

# National and International Comparisons of Gynecological Research in Germany Based on a Bibliometric Analysis of Publications

## Forschung in der Frauenheilkunde im internationalen und nationalen Vergleich auf Basis einer bibliometrischen Analyse von Publikationen



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### ABSTRACT

#### Background

Recent years have seen a considerable shift from male doctors to female doctors in the field of gynecology. Female doctors are traditionally more involved with planning and maintaining their family. For gynecology, this could be associated with a risk that research activities will decrease, particularly if results are published in scientific journals.

#### Methods

In view of this shift, a comparative observational study was carried for 2022 in which 1306 publications were matched to 1786 female and male doctors reported on the websites of the 44 locations of university gynecology departments in Germany. In addition, the volume of publications issued between 2014 and 2022 was compared for Germany, France, the United Kingdom, and the United States. In Germany, the volume of publications in Gynecology was additionally compared with the publication outputs of the specialties Urology and Trauma Surgery.

#### Results

Since 2014, the increase in the numbers of publications in the field of Gynecology in Germany was lower (225%) than that of the countries with which it was compared (238%/252%/260% for F/UK/USA). When Gynecology was compared with other medical specialties in Germany, the num-

ber of publications in Urology were found to have increased at a lower rate (196%) while the number of publications in the field of Trauma Surgery increased by more (286%) than that of Gynecology. At the start of 2023, the percentage of women who were working as doctors at the lowest hierarchical level (junior doctor) was 81%. The publication output per capita of female doctors working at lower levels in the medical hierarchy, i.e., working as junior doctors and senior physicians, was between 40% and 80% lower than that of male doctors working at the same level. However, female directors published as much as male directors did. In the lower hierarchy levels, men were up to 14% more likely to be without an academic title. Predictors for more extensive publication activities by young female and male doctors include the extent and quality of publications by doctors in senior positions, the presence of a comprehensive cancer center or an institute for human genetics at the location where the young doctors were working, and joint publications with foreign authors.

### Conclusion

For the German Society of Gynecology and Obstetrics, the results suggest a number of approaches to promote young researchers. The support provided to young female doctors is especially important as this should help to retain them as junior researchers over the long term.

## ZUSAMMENFASSUNG

### Hintergrund

In der Frauenheilkunde hat in den vergangenen Jahren eine starke Verschiebung von Ärzten zu Ärztinnen stattgefunden. Diese sind traditionell stärker in die Familienplanung eingebunden. Für das Fachgebiet könnte daraus die Gefahr erwachsen, dass wissenschaftliche Aktivitäten abnehmen, insbesondere in Form von wissenschaftlichen Publikationen.

### Methoden

Vor diesem Hintergrund wurden in einer vergleichenden Beobachtungsstudie für das Jahr 2022 insgesamt 1306 Publikationen den 1786 Ärztinnen und Ärzten zugeordnet, die an einem der 44 universitären frauenheilkundlichen Standorte auf deren Internetseiten dokumentiert waren. Zusätzlich wurde das Publikationsvolumen von 2014 bis 2022 zwischen Deutschland, Frankreich, dem Vereinigten Königreich und den Vereinigten Staaten verglichen sowie – auf Deutschland begrenzt – mit dem Output der Fachgebiete Urologie und Unfallchirurgie.

### Ergebnisse

Frauenheilkundliche Publikationen sind in Deutschland seit 2014 mit 225% weniger stark gewachsen als in den Vergleichsländern (238%/252%/260% für F/UK/USA). Im Vergleich zu den deutschen Fachgebieten sind die Publikationen in der Urologie geringer gewachsen (196%), in der Unfallchirurgie dagegen schneller (286%). In der unteren Hierarchiestufe „Assistenzarzt“ beträgt der Anteil der Frauen zu Beginn des Jahres 2023 81%. Die Publikationsleistung war bei den Ärztinnen in den Hierarchiestufen „Assistenzarzt“ bis „Leitender Oberarzt“ pro Kopf zwischen 40% und 80% geringer als bei den männlichen Ärzten. Direktorinnen publizierten jedoch gleich häufig wie Direktoren. In den unteren Hierarchiestufen waren Männer bis zu 14% häufiger ohne akademischen Titel. Prädiktoren für eine stärkere Publikationstätigkeit von jüngeren Ärztinnen und Ärzten waren die Stärke der Publikationsleistungen von Ärzten in Senior-Positionen, die Verfügung über ein Comprehensive Cancer Center sowie ein Humangenetik-Institut am Standort und die gemeinsame Publikation mit ausländischen Autoren.

### Schlussfolgerungen

Für die „Deutsche Gesellschaft für Gynäkologie und Geburtshilfe“ ergeben sich zahlreiche Ansatzpunkte für eine Stärkung der Nachwuchsförderung. Von besonderer Bedeutung bleibt weiterhin die Förderung von jungen Ärztinnen, um sie als wissenschaftlichen Nachwuchs langfristig zu gewinnen.

