in the average length of life are assumed to narrow, women will keep their advantage in life expectancy and will outnumber men at older ages in the general Danish population. Nevertheless, the female predominance in survival will, to some degree, be set off by the higher hospitalization risk among men found both here – and in previous studies of older Danes. [20]

Relevance and Implications

It has proven difficult to convince medical students and student nurses to make treatment of the elderly one of their career priorities, and their attitudes are often associated with a poor general impression of the elderly. [24] Working with the elderly is often perceived as negative because the prospect for patient's improvement and progress is seen as low. [25] However, survival and, particularly, cognitive functioning has improved within recent decades, and elderly are remarkably satisfied with their life considering the toll that aging generally takes on health and functioning. [26,27] This underscores the need for a more positive attitude among future health care professionals towards elderly patients.

Conclusion

Our study showed that population aging will raise the total amount of health care provided in Danish hospitals. At older ages, men have a higher risk of admission than women. The combination of greater improvements in life expectancy among men with their greater use of hospital healthcare services will make men aged 70+ to be the largest patient group in Danish hospitals by 2050. These findings indicate the need for societal-level responses as the preferences, needs and disease patterns of hospital patients vary with age and sex.

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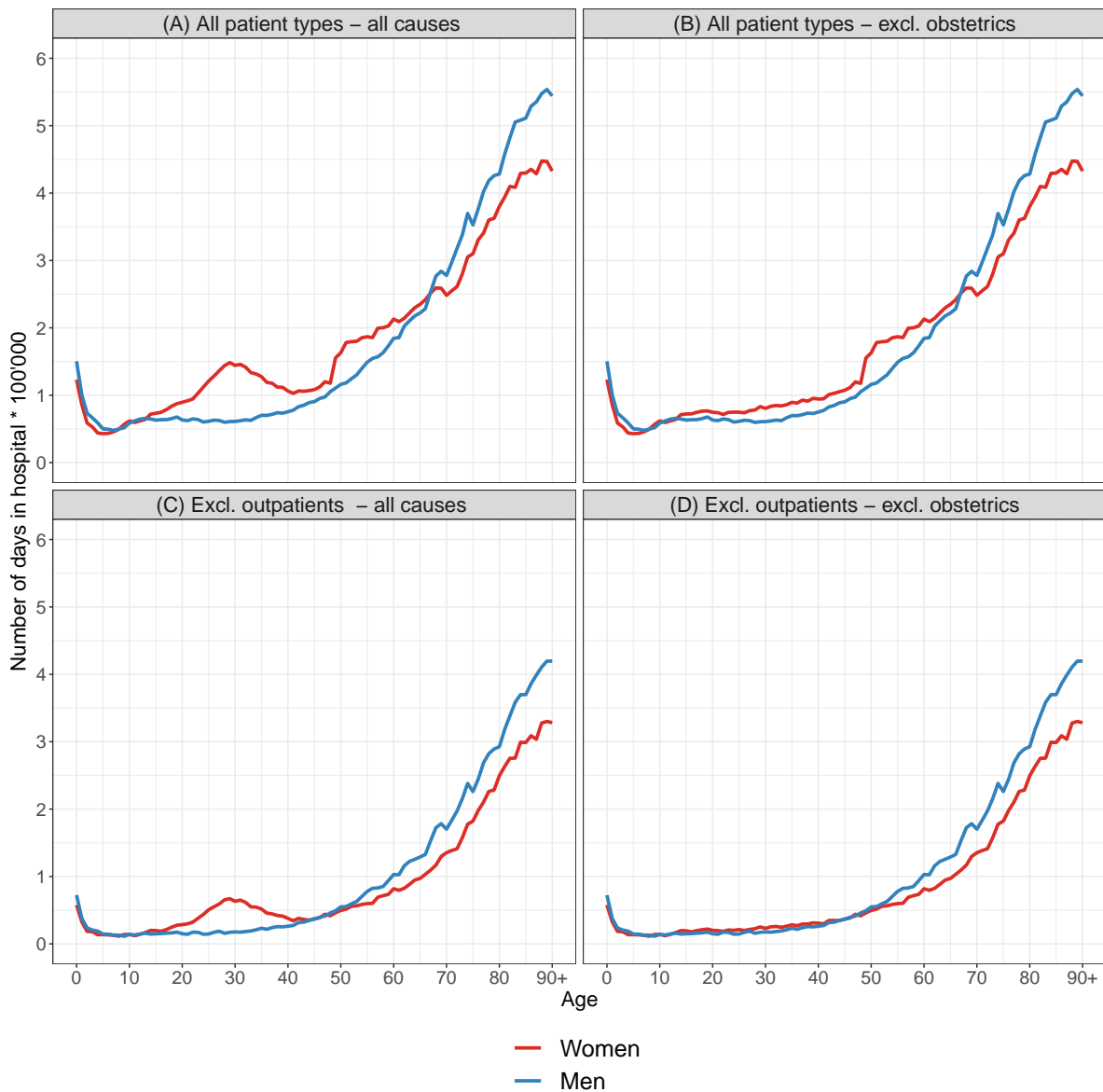# Supplementary Material: Sensitivity Analysis

