

## Challenges and aspirations of neurosurgery residents in Germany: Insights from a questionnaire-based survey

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### ABSTRACT

**Objective:** Neurosurgery residents in Germany face numerous challenges including receiving comprehensive surgical training with adequate learning opportunities, achieving balanced work life equilibrium, maintaining a positive work environment and navigating career prospects. The objectives of this study are to assess overall satisfaction with the training program, identify factors contributing to dissatisfaction, explore various dimensions of the training program, evaluate the psychological well-being of residents, and ascertain their preferences for future subspecialties.

**Methods:** A questionnaire-based survey was conducted anonymously among neurosurgery residents from various training hospitals, nationwide. The survey utilized a quantitative questionnaire as data collection tool. The data collection took place from June 2021 to January 2023.

**Results:** The survey encompassed 120 neurosurgery residents, with a gender distribution of 55 % male and 45 % female. The respondents were primarily from university hospitals (53 %), followed by community hospitals (38 %) and private hospitals (9 %). In terms of training program satisfaction, 37 % reported moderate satisfaction, 39 % indicated below-moderate satisfaction, and 28 % experienced above-moderate satisfaction. The predominant causes of dissatisfaction identified were insufficient surgical exposure (reported by 39 % of respondents), suboptimal educational content (38 %), and inadequate research opportunities (32 %). Additionally, 24 % of respondents highlighted psychological stress, and 36 % reported frequent experiences of burnout. A majority (63 %) indicated a workload of 60–80 h weekly. About half of the residents indicated a future specialization interest in neurosurgical oncology.

**Conclusion:** The results of the survey findings provide valuable insights into the challenges and aspirations of neurosurgery trainees in Germany. These results serve as a basis for improving the training system, enhancing the working environment, and guiding future planning in this field. To optimize the training of residents, it is important to address issues such as limited surgical and research opportunities and psychological well-being. The expressed interest in subspecializing offers guidance for shaping the training program's future direction.

**Abbreviations:** EANS, European Association of Neurosurgical Societies; EWT, European Working Time Directive.

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## 1. Introduction

The landscape of neurosurgical residency in Germany presents a multifaceted picture, marked by a complex array of challenges, aspirations, and evolving recommendations. Nearly 1000 neurosurgery residents are distributed across various types of hospitals in Germany, including university, private, and community facilities [1]. While there is a defined curriculum for neurosurgical residency, the absence of a centralized authority overseeing and standardizing the training across these institutions leads to a potential inconsistency in the quality of training. Although the medical associations of doctors in each state are considered to be the board-certifying bodies, the responsibility for meeting program requirements is placed on individual hospitals, which could result in variable training standards throughout the country [2].

Recent studies have further illuminated some important issues within the German neurosurgical training framework. These include widespread trainee satisfaction issues with existing programs, concerns regarding the practical aspects of the training and the adequacy of their training experiences including operation exposure, mentorship and future aspects and uncertainties of their careers [1,3]. While important publications such as that by Ringel et al. have recently documented a steady increase in the number of neurosurgeons in Germany [4], there is a notable gap in the literature regarding the quality of these training programs. This lack of focus on the qualitative aspects of neurosurgical education and training underscores the need for a deeper exploration into the caliber of neurosurgical training, beyond merely its numerical expansion.

In the member countries of the European Union, laws limiting the working hours aim to improve work-life balance and prevent burnout [5]. However, this raises new challenges for neurosurgical training programs. The key issue is whether the law can enable high-quality training including hands-on surgical experience and theoretical learning while achieving its objectives. This necessitates a re-evaluation of neurosurgical training strategies to ensure residents receive thorough training within the new time constraints, without compromising their preparedness for the demanding neurosurgical field.

Psychological well-being of the residents correlates with a high performance of the residents as well as the quality of the training [6]. Recent studies indicate a high level of psychological stress among surgical residents, leading to burnout and increased dropout rates [7,8]. This highlights the importance of identifying and investigating stress factors among neurosurgery residence and implementing solutions to enhance the well-being of residents and the attractiveness of residency programs.

There is a gap in the literature investigating the quality of neurosurgery residency programs in Germany. This article aims to comprehensively explore various aspects of neurosurgical training programs in Germany. It delves into key elements such as surgical exposure, work environment, work-life balance, and the psychological stressors encountered during residency. By evaluating these aspects, the current study seeks to understand the aspirations of neurosurgery residents better and to formulate targeted recommendations. These recommendations are aimed at enhancing the quality and effectiveness of neurosurgical residency programs, thereby addressing the current challenges, and advancing the future of neurosurgical training in Germany.