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## 1. Background and Aim of the Analysis

Publications have an important function in scientific research, one which has led to the expression “publish or perish.” The visibility of a medical specialty, its institutions, and its researchers is closely tied to the publication output [1]. In addition to the quantity of publications, their quality is also important. The importance of a publication is measured by the number of times it is cited elsewhere or to the journal in which it is published; this is also known as the impact factor of a publication [2].

In terms of the conditions for scientific medical publications, Germany is not considered a frontrunner. There are some indications that while many clinical studies are being carried out in Germany, these activities do not necessarily translate into increased numbers of publications [3].

Given this context, an investigation into the possible reasons for this may need to focus on working conditions, as in medicine, the time required to provide good patient care competes with the time needed to carry out scientific research. There are some indications that many young researchers are dissatisfied with the long

working hours required to carry out research in addition to providing medical care [4]. Such time pressures become even more urgent when doctors are obliged to balance the demands of work with those of family [5]. When attempting to balance family and work, women face the special additional challenges of pregnancy and birth. Unfavorable working conditions could be the reason for insufficient scientific achievements, including fewer publications.

Another development which also deserves more attention when considering the development of scientific outputs is the marked increase in the number of female doctors in Gynecology (often referred to as the “feminization of the medical profession”) [6, 7].

Working conditions in surgical specialties are considered particularly onerous because working hours are frequently unpredictable [8]. This has been specifically reported for Gynecology [9] and particularly for Obstetrics [10]. Other medical specialties such as Urology or Trauma Surgery also share these working conditions and are therefore useful when carrying out a comparative evaluation.

The German Society for Gynecology and Obstetrics (*Deutsche Gesellschaft für Gynäkologie und Geburtshilfe*, DGGG) wanted to obtain an overview of publication achievements in the field of Gynecology as part of the Society’s continued drive to continue to support research and scholarship in the field of Gynecology and Obstetrics in future. To obtain the necessary information, DGGG commissioned the independent IGES institute, which developed the concept and collected and analyzed the relevant data.

The concept is based predominantly on comparisons, including international comparisons and comparisons between clinical specialties with similar demands in terms of inhibiting and supporting factors which affect publication output.

The question also arose whether the successful acquisition of research grants from public funding agencies has an impact on publication activities.

In this context, possible measures are being discussed which are particularly relevant for the DGGG as a professional society.

## 2. Data and Methods

The empirical basis for this study was data on scientific publications by university gynecology and/or obstetrics departments in Germany. The data was obtained from the database PubMed (National Library of Medicine [NLM]). The database was searched on March 14, 2023, using the following search strings: (((“gynecology”[Affiliation]) OR (“gynaecology”[Affiliation])) OR (“obstetrics”[Affiliation])) OR (“geburtshilfe”[Affiliation])) OR (“frauenheilkunde”[Affiliation])). Analogous searches were additionally carried out for the specialties Urology and Trauma Surgery.

For the comparative international analysis, additional queries of the database were carried out for the three medical specialties to identify whether publications were associated with an affiliation in one of the countries Germany, France, Great Britain, or the United

States of America. Timelines for the years 2014 to 2022 were compiled for the four countries using the timeline function.

To carry out a more detailed analysis of publications in the fields of Gynecology and Obstetrics in Germany, the investigation focused on the 2050 publications published in 2022 which could be mapped to a university department in Germany. Ultimately the analysis only included 1306 publications which could be assigned to authors working in university gynecology or obstetrics departments in Germany (see below).

For the assignment to a gynecology or obstetrics department, a search was carried out in February 2022 across 51 departments to identify all doctors involved in patient care working in the departments. The websites of the respective departments served as the basis for the search. The gender, academic degree (none, Dr med, university lecturer, professor), and the job title of the doctors was recorded. The analysis differentiated between junior doctors, medical specialists, senior physicians, chief physicians, and medical directors. This information also provided indirect clues about the doctors’ age groups. A total of 1786 doctors were recorded. The 51 departments were summarized into 44 university locations. However, some analyses could only include 40 locations with a total of 1749 doctors because four sites did not list the junior doctors working there.

The chosen central indicator was “involvement in publications”<sup>1</sup> as seen from the perspective of the individual author. This means that while the evaluation included whether someone from the pool of the 1786 German doctors was involved in one of the 1306 publications, the analysis did not assess whether someone might have listed several affiliations<sup>2</sup>. A total of 3754 involvements in publications was recorded.

Two parameters were calculated for each location: the “big-shot” factor, calculated as the ratio of the reported involvement of leading medical staff (chief physicians or medical directors) in all publications from a specific location; and the “foreign factor” i.e., the involvement by the selected doctors in publications with a foreign affiliation measured against all involvements in publications.

In addition, the records of the funding activities of the German Research Foundation (DFG) and the Federal Ministry for Education and Research (BMBF) were consulted and assigned to Gynecology and the other medical specialties.

The websites at the different university locations were used to determine whether there were special medical facilities at the respective location which could provide resources for research and scientific publications; such special facilities included coordination centers for clinical studies (CCS), comprehensive cancer centers (CCC)<sup>3</sup>, and institutes or departments for human genetics.

