

Trends in female authorship in Acta Anaesthesiologica Belgica from 2005 to 2021

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Abstract

Purpose: This study aims to investigate the trend of female representation in publishing in the Acta Anaesthesiologica Belgica (AAB) from 2005 to 2021. In recent years, there has been an increased focus on gender equality and disparity. However, as far as we know, an evaluation of the Belgian literature in this regard has not been undertaken before.

Methods: The study's main objective is on determining the gender of the first author, with the gender of the second and last authorship position being secondary outcomes. Additionally, the study aimed to investigate whether other variables, such as the field in which the article was published, study type, the country of origin (of the first author), the first author's academic degree, the number of authors, and coauthors' gender, are related to these outcomes.

Results: In total 475 manuscripts were included for data collection, of which 146 (30.7%) had a female first author, 94 (19.8%) had a female second author, and 61 (12.8%) had a female last authorship position. We demonstrated a trend towards greater gender equality in the AAB over time, with more women occupying first and second authorship positions. However, we observed a stagnation in female last authorship positions, with only a small increase of last female authorship of 1.16% reaching 7.41% in 2021. Further analysis showed that female last authorship affected first female authorship. As the number of authors increases, the representation of women (particularly for the last author) diminishes compared to their male colleagues. Lastly, the analysis of gender in relation to the number of coauthors showed that male authors are more likely to publish alone (as a single author) compared to their female colleagues. The AAB predominantly published case reports, observational studies, and narrative reviews, all of which had a higher number of male authors than female authors. The study also uncovered the absence of female first authors in the four systematic reviews published.

Conclusion: From 2005 to 2021, the number of female first authors in the AAB has increased, and there has been a small but steady rise in female last authorship position. However, articles published in the AAB still exhibit a lower representation of female first authors. It is crucial to conduct further research and raise attention to gender disparity in anesthetic – and per extension in scientific - literature.

Keywords (MeSH): gender disparity, gender equity, anesthesiology, authorship, female, male.

Introduction

In recent years, efforts have been made to improve the representation of women in medical literature, as women remain a minority in academic literature¹⁻⁸. Miller et al. assessed the trend in major anesthesiologic journals, and reported an increase in female authorship, both for first and last authorship positions, and a higher proportion of female first authorship position when the last author was also female¹. Kinoshita et al. evaluated the trend for Japanese female authors in anesthesiology journals². They observed similar gender distributions of authors in the *Journal of Anesthesia* when compared to 11 international anesthesiology journals between 2010 and 2022. The percentage of female first authors increased proportionately with the percentage of female anesthesiologists. However, the number of female last authorship position did not show a similar increase. Despite gender parity in medical school admissions and graduations³⁻⁵, less women are active in academic and leadership positions, honor awards, and academic promotions^{4,6,7}. In 2020, in a majority of the EU member states, a higher number of female (rather than male) physicians were active⁹.

The aim of this study is to assess the trends in gender distribution of authorship in research articles published in *Acta Anaesthesiologica Belgica*, a Belgian anesthesiology journal, from 2005 to 2021, with a focus on changes over time. This study is the first of its kind for the Belgian anesthesiology literature. The study aims to present the evolution of disparity in authorship, primarily using first, second and last authorship, and does not intend to search for validation or potential underlying mechanisms.

Methodology

The study's main focus is on determining the gender of the first author, with the gender of the second and last authorship positions being secondary outcomes. The primary objective of the study is to assess these outcomes over a period of 17 years, spanning the study period. Additionally, the study seeks to investigate whether other variables, such as the field in which the article was published, study type, country of origin (of the first author), the first author's degree, number of authors, and coauthors' gender, are related to these outcomes.

