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Master thesis | Original study

Trends in age profiles of surgical patients over 4 years in a Belgian tertiary hospital

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Abstract

Background: **In surgical care, advancing age is associated with more specific and long-lasting care with more complications and a higher mortality rate. In order to take the right precautions in the long term, with the aim of improving patient care and reducing the pressure on care and costs for hospitals and healthcare, it is important to review the past and understand likely future trends in the epidemiology of the surgical population.**
Objective: **To perform a first investigation on the impact of the age profile of the ageing general Belgian population on the age profile of the surgical population.**
Design and setting: **A time trend ecological retrospective, single-centre study was conducted at the Ghent University Hospital.**
Methods: **After approval by the Ethical Commission of the centre, all patients admitted for surgery with anaesthetic care during a 4-year period were included in this study. The proportion of surgical patients in different age groups and their change in age profile over time were analysed. Official public data on the epidemiology and forecasted trends of age groups were used as inputs to estimate the future growth in the surgical population.**
Main outcome measures: **Age distribution of the surgical population compared to the Belgian population.**
Results: **Between January 1st, 2016 and December 31st, 2019, 124.189 surgical episodes (28,1%%of all episodes) were recorded. Percentage of patients > 74 years old in the surgical population ranged from 4.4 % to 4.9 % and from 3.9 % to 4.3 % for males and females, respectively. This corresponds with an underrepresentation for females by factor 0.71-0.73 and an overrepresentation for males by factor 1.26-1.4 in relation to the general Belgian population. Using these factors, specific for each observation year and each 5 year group, a prediction for the evolution of the surgical population up until 2038 was calculated.**
Conclusions: **At the Ghent University Hospital, differences are found between the age profile of male and female patients and between the age profiles of the general population. These disparities are seen as a unique fingerprint of hospital practices and represent a specific dynamic modelling the impact of an ageing population on future hospital resources.**
Trial registration: **No trial registration was required.**

Keywords: **Aged, Belgium/Epidemiology, Forecasting, Surgical Procedures, Operative/Statistics and Numerical Data, Surgical Procedures, Operative/Trends.**

Approval by the Commission for Medical Ethics of the University Hospital of Ghent, (Chairman: Prof. dr. Deron P., address: C. Heymanslaan 10, 9000 Ghent, internal reference number: THE-2022-0165 on September 22th 2022). Written informed consent was not required. Data was obtained from the 1st of January 2016 until the 31st December 2019. .

Introduction

Ageing is a human success story, thanks in part to the progress in medicine and healthcare. In 2019, there were 2.2 million people aged 65 years or over in Belgium, representing 18.9 % of the Belgian population. Compared to five years earlier, this age group grew by 1 % per year, while the average Belgian population grew by 0.5 % per year[1,2]. As a result, the population pyramid is changing, with an increase in the older age groups and a widening at the top in the future.

Ageing is associated with major problems through progressive loss of physiological integrity, increased susceptibility to death and disease and implies an increasing need for surgical intervention. In surgical care, ageing is associated with more specific and prolonged care, more post-operative complications and a higher risk of mortality[3,4,5]. Schwarze et al. published a list of high-risk surgical procedures for patients aged 65 years and older with a crude inpatient mortality rate of at least 1 %. The pooled inpatient mortality for these procedures in patients aged 65 years or older was twice as high as the pooled inpatient mortality for patients aged < 65 years (6 % vs. 3 %)[6]. The POSE-trial showed an overall 30-day mortality rate of 4.2% in patients aged 80 years or older[7]. Although the lower mortality rate found in this study, they showed that it increased with age. These findings highlight the need for specific peri-interventional adjustments and further patient-centred research.

In order to take the right precautions in the long term, with the aim of improving patient care and reducing the pressure on care and costs for hospitals and healthcare, it is important to review the past and understand likely future trends in the epidemiology of the surgical population. Unfortunately, over the past 10 years only few data and trends in the age profile of the surgical population have been studied. For example did Fowler et al. describe a surgical population for the NHS that aged faster than the general population[8,9]. As Belgium does not systematically track these figures, it is therefore difficult to gain a full understanding of the epidemiology and how to improve safety and efficacy for this older population. Against this background, we aimed to describe the distribution of the surgical population in relation to the age profile in the Belgian population and to model future trends.