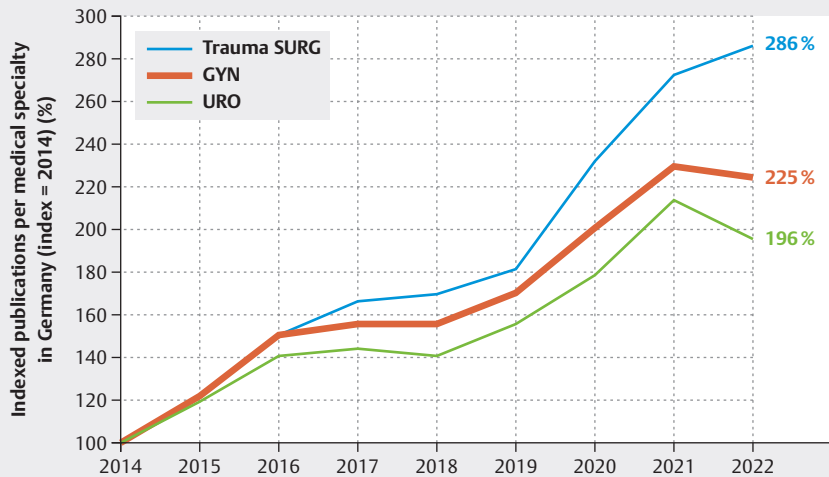
The following analyses were carried out: simple time lines of involvements in publications, comparisons between per capita figures, and bivariate or multivariate regression analysis with testing for significance.

This study is an observational study and its limitations are discussed in chapter 5.

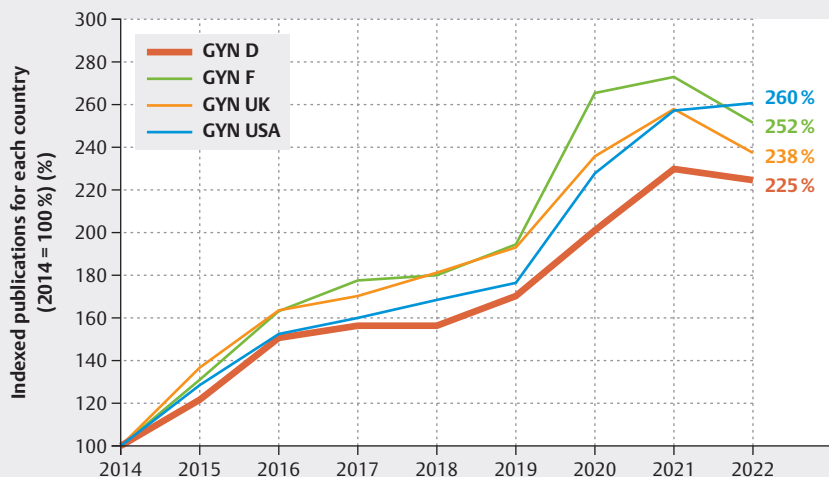
<sup>1</sup> To simplify matters, in several places this is shortened to “publications.”

<sup>2</sup> Affiliation of an author to an institution, usually an academic institution, as reported in PubMed.

<sup>3</sup> The term “comprehensive cancer care center” (CCCC) was also included in this.



► **Fig. 1** Development of publications for three different medical specialties in Germany over time based on index values. Source: own research and analysis based on data from PubMed (National Library of Medicine [NLM]).



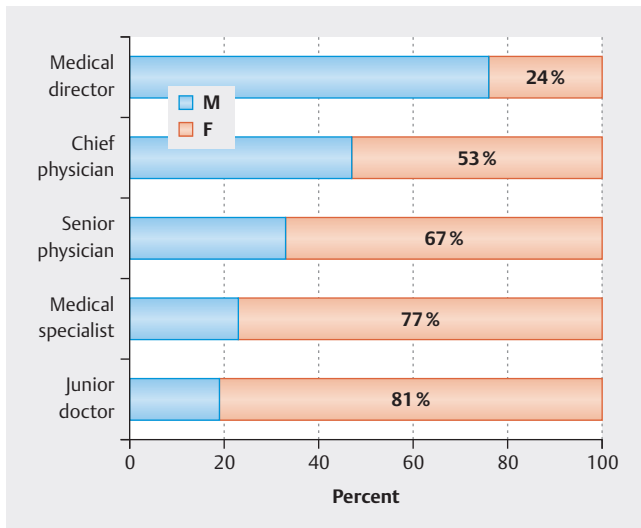
► **Fig. 2** Increase in publications over time in four different countries based on index values. Source: own research and analysis using data from PubMed (National Library of Medicine [NLM]).