Figure 3: Average annual number of days spend in hospital per person over age in 2014 under consideration of different admission types and causes.*

We specified obstetrics related admissions as O.00 – O.99 and Z.30 – Z.39 according to the International Classification of Diseases (ICD), 10th Revision.
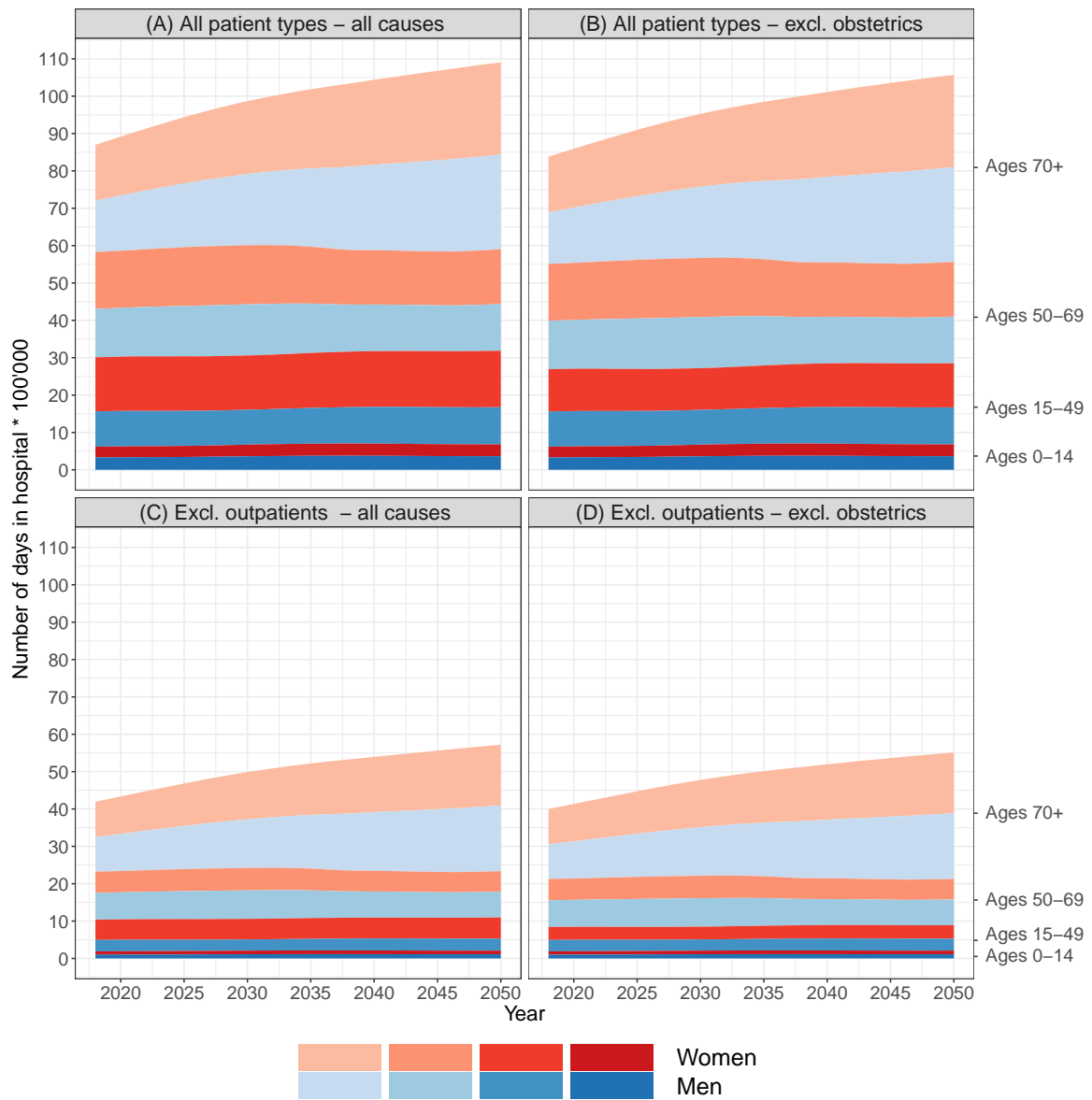
Figure 4: Projected average annual number of days spend in hospital per person 2018-2050 under consideration of different admission types and causes.

Funding

Ethics Approval

The study involves secondary data analysis of existing register data. The project was approved by the ethical committee assigned through the Danish National Committee on Biomedical Research and the Danish Data Protection Agency.