Methods

Approval for the time trend ecological retrospective, single-centre study was obtained by the Ethics Committee of the Ghent University Hospital (THE-2022-0165), according to the Helsinki Declaration. All patients signed informed consent. As no patient identifying information was extracted for this study, patient informed consent was not deemed to be required.

Data sources

The MZG ("Minimale Ziekenhuisgegevens"/ Minimum Hospital Data) department of the Ghent University Hospital collects, as by law required by the Belgian Ministry of Public Health, anonymised data on all patients admitted and treated. The data required for this study was provided after approval by the ethical committee.

Population estimates for all inhabitants of Belgium (as published online annually) and more detailed data such as average age by sex (which is not publicly available online) has been provided by StatBel, the Belgian statistical office that collects, produces and disseminates reliable figures based on administrative data sources and surveys.

Study periods

Data of all hospital episodes from 1st 2016 until December 31st 2019 were obtained.

Inclusion and exclusion criteria

Data were collected for all patients (children and adults) undergoing any procedure (including diagnostic, interventional and endoscopic procedures) with local, regional or general anaesthesia. Patients who underwent procedures without anaesthesia, who had missing data or those without any procedure during their hospital stay, were excluded from the analysis.

Variables

Data are screened for age, gender, ICD9/10-code (International Statistical Classification of Diseases and Related Health Problems), DRG code (Disease Related Group), type of anaesthesia, type of hospital stay, length of hospital stay, main diagnosis and destination after discharge from each surgical patient. Each surgical procedure is coded with a unique ICD which is used to identify the coded clinical entry. In addition, each hospital episode is coupled with a DRG-code, which is a statistical system for classifying each inpatient stay into groups. In this study, only the variables of age, gender and length of hospital stay were analysed. For further research after the initial results, the other variables were also implemented in the database but have not yet been used in the following analyses.

Data analysis

Data sheets were created for each year from 2016 until 2019. Data were verified both manually and

with the Python and R programming languages, as double confirmation. For each admission episode ICD9/10 and DRG codes were scanned for procedures and anaesthetic care. Age data were divided into four age groups: 0-14 y/o, 15-59 y/o, 60-74 y/o and over 74 y/o. Additionally, patient age of each unique episode was divided into five-year groups. For each included year, population pyramids were constructed based on the percentage of each group for each gender of the total number surgical patients. The same methodology was used to construct demographic pyramids of the Belgian population. Pyramids of the total population were based on the four defined groups. The "over 74 y/o"-group was analysed and depicted in detail using the five-year groups.

Based on the distribution of the surgical and general (Belgian) population distribution, the hospital specific age profile corrected for the general population was constructed by dividing the percentage of each group of the surgical population by the percentage of the corresponding group of the general population. This was done for each group of each gender and for each year. This pyramid can be seen as a unique profile of the age-related activities, corrected for the underlying general population. In other words, this would be the age profile of surgical patients if all ages were equally distributed in the general population.

These four profiles, one for each year monitored, were used to predict future trends in the surgical population, since the distribution of the surgical population can now be calculated as the product of the distribution of the general population and the hospital specific profile of age-related activities. Predictions of these trends were made using the prediction of the trends in population of the Belgian population for the next 15 years (i.e. to 2038).

Finally, for the five-year groups of the population over 74 y/o, the distribution of the cumulative length of hospital stay (LOH) was determined as the sum of the LOH of each episode of patients within each group.

Statistical analysis

Data were stored in Office Excel® 2011 sheets (Microsoft, Redmond, Washington, USA) and analyses were performed using Python version 3.10.7 (Python Software Foundation, Wilmington, Delaware, USA), R version 4.2.0 and Tidyverse-package 1.3.2 for data-wrangling and visualisation (R Foundation for Statistical Computing, Vienna, Austria). To test differences in population distribution chi-square test was used.