## 2. Methods

### 2.1. Study design, data collection and statistical analysis

This cross-sectional survey study utilized a standardized questionnaire to collect data from neurosurgery residents across Germany. The distribution of the questionnaire was facilitated by the German Society of Neurosurgery (DGNC), leveraging their community network, which contains about 350 neurosurgical residents. The questionnaire was also distributed via email links to neurosurgery residents who were not

**Table 1**

Demographic and Professional Characteristics of Neurosurgery Residents.

Characteristics	Male N (%)	Female N (%)	Overall N (%)
<b>Gender</b>			
Male	66 (55 %)	-	<b>66 (55 %)</b>
Female	-	54 (45 %)	<b>54 (45 %)</b>
<b>Total</b>			<b>120 (100 %)</b>
<b>Training Year</b>			
1–2	12 (18 %)	18 (33 %)	<b>30 (25 %)</b>
3–4	27 (41 %)	10 (18.5 %)	<b>37 (30.8)</b>
5–6	15 (22.7 %)	16 (29.5 %)	<b>31 (25.9 %)</b>
>6	12 (18.3 %)	10 (19 %)	<b>22 (18.3 %)</b>
<b>Relationship Status</b>			
Married or in a relationship	49 (74 %)	34 (63 %)	<b>83 (69 %)</b>
Not in a relationship	16 (24 %)	17 (31.5 %)	<b>33 (27.7 %)</b>
Divorced or widowed	1 (2 %)	3 (5.5 %)	<b>4 (3.3 %)</b>
<b>Type of the Hospital</b>			
University Hospital	30 (45.4 %)	33 (61 %)	<b>63 (52.6 %)</b>
Community Hospital	29 (44 %)	17 (31.4 %)	<b>46 (38.3 %)</b>
Private Hospital	7 (10.6 %)	4 (7.6 %)	<b>11 (9.1 %)</b>
<b>Children</b>			
No Children	38 (57.5 %)	42 (77.7 %)	<b>80 (66.6 %)</b>
One Child	12 (18 %)	8 (15 %)	<b>20 (16.7 %)</b>
More than one Child	16 (24.5 %)	4 (7.3 %)	<b>20 (16.7 %)</b>
<b>Ethnicity</b>			
White	25 (38 %)	40 (74 %)	<b>65 (54 %)</b>
Black	3 (4.5 %)	1 (2 %)	<b>4 (3.5 %)</b>
Asian	0 (0 %)	5 (9 %)	<b>5 (4 %)</b>
Arabic	28 (42.5 %)	4 (7.5 %)	<b>32 (26.9 %)</b>
Hispanic	4 (6 %)	4 (7.5 %)	<b>8 (6.6 %)</b>
Other	6 (9 %)	0 (0 %)	<b>6 (5 %)</b>
<b>Program Location*</b>			
North	20 (30 %)	9 (16.7 %)	<b>29 (23 %)</b>
South	23 (35 %)	21 (38.9 %)	<b>44 (35 %)</b>
East	13 (20 %)	10 (18.5 %)	<b>23 (18 %)</b>
West	10 (15 %)	14 (25.9 %)	<b>24 (24 %)</b>

\* **North** = Schleswig-Holstein, Hamburg, Lower Saxony, Bremen, **South** = Thuringia, Baden-Wurttemberg, Bavaria, **West** = North Rhine-Westphalia, Hessen, Rhineland Palatinate, **East** = Mecklenburg Western Pomerania, Brandenburg, Saxony-Anhalt, Berlin

members of the German Society of Neurosurgery, and their contact data were available publicly. This sample size was calculated to achieve a 90 % confidence level, with a margin of error of plus or minus 7 %. The Survey was piloted with 15 residents (about 12.5 % of the total interviewee) to identify and address issues related to question clarity, survey length and overall design. The response rate was about 40 %, reminders were sent in a regular interval to encourage participation. The participants represented a diverse range of hospital settings, including university hospitals, private hospitals, and community hospitals. The anonymous questionnaire comprised multiple sections designed to elicit detailed responses on various aspects of residency training, work environment, career aspirations, perceived challenges and recommendations (**Supplement Content 1**). The data collection period spanned from June 2021 to January 2023. This study was conducted according to the Checklist for Reporting of Survey Studies (**Supplement Content 2**).

For the statistical analysis, R Studio (version 4.3.2) was employed to process the collected data. The analysis focused on comparing different aspects of residency experiences and outcomes using a combination of chi-square test to assess the significance of differences between groups and percentage comparisons for a straightforward representation of the data. Statistical significance was set at  $P < .05$ .