Data Collection

The Belgian anesthesia journal (*Acta Anaesthesiologica Belgica*) was selected for evaluation. All submissions published during calendar years 2005 until 2021 were included

in the data set. For each article, data collected included time of publication (year), gender of first, second and last authorship position (male or female, total number of authors, country of origin of the corresponding author (every country was given its individual coding), and subspecialty topic (general anesthesia, locoregional anesthesia, critical care, pain medicine, psychosociology, and emergency medicine). For Belgian authors, the province in which they operate was also noted. To examine the relationship between author gender and study type, articles were classified as randomized controlled trials, systematic reviews, observational studies, narrative reviews, editorials, case reports, or other (such as letters to the editor, consensus statements, etc.). The degree of the author was also analyzed and categorized into the following categories: Medical Doctor (MD), Doctor of Philosophy (PhD), Professor, or other. We would like to note that all PhDs included in this study also hold MD degrees. Furthermore, the category of 'Professor' also includes Clinical Professors. The 'Other' category includes nurse anesthesiologists (as is the case in the Netherlands) or all other persons for whom the previous categories do not apply.

Author gender was determined based on an initial inspection of the first name, and in case of doubt, alternative search strategies were employed, such as search engines, institutional website profiles, and social media portals (e.g., LinkedIn, Facebook), as well as tax records of (Belgian) authors. Using this method, it was not possible to obtain information about nonbinary gender. In cases where a single author was listed, this was counted as a first author only.

Additionally, we obtained data about the distribution of full-time anesthesia faculty and information on gender for the period of 2008-2016 by querying the federal public service 'Public Health, Food Chain Safety and Environment'¹⁰. No additional data were available at this point since neither PlanKad (the reporting service of the federal public service) nor the Datawarehouse Labor Market & Social Protection (DWH MT & PS) provided data since 2016 regarding the gender distribution of the Belgian anesthesiologists. European figures were also obtained and included in our discussion.

Statistical Analysis

The data was collected manually by the first author and stored in Microsoft Excel (Version 16.66.1, Microsoft Corporation, Redmond, WA). Statistical analysis was conducted using SPSS (version 27, IBM, Armonk, NY). We calculated the percentage of women in first, second and last authorship positions

across the articles included in this study. Statistical significance was established throughout at $P < 0.05$, and two-sided significance was used. For the analysis of categorical variables, the χ^2 test analysis was chosen. It was used to determine whether there were any relationships among the proportions of first author gender and second author gender, last author gender, country of origin, study type, and author's degree. Continuous variables were evaluated using the Mann-Whitney U-test as they were not normally distributed. To evaluate trends in female authorship over time, multiple linear regression analyses of the proportion of first, second and last authors during each studied year were performed to determine whether this was affected by the country of origin, type of study, the degree held by the first author, and the field (subspeciality) in which the study dealt with.

Results

A total of 475 manuscripts were included for data collection. Seven articles (1,47%) were excluded

because the gender of the first author could not be determined.

Of all articles included in the study, 146 (30.7%) had a female first author, 94 (19.8%) had a female second author, and 61 (12.8%) had a female last authorship position. When the first author was a woman, the second and last authors were female in 7,8% and 5,3%, respectively, which was a lower percentage compared to when the first author was a man (see Table I). The gender distribution of first authorship over time can be found in Table II. The progression over time for first, second, and last authorship is represented in Figure 1. The graphs demonstrate a trend towards greater gender equality over time, with more women occupying first, and second authorship positions. However, we observed a stagnation in the number of female authors achieving last authorship positions, with only a small increase of last female authorship of 1.16% reaching 7.41% in 2021.

Further analysis showed that female last authorship did affect first female authorship.

Table I. — Gender distribution within the Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Total	146 (30.7)	322 (67.8)	
Female second author	37 (7.8)	54 (11.4)	p = 0.007
Female last author	25 (5.3)	35 (7.4)	p = 0.005
NA = not applicable, n = number.			

Table II. — Distribution of first authorship over time within the Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Number by year			p = 0.363
2005	5 (1.0)	21 (4.4)	p = 0.004
2006	8 (1.7)	30 (6.3)	p < 0.001
2007	9 (1.9)	24 (5.1)	p = 0.024
2008	13 (2.7)	30 (6.3)	p = 0.014
2009	9 (1.9)	15 (3.2)	p = 0.307
2010	11 (2.3)	26 (5.5)	p = 0.020
2011	9 (1.9)	21 (4.4)	p = 0.043
2012	10 (2.1)	15 (3.2)	p = 0.557
2013	7 (2.9)	14 (3.0)	p = 0.189
2014	11 (2.3)	10 (2.1)	p = 0.832
2015	4 (0.8)	19 (4.0)	p = 0.003
2016	12 (2.5)	15 (3.2)	p = 0.701
2017	7 (2.9)	9 (1.9)	p = 1.000
2018	7 (2.9)	18 (3.8)	p = 0.076
2019	6 (1.3)	18 (3.8)	p = 0.043
2020	5 (1.1)	23 (4.8)	p < 0.001
2021	13 (2.7)	14 (3.0)	p = 1.000
n = number.			