### 3. Results

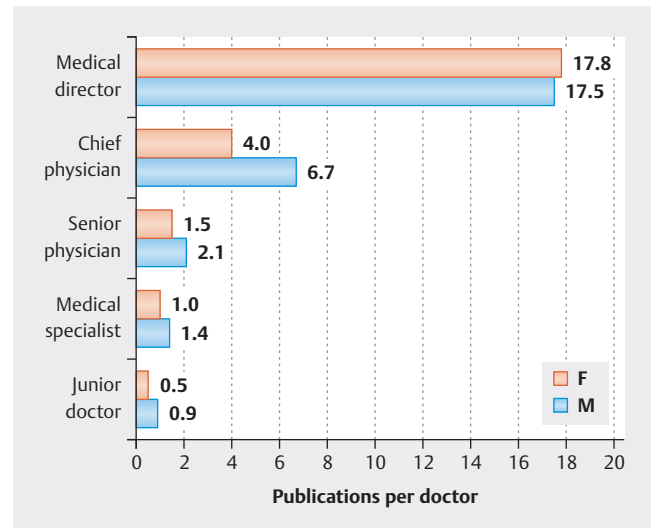
A number of comparisons were carried out as part of the bibliometric analysis into the ranking of Gynecology in the competition for scientific publications; inhibiting and supporting factors which influence publication activities were also considered. To begin with, Gynecology publications overall were compared with publication numbers for other medical specialties. An international comparison in the field of Gynecology and Obstetrics was done, and finally, publication outputs were compared for men and women and in particular between different university locations.

#### 3.1 Comparisons with medical specialties

The increase in the number of scientific publications in Gynecology and Obstetrics in Germany was initially compared to the developments in Urology and Trauma Surgery. The increases in the three medical specialties showed the same structural progress, with constant increases in publications except for last year, and a significant increase in publications in the years 2020 and 2021, the first two years of the Covid-19 pandemic (► **Fig. 1**). This striking upturn, which was also apparent in the international comparisons (► **Fig. 2**), could be due to the fact that more time was available for publications because hospital activities were significantly reduced.



► **Fig. 3** Gender structure of the 1786 medical staff in gynecological departments and hospitals according to the position they hold. Source: own research carried out in February 2023.



► **Fig. 4** Gender-specific intensity of involvement in publications per female or male doctor according to their position in the hierarchy. Source: own research and analysis carried out in February 2023.

The increase in the number of publications from gynecological/obstetric institutions in Germany was slightly higher than was recorded for Urology but significantly less dynamic than in Trauma Surgery. This significant difference was largely due to the Covid years. The number of road traffic casualties during the two years of the pandemic decreased by more than 15% compared to 2019 [11] (German Federal Statistical Office 2023), whereas the number of births increased slightly over the same period.

### 3.2 International comparisons

An isolated examination of the developments in Gynecology showed analogous developments when comparisons were made between selected countries (France, Great Britain, USA). However, since 2018 the increase in publications in Germany has remained significantly lower than in the other examined countries. For the period from 2014 to 2022, publications with a USA affiliation increased by almost 260%, meaning that the increase was 16% higher than that for publications with only a German affiliation where the increase was only 225% (► **Fig. 2**).

### 3.3 Gender comparisons of publication outputs and academic titles

Currently, there is a clear trend whereby the higher the percentage of women is in medicine, the lower the position is that they hold (► **Fig. 3**). As this issue was found following a cross-sectional observation, it should be noted that it conceals the fact that more and more women are choosing to become doctors. This “feminization of the medical profession” then becomes relevant for changes in the scientific output of a specific field if younger women or women in general show less publication activities.

Our observation of the publication output per female or male doctor showed that men published significantly more relative to

women if the men and women held a position in the lower four hierarchy levels (► **Fig. 4**).

However, when the group of female and male medical directors were reviewed, women at this level had a slightly higher publication output compared to their male colleagues at the same level.

The differentiation based on academic titles was aggregated into the attribute “no title.” As expected, this attribute decreased, the higher the position held by the individual. There was no medical director who did not at least have a PhD (► **Fig. 5**).

The differentiation according to gender showed that up until the position of senior physician, the percentage of women without an academic title was lower. Only at the level of the top medical positions were there slightly more women than men without an academic title.

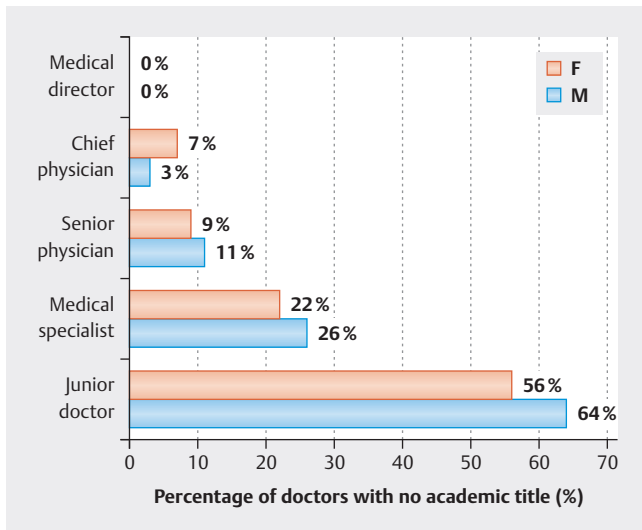
This may be related to the finding that until women held a leading medical position, they had fewer publications per capita. At the same time, women showed an inverse preference for obtaining an academic title.

### 3.4 Comparisons between locations

As outlined in the epistemic classification of this study at the end of chapter 1, different subgroups are presented below and differences in the manifestation of findings can offer clues as to causes.