Results

During the study period, a total of 441.711 hospital episodes were recorded, of which 124.189 hospital episodes (28.11%) were linked to a procedure requiring anaesthesia. Of 201 episodes (0.2%) there was no recording of a variable discussed above. Of the 124.189 episodes with hospitalised patients, 63.008 were males (50.7%), 59.480 females (47.9%) and 1.701 were patients with other gender identities (1.4%).

1. Age distribution and trends

1.1. Age pyramids

The age data for the general Belgian population and the surgical population are divided into four age groups (0 - 14 years, 15 - 60 years, 61 - 74 years and > 74 years) for the male and female population by year, plotted in separate age pyramids.

1.1.1. Belgian population

Demographically, the total Belgian population grew at an average annual rate of 0.5% from 11.267.910 to 11.431.406 inhabitants during the period 2016-2019. The overall distribution is shown in Figure 1. During this period, a stable proportion of children aged 0-14 years was observed (17% of the total population) combined with a decrease in the proportion of 15-59 year olds from 58.8% in 2016 to 57.9% in 2019. The age group of people over 60 years grew on average by 1.7% per year to 2,725,675 inhabitants in the same period, increasing its share in the total population from 24.3% to 25.2%, mainly in the 60-74 age group. These shifts were statistically significant ($p < 0.005$). The total Belgian population is thus aging, as the age groups of over 60 years old grew more than three times faster than the total population.

1.1.2. Surgical population

Clinically, the number of surgical patients increased on average by 1.1% per year from 27 905 to 28 809 over the same period. The proportion of children aged 0-14 years increased from 19% to 19. %, while the proportion of the age group aged 15-59 years decreased from 49.2% in 2016 to 46.8% in 2019. The age group > 60 years within this surgical population grew faster, by 2.9% per year: from 22.2% in 2016 to 23.1% in 2019 in the age group 60-74 years and from 8.3% to 9.2% for the patients over 74 years. These shifts were statistically significant ($p < 0.005$). The overall distribution of the surgical population is shown in Figure 2.

For every male person, in the general population, older than 60 years there are 2.7 people between 15 and 59 years of age. For the female population, the ratio is 2.2. During the study period, these ratios remain approximately the same.

For the surgical population, the proportions are markedly different. For the male population, there

are only 1.3 people between the ages of 15 and 59 for every person older than 74. For the female population, the ratio is more in line with the general Belgian population and amounts to 2.1.

2. Practices and indications

By taking the general population of Belgium as a base and representing/indexing their average age per group as 1, the age groups of patients undergoing surgery can be plotted against this benchmark. Thus, the overall evolution of the older surgical population relative to this base population is visualized in Figure 3.

On the left side of Figure 3, the blue columns, the proportions in the male surgical population relative to the male general population are shown as a baseline with the black dashed line. For the young age group of 0 - 14 years, a higher proportion of procedures in young male children can be seen compared to the proportion of young male children in the general Belgian population. In the age group 15 - 59 years, a gross decrease with significantly fewer procedures compared to the male population is observed. These results remain the same for 2016 to 2019 with no major changes. The older age groups have a marked increase in the number of procedures