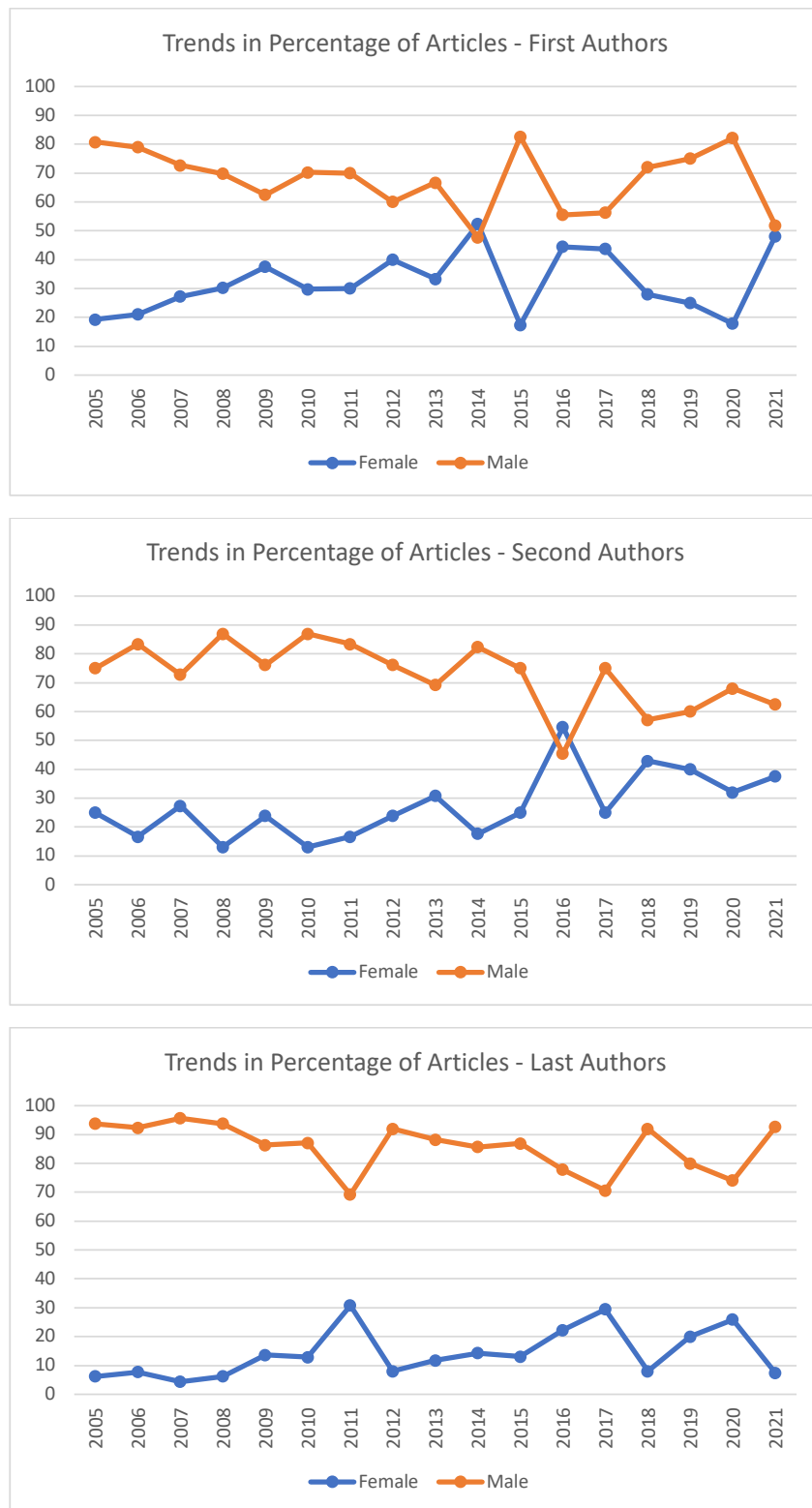


Fig. 1 — Trends in percentage of articles for first, second and last authors in Acta Anaesthesiologica Belgica (2005-2021).