#### 3.4.1 Acquisition of funds from public funding bodies

Following grant applications, public funding bodies such as the German Federal Ministry for Education and Research (BMBF) or the German Research Foundation (*Deutsche Forschungsgemeinschaft*, DFG) award funding which can be used for research and therefore ultimately for publications.



► **Fig. 5** Percentage of female and male doctors with no academic title according to their position in the hierarchy. Source: own research and analysis carried out in February 2023.

As regards the number of DFG funding awards, the average number of approved grant applications decreased from 22 to 12 compared to the period from 1999 to 2002.<sup>4</sup> For the entirety of all medical specialties, however, there was a slight increase in the same period.

With regards to the period from 2018 to 2022, the DFG classified 64 of the approved grants as being related to the field of Gynecology. This means that the number of funding measures allocated to Gynecology were below those of Urology (99) or Orthopedics/Trauma Surgery (153 approved funding proposals). Of the 64 approved funding awards for Gynecology, only 34 were in response to applications from university gynecology departments. The DFG grants for the years 2018–2022 were only awarded to 17 gynecological or obstetric university locations and there was a relatively strong focus on just three locations.

Of the 34 DFG grants awarded in response to applications from university institutions for gynecology in the period 2018–2022, the majority (24) were for research grants, seven awards were for individual research fellowships and research projects, and only two grants were for clinical trials.

As regards the areas prioritized by DFG funding grants, the field was dominated by Gynecological Oncology, with an average of 67% of grants going to Gynecological Oncology in the period 2018–2022.<sup>5</sup> Obstetrics and Perinatal Medicine received 25% of the awards, and Gynecological Endocrinology and Reproductive Medicine received 8% of the awarded DFG funding.

In contrast to the DFG, the BMBF does not explicitly allocate its funding to medical specialties but it does include information about the amount of funding. A search using specialty-specific

search terms was able to identify 106 funding measures linked to gynecological and obstetric topics for the period from 2016 to 2022, of which 63 involved university institutions; however, only 13 involved university institutions for gynecology and obstetrics. The average sum disbursed for these 13 funding measures was just under 850 000 Euros, with the amount ranging from just under 40 000 Euros to just under 4.1 million Euros.

The 13 projects involving university gynecology institutions which received funding from the BMBF also focused on oncological issues.

### 3.4.2 Size of respective locations

The size of a location as measured by the number of doctors who work there has a positive impact on the number of publications from a location, because more people can publish more. But we also found a positive relationship between the number of doctors per location and the number of publications per female or male doctor (► **Fig. 6**). It was found that the output per female or male doctor tended to be higher if the location was bigger. This could be due to synergies developing between different researchers or to more support for scientific publications being available at larger locations.

For middle-sized locations where the number of doctors ranged from 40 to 60 doctors per location, output tended to range from 0.4 to 2.1 publications per male or female doctor. This indicates that there may be more factors that influence publication output (see chapter 3.4.4) but also that there is some leeway for action which location-specific initiatives can make use of.

### 3.4.3 Are there differences between locations with special obstetric and oncology facilities?

In view of the findings reported above, it is starting to become clear that the workload associated with patient care is one factor that can inhibit publication activities. In this context, it is important to consider the issue of obstetric departments as well as locations where the intensity of work outside regular working hours is high. This led us to categorize different locations according to the frequency with which publications could be attributed to departments with the term “obstetric” in their name.<sup>6</sup> There were seven locations in which obstetric departments made an above average contribution to the publication output.

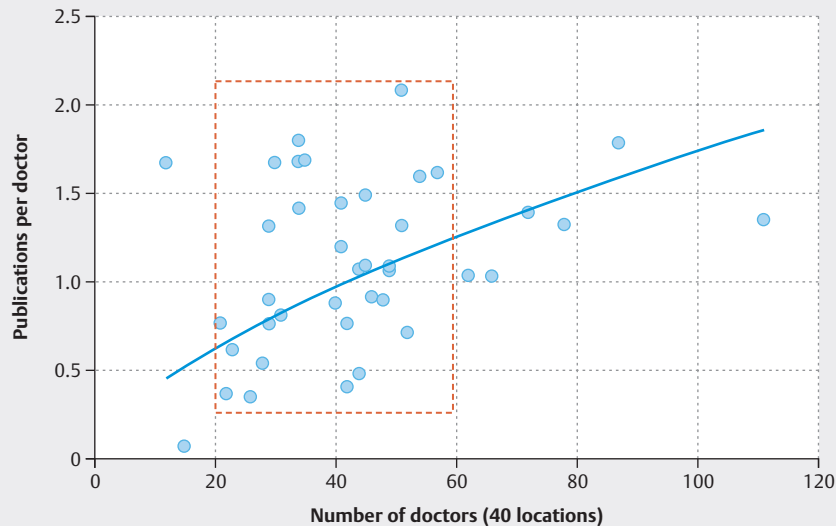
A similar categorization was also done for locations with departments with “cancer” in their name. This applied to three locations. A total of 30 locations could not be assigned to either of these two areas.