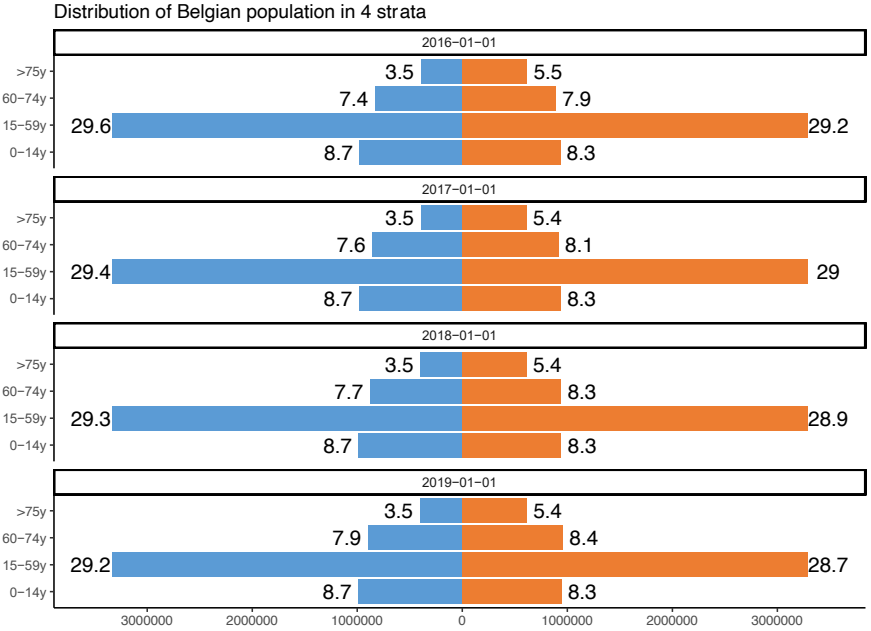

Fig. 1 — Distribution of Belgian population from 2016 until 2019 in 4 age groups.
x-axis: absolute numbers, bar number in percentage. Blue bars: Male, Orange bars: Female.

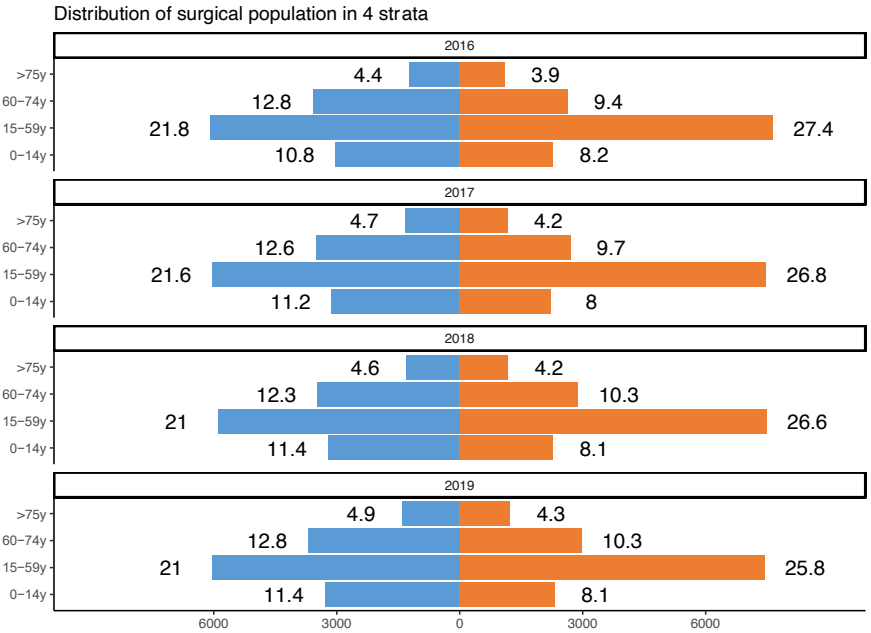

Fig. 2 — Distribution of Belgian population from 2016 until 2019 in 4 age groups.
x-axis: absolute numbers, bar number in percentage. Blue bars: Male, Orange bars: Female.

Fig. 3 — Comparison of the age structure of the surgical population relative to the age structure of the Belgian population taken as a baseline.
x-axis: absolute numbers, bar number in percentage. Blue bars: Male, Orange bars: Female.

compared to baseline, an overrepresentation. In 2016, most procedures fall among older people in the 60-74 age group, but an evolution can be seen towards 2019 with a small decrease in the proportion in this group and a slight increase among the very oldest, >74 years old.