Women made up a higher percentage of first authorship on manuscripts with female last authors compared to those with male last authors (17.1% vs 10.8%; $p = 0.005$).

Table III indicates that the median number of co-authors was significantly higher for female first authors. Lastly, the analysis of gender in relation to the number of co-authors showed that male authors

are more likely to publish alone (as a single author) compared to their female colleagues. Out of the 474 articles analyzed, 60 articles (12.6%) had a single author. Among these studies, 7 (2.9%) had a female single author, while 52 (11%) had a male single author ($p < 0,001$).

The study also examined the relation between the gender of the first author and the study type

Table III. — First author gender and number of co-authors within Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Number of co-authors			p = 0.066
No co-author	7 (2.9)	52 (11.0)	p < 0.001
1 co-author	20 (4.2)	50 (10.5)	p < 0.001
2 co-authors	47 (9.9)	22 (4.6)	p < 0.001
3 co-authors	60 (12.6)	29 (6.1)	p < 0.001
4 co-authors	40 (8.4)	28 (5.9)	p < 0.001
5 or more co-authors	40 (8.4)	73 (15.4)	p < 0.001
Median number of co-authors	4.38 (1.9)	4.04 (2.8)	p = 0.004

n = number.

Table IV. — First author gender and study type in Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Type of study			p = 0.004
RCT	25 (5.3)	42 (8.8)	p < 0.001
Systematic review	0 (0)	4 (0.8)	p = 0.062
Observational	45 (9.5)	60 (12.6)	p < 0.001
Narrative review	25 (5.3)	59 (12.4)	p < 0.001
Editorial	8 (1.7)	35 (7.4)	p < 0.001
Case report	38 (8.0)	94 (19.8)	p < 0.001
Other	5 (1.1)	28 (5.9)	p < 0.001

RCT = Randomized controlled trial – Other = all studies that could not be categorized in other categories - n = number.

(presented in Table IV). The AAB predominantly published case reports, observational studies, and narrative reviews, all of which had a higher number of male authors than female authors. A χ^2 test showed statistical significance with a p-value of 0.004 for female authors in relation to the type of study. The study also revealed the absence of female first authors in the four systematic reviews published.

The study demonstrates that European colleagues, followed by Indian and American colleagues, published the highest numbers of research articles in AAB during the study period (Table V). Female authors from Belgium represented 33.5% of all in-country articles compared to 66.5% by male authors (p < 0.001). No effect was observed between the

Table V. — First author gender and country of origin in Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Country of origin			p < 0.001
Belgium	83 (17.5)	163 (34.3)	p < 0.001
Europe	39 (8.2)	79 (16.6)	p < 0.001
America	3 (0.6)	26 (5.5)	p = 0.186
Australia	4 (0.8)	1 (0.2)	p = 0.062
India	15 (3.2)	32 (6.7)	p < 0.001
Middle-East	4 (0.8)	10 (2.1)	p = 0.687
Asia	0 (0)	6 (1.3)	p < 0.001
Africa	0 (0)	5 (1.1)	p < 0.001

Europe (Netherlands, France, Germany, Austria, United-Kingdom, Ireland, Finland, Sweden, Romania, Croatia, Italy, Spain, Portugal, Greece, Switzerland and Turkey), America (United States of America, Canada and Uruguay) – Middle-East (Iran, Israel, Egypt and Lebanon) – Asia (Japan and Singapore) – Africa (Cameroon, Benin, Togo and Morocco).
n = number.

gender of the first author and the country of origin, although articles presented by Egyptian, Turkish, Italian, and Austrian authors were all from female first authors. It is noteworthy that Indian authors, as first, second, and last authors, contributed significantly more (in terms of percentage of all female authors) to the published articles in the AAB.