The analysis of the different locations with regards to the frequency of publications per female or male doctor showed that locations with a department which focused on obstetrics had slightly lower numbers (2.1) compared to general locations which did not specifically focus on obstetrics (2.2) and especially compared to locations which focused on cancer (2.4) (► **Fig. 7**).

<sup>4</sup> Sub-projects were also included; if there were several applicants, all applicants were included.

<sup>5</sup> Of the 64 DFG funding awards, only 51 were taken into account as they could be definitively allocated to gynecology and/or obstetrics.

<sup>6</sup> Departments or centers which included “Frauenheilkunde” or “Gynäkologie” in their names (including all English forms) were not included.



► **Fig. 6** Number of involvements in publications per female or male doctor and number of medical staff at the 40 university locations with gynecological facilities. Source: own research and analysis based on data from PubMed (National Library of Medicine [NLM] for 2022).

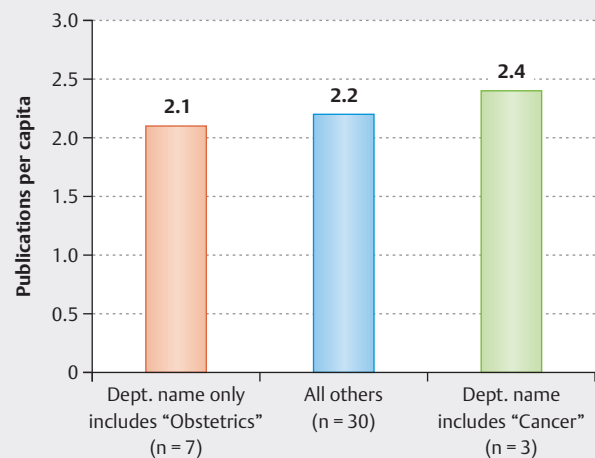
#### 3.4.4 Influence of the publication output of doctors in senior positions on the publication output of doctors in junior positions

Although in practice, the position “senior physician” is not classified as a junior position but as a senior position, the analysis in chapter 3.3 shows that with regards to publication outputs, that the output of doctors in senior physician positions which had an explicit leadership function (e.g., chief physician) was much closer to the output associated with medical directors (► **Fig. 4**). From this perspective, a position as “senior physician” should be classified as belonging to the “junior” positions (or “juniors”), and only senior physicians who hold the position of chief physician or medical director should be classified as holding a “senior position” (or “seniors”).

When the evaluated locations were reviewed with regards to the number of publications attributable to “juniors” and “seniors,” a clear correlation became apparent: the per capita number of junior publications was closely linked to the number of senior publications (► **Fig. 8**). As already mentioned above, seniors publish about 20 times as much as juniors. But it is important to point out that there were at least five locations where the number of junior publications was far above the expected number (green area) and four locations where the opposite held true (red area).

### 3.5 The publication output of locations in relation to different influencing factors

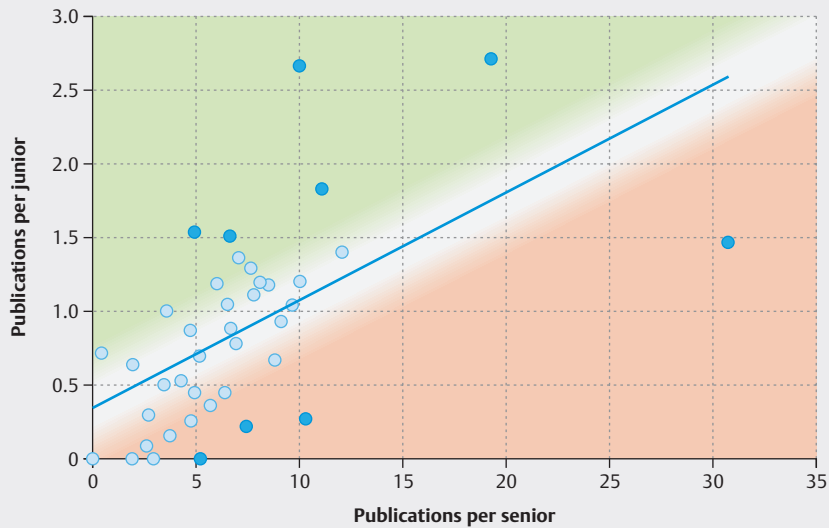
As already mentioned in chapter 2, some location factors could be classified as resources which promote more scientific research. Both bivariate and multivariate regression analysis was used to investigate whether there were significant associations with the number of per capita publications. Calculations were done separately for all medical staff but also focused on the number of pub-



► **Fig. 7** Number of publications per female or male doctor according to the locations of departments with departmental names which indicate a special focus on “obstetrics” or “cancer”. Source: own research and analysis based on data from PubMed (National Library of Medicine [NLM] for 2022).

lications by doctors in junior positions, which was one of the main focuses of interest.

To do this, first all bivariate associations which had a significance level of 5% were identified. The bivariate associations where this applied were entered into multivariate regression calculations. The summarized results are shown in ► **Table 1**. The influencing factors were ascribed a qualitative index value which aggregated the type and level of the significant relationship with the different per capita publication involvements.