The right side of Figure 3, the orange columns, show the proportions of the female surgical population relative to the female Belgian population (again shown as a baseline, black dashed line). Among the female population, it is striking that in the youngest age group of 0 - 14 years, the ratio is almost equal to that of the general population. The age group 15 - 59 years shows a slight decrease, but not as significant as in the male population. This decrease increases slightly from 2016 to 2019. An interesting phenomenon occurs in the oldest age groups. Like the male population, there is an increase in the ratio in the 60 - 74 age group, with a slight increase from 2016 to 2019. But unlike the male population, a significant decrease in the female surgical population compared to the female Belgian population is observed. Thus, there is an underrepresentation of the female surgical population.

3. Predictions

In 2020 the Federal Planning Bureau, an independent public agency of the Belgian government, published the demographic outlook up to 2035 based on current trends10. These predictions are used in the same way as the above calculations. Due to the emphasis of this study, careful attention is paid to the predictions of the older age categories.

In Figure 4, the forecast of the general Belgian population represented by the columns on the x-axis, there is a steady rising trend in the ageing of both male and female population from 2023 until 2037. This movement is consistent with the results from 2016 to 2019.

The largest shares of the elderly population, for both female and male, are found in the 75-80 and 80-85 age groups, between 1 and 2 %. In the 85-90 years category, the proportion in men (0.7 % in 2023 – 1 % in 2037) drops by a third compared to the female population (1.1 % in 2023 – 1.5 % in 2037) in this age group. Between 90 - 95 years, the male population (0.3 % in 2023 – 0.4 % in 2037) drops further to half the female population (0.6 % in 2023 – 0.8 % in 2037) to be only one-third in proportion by the oldest population, 95 - 99 years and > 100 years.

The black lines show the predicted trends in the surgical population from the surveyed years 2016 to 2019. Growth and ageing is in line with that of the general population. But the male surgical population shows a clear overrepresentation compared to the general population for the age groups 75-80 years and 80-85 years. After this, the ratio evens out to become an underrepresentation in the oldest age categories. In the female surgical population, an equal ratio can be observed in the 75-80 age group compared to the general population. After this, the ratio gradually becomes a greater underrepresentation and is more pronounced than that of the male population. This trends parallels the results in the 2016 to 2019 survey.

The surgical population is ageing and growing along with the general population, but the