The educational degree held by the authors can be seen in Table VI. The data revealed that predominantly MDs published their data in the AAB.

The domain in which the author chose to publish in the AAB concerned mostly general anesthesia.

However, upon evaluating female representation, there was no specific subject area in which it was found to be higher compared to others (see Table VII).

The distribution of female authorship was also analyzed according to the different regions in Belgium. The majority of articles originated from the Flemish-Brabant region, followed by Liège, Brussels, East-Flanders, and Antwerp, as indicated in Table VIII. Other regions had a smaller share of published data, and Luxembourg did not contribute any articles to the journal. In terms of author's gender and its relationship to the region, we did

Table VI. — First author gender and authors' degree within Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Degree held by first author			p < 0.001
MD	123 (25.9)	246 (51.8)	p < 0.001
PhD	3 (0.6)	39 (8.2)	p < 0.001
Professor	14 (3.0)	31 (6.5)	p < 0.001
Other	6 (1.3)	6 (1.3)	p < 0.001
n = number.			

Table VII. — First author gender and subspecialty in the Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Subspecialty			p = 0.483
General anesthesia	125 (26.3)	250 (52.6)	p < 0.001
Locoregional anesthesia	10 (2.1)	42 (8.8)	p < 0.001
Pain medicine	1 (0.2)	5 (1.1)	p = 0.031
Intensive Care	6 (1.3)	14 (3.0)	p < 0.001
Psychosociology	1 (0.2)	0 (0)	p = 0.317
Emergency Medicine	3 (0.6)	11 (2.3)	p < 0.001
n = number.			

Table VIII. — First author gender and region in Belgium within Acta Anaesthesiologica Belgica (2005-2021).

	Female first author (n / %)	Male first author (n / %)	P-value
Region in Belgium			p = 0.995
West-Flanders	4 (0.8)	5 (1.1)	p = 0.002
East-Flanders	11 (2.3)	22 (4.6)	p < 0.001
Antwerp	10 (2.1)	15 (3.2)	p < 0.001
Limbourg	4 (0.8)	5 (1.1)	p = 0.002
Flemish-Brabant	16 (3.4)	36 (7.6)	p < 0.001
Walloon-Brabant	4 (0.8)	7 (2.9)	p < 0.001
Hainault	1 (0.2)	4 (0.8)	p = 0.031
Liège	12 (2.5)	32 (6.7)	p < 0.001
Luxembourg	0 (0)	0 (0)	NA
Namur	4 (0.8)	7 (2.9)	p < 0.001
Bruxelles	16 (3.4)	30 (6.3)	p < 0.001
n = number.			

not observe any statistically significant differences in gender proportions across the regions.

A multiple linear regression analysis was conducted to investigate the relationship between the gender of the first author and the year an article was published. The results indicated an R² value of 0.041, which suggests that other factors ought to be considered.

Discussion

Over the 17-year period analyzed (2005-2021), there has been minimal advancement towards achieving gender equality in the articles published in the *Acta Anaesthesiologica Belgica*. The graphs in Figure 1 show a trend towards greater gender equality over time, with more female first, second and last authors. However, there is still considerable variability, particularly in the proportion of first female authors in the last few years of the study, indicating that the trend may not yet be stable. It must be noted that due to the relatively small number of articles published in the *Acta Anaesthesiologica Belgica* a more limited difference can result in sharp jolts in the observed pattern.

Our findings are in contrast to those of Miller et al., who observed an increase in the number of females as first and last authors. However, the latter were considered not as robust. Nonetheless, Miller et al. concurred with our study's conclusion that women are generally underrepresented in authorship. Previous research has also demonstrated that women are awarded fewer research grants due to this underrepresentation⁸.

Filardo et al. analyzed the period from 1994 to 2014, during which they observed a plateau or decline in female first authorship in their selected journals since 2009. These journals included the *Annals of Internal Medicine*, *British Medical Journal (BMJ)*, *Journal of the American Medical Association (JAMA)*, *JAMA Internal Medicine*, *The Lancet*, and the *New England Journal of Medicine (NEJM)*⁶. In contrast, the study by Rong et al. indicated an increase in female-authored studies from 37.3% to 45.7% between 2008 and 2018 ($p < 0.001$)⁵. These findings suggest that the AAB has a significant gap to bridge to reach these percentages.