► **Fig. 8** Number of involvements in publications per doctor according to senior and junior positions held at any of the 40 gynecological university locations. Source: own research and analysis based on data from PubMed (National Library of Medicine [NLM] for 2022).

► **Table 1** Factors influencing publication activities (in 2022) at 40 gynecological-obstetric university locations.

+	Variable/Influencing factor	All positions		Junior positions	
		Bivariate	Multivariate	Bivariate	Multivariate
●●●●	Publications by senior staff	***	***	***	*
●●	CCC	***		**	
●●	Number of medical staff	**		**	
●●	Foreign factor	*		*	
●	Institute for human genetics			*	
	Big-shot factor				
	Obstetrics as a priority area				
	CCS				
	DFG funding				
	BMBF funding				

Source: own calculations based on data from PubMed (National Library of Medicine [NLM])  
 (+) Own index value for the significance of the different influencing factors

### 3.5.1 Publications by doctors in senior positions

The variable “publications by doctors in senior positions” was found to be highly significant. “Per capita publications” were significantly higher both for the totality of doctors at a specific location and for doctors in positions where the publication output of senior physicians was high. This still applied following both bivariate and multivariate analysis. It might not come as surprise in terms of the total number of publications from a location because seniors constitute a subset of doctors with high publication outputs. With regards to doctors in “junior” positions it can be assumed that publications by seniors correlated significantly with

publications by juniors. The more the seniors published, the more the juniors published.

### 3.5.2 Presence of a “comprehensive cancer center”, “number of medical staff” and “foreign factor”

A “comprehensive cancer center” was present at 28 of the 40 locations. Bivariate analysis showed that the presence of such a facility was significantly associated with the publication output of all medical staff as well as that of the junior medical staff. The significantly higher number of publications from departments which explicitly



referenced oncology in their names as mentioned above (see chapter 3.4.3) coincides with this finding.

A significant association between the per capita publications of all medical staff, in particular the publications of doctors in “junior” positions, and the number of doctors at a specific location was only found with bivariate analysis. The number of medical staff can be considered an indication for the size of a location, also in terms of the numbers of the number of patients cared for and the turnover.

The term “foreign factor” refers to how many publications were also linked to foreign affiliations of the authors. Bivariate analysis found that this indicator for the “international involvement” of authors was associated with higher publication outputs, both with regards to all publications in general and specifically for the publication output of doctors in junior positions.

### 3.5.3 Presence of institutes or departments for human genetics

Using bivariate analysis, a significant association between per capita publications and the presence of institutes or departments for human genetics at the same location was only found for the publication outputs of doctors in junior positions<sup>7</sup>.

### 3.5.4 Other investigated influencing factors: “big-shot factor”, “obstetrics as a priority area”, presence of a CCS and funding from the DFG and the BMBF

Neither bivariate nor multivariate analysis found that the factors listed here had an impact on per capita publication outputs. That the extent of funding from the DFG and BMBF was not found to be significantly associated with publication output can be explained by the fact that significantly less than half of all locations even applied for funding over a four-year period, and the amount of funding awarded was so marginal that it cannot be expected that application activities were correlated with publication activities.

## 4. Conclusion

This study has attempted to describe the research intensity in the field of Gynecology using the surrogate marker “publication output” and has searched for factors which encourage or inhibit research activity.

### 4.1 Discussion of the findings

This descriptive observation shows that changes in publication outputs in Gynecology over time compared to other medical specialties such as Urology (comparable due to the similar focus on surgical treatment, oncology, and reproductive medicine) or Trauma Surgery (comparable due to the similarities in workload pressures) showed similar increases. The development over time was also comparable to that of France, Great Britain, and the USA, although the increase in output was significantly higher in the USA.

As regards the publication output of women and men, it should be noted that female doctors tended to publish less per capita at the beginning of their careers than male doctors in comparable positions, but that there were no differences in publication output between women and men who were medical directors. The reverse was true with regards to obtaining an academic title: at the start of their medical career women were more likely to have a PhD than men.

If we wish to explain these contradictory findings, it is necessary to ask whether this conceals differences in the preferences of women and men. It is possible that for young female doctors, working in a clinical setting and rapidly obtaining a qualification as a medical specialist are more important than research activities. As an academic title is more visible than publications, acquiring an academic title could prove to be a better choice in terms of optimizing the benefit when the available time budget is very limited.

It is also important to consider this finding in the context that the majority of doctors in junior positions are of an age to be planning their family and women still often play a more important role in managing the family [7]. It can also be assumed that the lower publication output of younger female doctors is also connected to the fact that more female doctors tend to be working part-time [6]. It would be interesting to find out whether male colleagues are better able to free up time for scientific work.

The fact that women who are postgraduates or young medical specialists publish less than men must be scrutinized critically, given the increasing “feminization” [6] occurring in Gynecology. It is urgent that supportive measures are developed and maintained to ensure that the feminization of Gynecology will not have a negative impact on future publication outputs. It is also important to ensure that women can go on to hold leading medical positions which require a significant publication output.