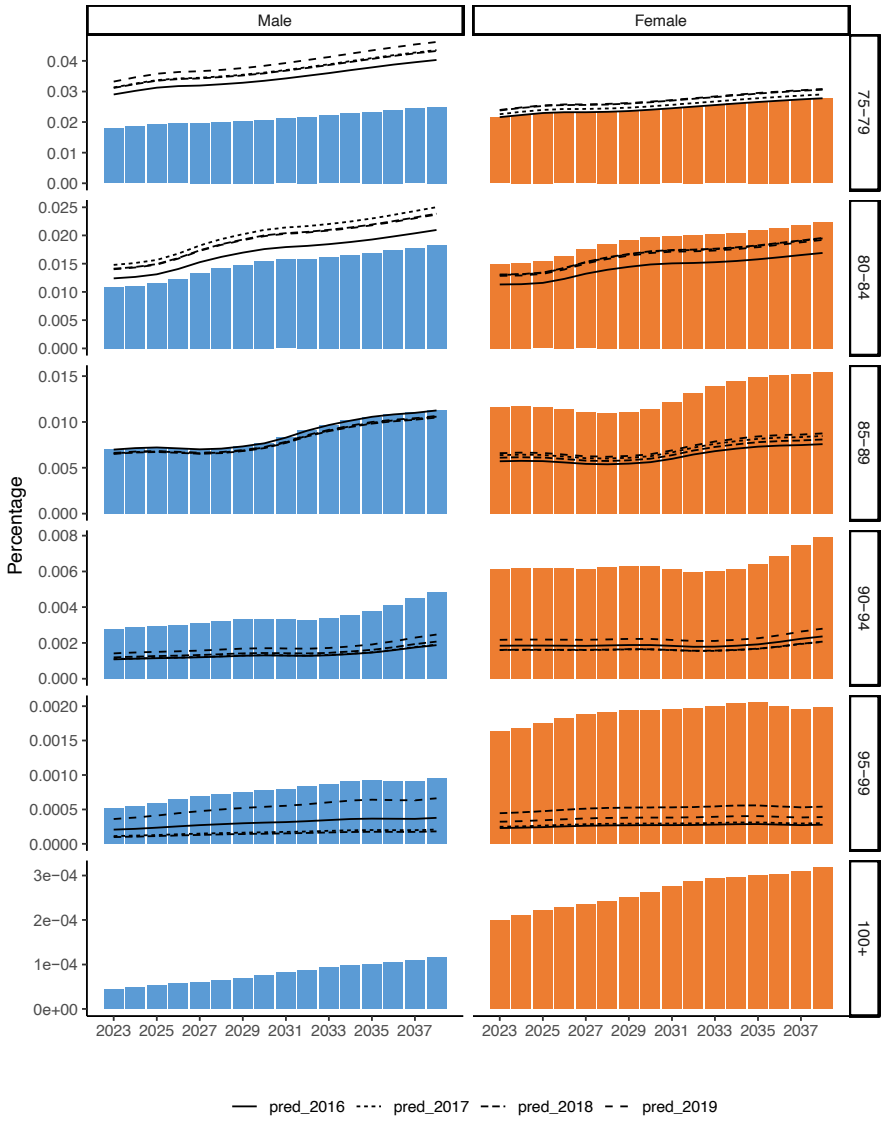

Fig. 4 — Prediction of the age structure > 74 years of the Belgian population in comparison with the prediction of the surgical population.
x-axis: absolute numbers, bar number in percentage. Blue bars: Male, Orange bars: Female.

overrepresentation in the younger age groups balances out the underrepresentation in the older ages.

4. Hospital stay

4.1. Mean length of hospital stay

The mean length of hospital stay per age groups in the period 2016 – 2019 is 2.84 days for patients between 0 and 15 years old, 3.86 days for patients between 16 and 60 years old, 5.76 years for patients between 61 and 75 years old and the eldest - above 75 years old - have a mean length of 9.11 days. A clear increase in the number of days as the population ages is observed.

4.2.Cumulative length of hospital stay

The cumulative length of hospital stay in the four different age groups is shown in Figure 5. Despite the children (0 – 14 years) not being the smallest proportion in the surgical population, as discussed in 1.1.2, they have the smallest proportion in the total number of bed days. This trend is observed for both female and male, but with slightly more hospital days for the male proportion in line with the slightly larger male population in the 0 - 14 years category.

For the 15 - 59 age group the number of cumulative hospital days is expected to be the highest given that this category, for both male and female population, contains the largest proportion of the surgical population. The cumulative length of hospital stay is higher for males than females, despite more females representing the population in this category. Among the elderly, as can be inspected from the absolute numbers in the surgical population, a greater number of cumulative days in hospital stay in the 60 - 74 years group was found than in the > 74 years group. Also accompanied by a greater proportion for the male population than the female population.