Our literature review yielded only a limited number of articles pertaining to critical care medicine and anesthesia, whereas surgical societies have made efforts towards narrowing the gender gap in the scientific community¹²⁻¹⁷. Jagsi et al. analyzed the overall proportion of female authorship in medicine over 35 years in six leading

US journals, namely *NEJM*, *JAMA*, *Annals of Internal Medicine (Ann Intern Med)*, *Annals of Surgery (Ann Surg)*, *Obstetrics & Gynecology (Obstet Gynecol)*, and *Journal of Pediatrics (J Pediatr)*. Their findings showed an upward trend for first and last female authorship, from 5.9% and 3.7% in 1970 to 29.3% and 19.3% in 2004, respectively⁴. However, their data also raised concerns about a possible loss of momentum in both first and last authorship compared to 2000, which may reflect the lower-than-expected number of women advancing to become professors and their underrepresentation among associate and full professors in the clinical faculties of medical schools, constituting only 19%^{3-5,7}.

Previous evaluations have suggested that multiple factors might contribute to female underrepresentation, such as unsupportive work environments, lack of mentorship, personal choices, childcare responsibilities, active discrimination against women, a higher requirement for women to publish in high-impact or top-tier journals in their field in order to achieve the same application score as men, and an archaic view of leadership qualities as traits more commonly associated with male behavior, with women not typically expected to display such behavior, and sometimes even judged negatively as showing increased hostility and reduced rationality³.

It is important to recognize that experiences and perspectives can vary among female (or male for that matter) anesthesiologists. While some female anesthesiologists may consider the underrepresentation in scientific journals as a major problem and actively seek opportunities for publication, others may prioritize different aspects of their careers or may opt for personal priorities. Achieving a balanced representation of male and female anesthesiologists does not necessarily imply that the same distribution must be seen in scientific research. Factors such as clinical responsibilities, teaching commitments, other professional obligations, and personal priorities will influence the level of engagement in research and must be considered.

When addressing the gender disparity in current literature and making a change to the underrepresentation of female authors, we posit the following possibilities, yet by no means we intend to limit further actions to be confined to these. Firstly, at an academic level gender equality should be prioritized and promotion towards the implementation of policies and initiatives to address bias, gender-based discrimination, and barriers that hinder women's academic progress. This linked to equitable access to research funding,

resources, and mentorship programs for female researchers. Secondly, collaboration should be encouraged among researchers, including women, to foster interdisciplinary partnerships, knowledge sharing, and publication opportunities. Lastly, institutional policies should be regularly evaluated and revised to ensure gender equality, including promotion criteria, hiring practices, and diversity representation in decision-making bodies.

There is the need to a multifaceted approach involving systemic changes, cultural shifts, and individual efforts to create an inclusive and equitable research environment for all researchers, to address the underrepresentation of female authors.

To gain a comprehensive understanding of the evolution within the AAB, we must also consider the current landscape of anesthesiology. As mentioned earlier, we evaluated regional and global trends in anesthesiology. We also examined the gender distribution of Belgian anesthesiologists between 2008 and 2016, using PlanKad data. This data revealed a similar distribution of female anesthesiologists between the two Belgian communities (Flemish and French), with an overall percentage of 39.3% in the Licensed to practice (LTP) category. For the Professionally active (PA) and Practicing (PR) categories, the representation of female anesthesiologists was 40.6% and 41.3%, respectively¹⁰.

Figure 2 shows a clear trend in the evolution of gender distribution within the anesthesiology profession. During the studied period (2004-2016),

there was a 64% increase in female practicing anesthesiologists and a 26% increase in male anesthesiologists¹⁰. At the European level, recent figures from 2020 demonstrate a steady increase in the overall proportion of female physicians. In 17 EU Member States, a higher number of female physicians is reported, with the highest representation of female doctors in Latvia (74%) and Estonia (73%). Luxembourg (64% male) and Cyprus (62% male) had more male physicians⁹. This trend can be seen in Figure 3. Information on the evolution within the graduated medical doctors is currently not available.