The analysis also identified influencing factors which might have a supportive or inhibiting impact on research activities and therefore need to be part of the discussion when considering how the publication output of a location could be increased over the medium term. As there were considerable differences between locations, the following influencing factors which support scientific activities and research were identified:

- The publication activity of chief physicians and medical directors in a location have an important impact on the overall publication output of the location, especially on the publication activities of more junior medical staff. This demonstrates the importance of the activities of medical staff in leading positions, including how they serve as role models. Conversely, when the publication output of a location was mainly linked to an individual doctor in a leading position (big-shot factor), it had no impact on the publication outputs of more junior medical staff.
- The impact of a heavy workload became indirectly clear when the limited surgical capacity and the reduction of beds during the coronavirus pandemic in 2020 and 2021 was found to be correlated with higher publication outputs. The slightly lower overall publication rate recorded for obstetric locations could be due to the higher workload in Obstetrics, much of which occurs outside regular working hours.

<sup>7</sup> A total of 31 institutions were identified.

- Central facilities such as a comprehensive cancer center or a department for human genetics at the location were associated with higher publication rates. No such significant impact was found for a CCS, probably because 27 of 40 locations had a CCS.
- The higher rate of publications from locations with a priority area focusing on oncology is probably due to the current intense interest in this topic which has led to a greater number of relevant studies and more support from intra- and extramural sources.
- The number of medical staff and thus the size of a location are also important. In larger locations, the clinical work and the workload and services provided are spread across a greater number of people, and it can be assumed that this offers a greater latitude for scientific work which, in turn, has a positive impact on publication outputs.
- Just as local interdisciplinary cooperations increase the publication output of a location, international networking with foreign universities also increases publication outputs.

The fact that the funding applications for Gynecology approved by the DFG and the BMBF had no demonstrable impact on publication outputs is a cause for concern. This issue is probably not noticeably different in other medical specialties because there, too, the relation between approved funding applications and publication outputs are of a similar order of magnitude. The numbers of approved funding applications in Gynecology and Obstetrics have decreased in recent years. It appears that the potential of an approved grant to lead to more publications of results is either not apparent or is not put to optimal use.

#### 4.2 Approaches to maintain or increase publication outputs

Both the comparisons between medical specialties and internationally between countries should be an opportunity to take critical stock of research activities and introduce measures to support research activities at different levels.

The overwhelming importance of the publication outputs of leading medical staff could be one starting point. The conditions to expand role model functions could be determined. It should not be forgotten that publication activities varied quite considerably, which points to significant differences in motivation and capabilities.

Suitable frameworks such as workshops and coaching sessions could be developed where leading medical staff could develop options to provide targeted support for publication outputs at their location by boosting the motivation of their younger colleagues.

The positive effect of international networking could also become the subject of a longer-term focus on strengthening networks.

Options to support scientific research, such as “Clinician Scientist” programs [12] already exist; they should be reviewed to see whether they suit the specific conditions of the medical specialty and suggestions for appropriate funding and support should be developed where necessary.

Incentives and opportunities for support should be developed which would provide support when making grant applications to public research funding bodies such as the DFG and the BMBF. In this context more work needs to be done to ensure that the work of colleagues who serve as medical specialists on decision-making bodies remains attractive.

The involvement in multicenter studies which are used to approve new medications should be supported, especially in Oncological Gynecology, and could further boost publications, which usually also have high impact factors.

More needs to be known about the preference structures of younger female and male doctors to be able to provide more appropriate supportive measures which are compatible with family circumstances. Developing supportive measures for doctors returning from parental leave and doctors working part-time is particularly important. The results of our study clearly show that maintaining programs which promote the advancement of women in the field of Gynecology is incredibly important.

Innovative concepts will need to be developed which will allow research to be realized better in Gynecology. One approach could be filling more medical staff positions in the gynecological departments of universities with W2 or W3 professors who have their own research and teaching budgets.

## 5. Limitations

This was an observational study in which data collection was not carried out under controlled conditions. Therefore, no confirmatory results from the testing of hypotheses were to be expected from this study. Nevertheless, based on comparisons between various subgroups, it was possible to obtain general impressions about the framework of hypothetical causative influencing factors which can serve as the basis for hypotheses in future studies.

The study was limited to medical university locations to ensure that the environment where research and publications are carried out was relatively homogeneous. It is therefore important to clearly state at this point that there are many gynecological departments in maximum care hospitals whose clinical research is equal to that of university-affiliated departments. This study focused only on medical staff who were also involved in providing patient care, as how medical staff were presented on the websites of different institutions was inconsistent. It was, of course, also not possible to obtain information about whether female and male doctors were working full-time or part-time from the websites. It was therefore not possible to pursue the question about how such differences affected publication outputs.

It has already been pointed out above that the number and positions of male and female doctors were identified using the websites of the different locations, meaning that, to a limited extent, some of the data will not be current. The evaluation of applications for public funding was limited to funding provided by the DFG and the BMBF, which means that smaller funding agencies were not included. Moreover, it was not possible to include non-public third-party funding.

## Conflict of Interest

The authors declare that they have no conflict of interest.

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