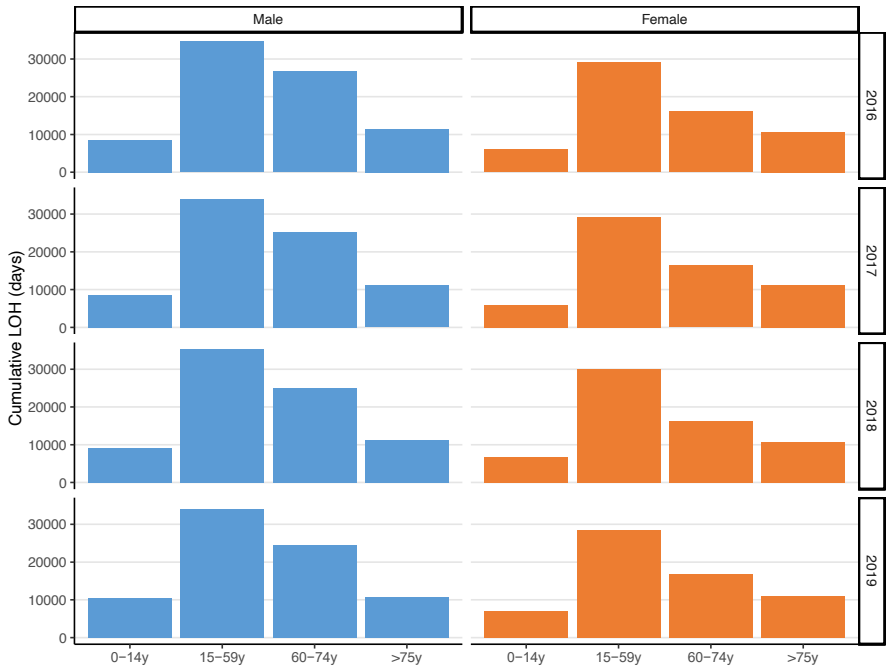

Fig. 5 — Cumulative length of hospital stay of the surgical population from 2016 until 2019 per age groups.
x-axis: absolute numbers, bar number in percentage. Blue bars: Male, Orange bars: Female.

Discussion

The surgical population at Ghent University Hospital is ageing faster than the general population, with clear differences between the sexes in the older groups.

There is a notable lack of comprehensive data and research regarding surgical patient demographics. Existing studies often overlook the distinction between genders, despite significant gender disparities observed in the general population. This gap in knowledge calls for further research to understand the specific trends within surgical populations, considering the unique healthcare needs and experiences of men and women. By addressing this gap, healthcare interventions can be better tailored to meet the diverse needs of patients, ultimately improving surgical care and outcomes.

The age distribution of surgical patients can vary across hospitals due to their unique characteristics and care programs. Factors such as the hospital's specialty, pediatric centers, and obstetric wards catering to complicated pregnancies contribute to differences in patient demographics. At Ghent University Hospital, cardiac, vascular, and oncological surgeries account for a higher proportion of older patients, while specialized units like the Neonatal Intensive Care Unit (NICU) and obstetric ward result in a larger representation of young and middle-aged women.

Hospital vs. Department-Level Analysis

This study examines anesthesia procedures at the overall hospital level, acknowledging that each department within a hospital has its own dynamics. Differences emerge between elective and urgent procedures within departments, influenced by indications, practices, and the distribution of the general population. Factors such as minimally invasive techniques and the hospital's identity also impact age distribution. While this study focuses on the hospital level, future research should consider department-level analyses to capture more nuanced variations.

Gender Paradox

Despite a higher proportion of elderly women in the general population, this study reveals that more men than women require surgery in older age groups. The gender paradox can be attributed to various factors. Women's longer life expectancy, lower rates of cardiovascular disease, and healthier lifestyles contribute to their lower surgical demand. In contrast, older men are more prone to chronic health conditions, occupational hazards, and potential delays in seeking healthcare[11,12,13].

Limitations and Strengths

This study, spanning a 4-year period with over 100,000 data points, is the first in continental Europe to explore geriatric surgery trends. Comparisons with accurate government-provided population data enhance its reliability. By including all procedures performed under anesthesia without selective criteria, the study minimizes selection bias. However, limitations should be considered, including the focus on a single hospital, which may

not represent other Belgian hospitals. The analysis covers a limited timeframe due to code revisions and excludes data from 2020 and 2021 due to the pandemic's impact on surgical activity. The study acknowledges the volatility of trends and the potential influence of future health crises on surgical patterns.

Conclusion

The surgical population of the Belgian UZ Ghent hospital is ageing faster than the general population with disparities between the male and female populations. These disparities are seen as a unique fingerprint of the hospital's practices and constitute a specific dynamic that models the impact of an ageing population on future hospital resources. More research is needed to meet with this growing demand for geriatric surgery.

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Conflicts of interest: None.

Data sharing: Data are available from the corresponding author upon reasonable request by email.

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