In future research, it may be useful to determine gender in both submitted and published articles in the *Acta Anaesthesiologica Belgica* to examine possible bias in the peer review process. This study possesses inherent limitations. One limitation involves the potential distortion of publication trends due to fewer articles being published for three years. Furthermore, there is a lack of reliable data concerning the proportion of active female anesthesiologists in relation to the publication years. The assessment of authors' professional activity was also not undertaken, as such determination cannot be solely inferred from the data provided in the articles. Likewise, details regarding authors' activity status (full-time or part-time) and gender distribution are not analyzed since these data are not readily accessible in current governmental datasets.

The order of authors provides an indication of the relative contributions of each author to the research

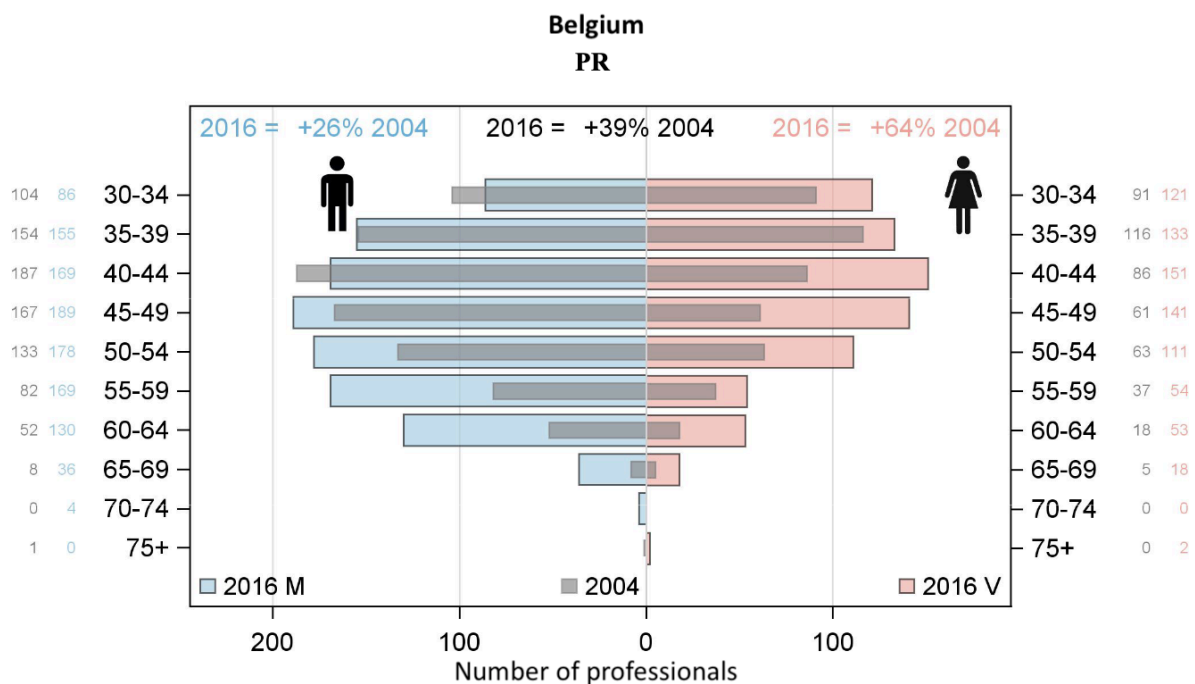
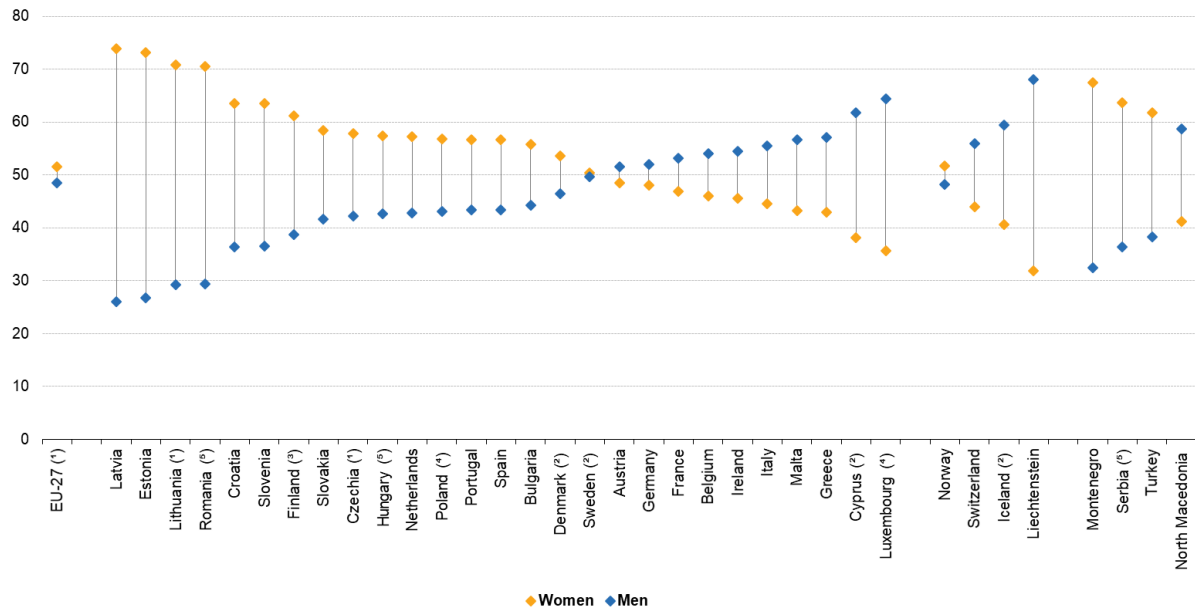


Fig. 2 — Comparison of the age pyramids of the physician specialists in Anesthesiology active in healthcare (PR), for Belgium, 2016 vs. 2004¹⁰.

Physicians, by sex, 2020 (%)



Note: practising physicians except Slovakia, Montenegro, North Macedonia, and Turkey (professionally active physicians), and Greece and Portugal (licensed to practise). The figure is ranked according to the proportion of female doctors
 (*) Estimates.
 (**) 2019.
 (***) 2018.
 (****) 2017.
 (**) Break in time series
 Source: Eurostat (online data code: hlth_rs_phys)



Fig. 3 — Physicians by sex (%) in the year 2020 throughout the European Union⁹.

work. The first author is typically considered to have made the most substantial contribution, while the last author is often the senior researcher or principal investigator who provided guidance and oversight. The middle authors are generally listed in order of their contribution to the project. Having an order of authors in a publication is essential for attributing contributions, recognizing individual efforts, and upholding the integrity and transparency of scientific research. However, it must be recognized that the determination of author order is not always a straightforward process, and it might be influenced by professional relationships and politics. Power dynamics might give researchers a more prominent position, regardless of their actual contributions. In this regard, we have also noticed an increase in the number of authors per article over the years, which could be attributed to similar reasons. This is a matter that cannot be controlled or taken into consideration, and it could be regarded as a limitation of our research.

To conclude, this study presents findings on the representation of female authors in the Belgian anaesthesiology literature, as published in the *Acta Anaesthesiologica Belgica*. The results indicate that female authors continue to be underrepresented in the field of anaesthesiology, although there has

been an increase in their number over the past 17 years, albeit in an inconsistent pattern. The profession is changing, as proved by the figures provided by PlanKad for the period 2004 till 2016 and supported by the European figures of 2020. While there has been progress in addressing gender disparities in medicine, there is still a need for additional efforts to be made. As Miller et al. noted, to attract more women to anaesthesiology and to continue the great progress that is being made, it is necessary to identify the factors that contribute to these disparities, address them, and create a more inclusive and flexible culture in the field of anaesthesiology¹. Therefore, we call for more research to be conducted on this subject, with a focus on understanding the underlying mechanisms and implementing policies to overcome barriers faced by female authors in the academic literature.

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doi.org/10.56126/75.1.03