### 2.2. Ethics approval

In compliance with the anonymous design of the study, where no personal or sensitive data were collected, this study was exempted from ethical review as per [paragraph 15 of the Professional Code for Physicians, Germany]. This exemption is in line with ethical guidelines for research involving human subjects. The guidelines stipulate that due to the anonymity of the data collected in this study, obtaining consent from

**Table 2**  
Evaluation of different aspects of the residency programs according to the neurosurgery residents.

	Male				Female				Sum N (%)	P-value
	University Hospital	Community	Private	Overall N (%)	University Hospital	Community	Private	Overall N (%)		
<b>Are you satisfied with the current training system?</b>										
1 (very unsatisfied)	6	2	-	8 (12 %)	3	-	-	3 (5.5 %)	11 (9.1 %)	0.457
2	6	5	2	13 (19.6 %)	7	10	1	18 (33.3 %)	31 (25.8 %)	0.596
3	15	10	-	25 (37.8 %)	14	2	3	19 (35.1 %)	44 (36.6 %)	0.749
4	3	10	3	16 (24.2 %)	8	4	-	12 (22.2 %)	28 (23.3 %)	0.705
5 (very satisfied)	-	2	2	4 (6 %)	1	1	-	2 (3.7 %)	6 (5 %)	0.421
<b>How do you assess the working atmosphere?</b>										
1 (very unsatisfied)	3	1	2	6 (9 %)	2	-	1	3 (5.5 %)	9 (7.5 %)	0.287
2	11	3	1	15 (22.7 %)	6	9	-	15 (27.7 %)	30 (25 %)	1.000
3	8	11	1	20 (30.4 %)	7	1	2	10 (18.6 %)	30 (25 %)	0.394
4	7	10	1	18 (27.3 %)	14	7	1	22 (40.7 %)	40 (33.3 %)	0.786
5 (very satisfied)	1	4	2	7 (10.6 %)	4	-	-	4 (7.5 %)	11 (9.2 %)	0.565
<b>What are the reasons for dissatisfaction with the current training system and environment?</b>										
Excessive training time	2	5	1	8 (12.5 %)	6	1	-	7 (13.4 %)	15 (12.6 %)	0.379
Limited kind of diseases and cases to be experienced	0	2	1	3 (5 %)	1	3	-	4 (6.7 %)	7 (5.9 %)	0.767
few opportunities for surgery by oneself	18	7	3	28 (42.7 %)	13	5	1	19 (33.6 %)	47 (39 %)	0.626
Little experience for research	2	6	1	9 (14 %)	9	4	1	14 (24 %)	23 (19 %)	0.582
poor treatment and discrimination from colleges/Supervisors	3	8	1	12 (16.8 %)	3	2	1	6 (12.6 %)	18 (15 %)	0.406
Other responses	4	1	1	6 (9 %)	3	1	-	4 (9.7 %)	10 (8.5 %)	0.643
<b>What is the most difficult point as a neurosurgical resident?</b>										
Excessive training time	7	5	2	14 (21.7 %)	7	4	1	12 (22.8 %)	26 (21.7 %)	0.782
less social contacts	5	3	2	10 (15.5 %)	5	2	1	8 (14.5 %)	18 (15 %)	0.677
Human relationships	4	2	2	8 (12.4 %)	8	1	1	10 (18 %)	18 (15 %)	0.797
Hardships of like on low pay	3	1	1	5 (7.7 %)	1	1	-	2 (4.6 %)	7 (5.8 %)	0.250
Anxiety about an uncertain future	5	5	2	12 (18.7 %)	4	4	1	9 (17 %)	21 (17.5 %)	0.518
Psychological Stress	5	9	3	17 (24 %)	4	7	2	13 (22.9 %)	30 (25 %)	0.590
<b>Average number of working hrs/wk</b>										
<60	3	9	-	12 (18.2 %)	8	3	2	13 (20.6 %)	25 (20.8 %)	0.922
60–80	24	18	4	46 (69.6 %)	16	11	2	29 (54.7 %)	75 (62.5 %)	0.475
80–100	3	2	3	8 (12.2 %)	8	3	-	11 (22.3 %)	19 (15.8 %)	0.693
>100 hrs	-	-	-	-	1	-	-	1 (2.4 %)	1 (0.83 %)	0.007
<b>Do you think the extra working time affect your social life/family relationship?</b>										
Yes	24	23	5	52 (78.7 %)	30	13	2	45 (83.3 %)	97 (80.8 %)	0.830
No	5	4	1	10 (15.3 %)	2	2	-	4 (7.4 %)	14 (11.6 %)	0.219
Not apply	1	2	1	4 (6 %)	1	2	2	5 (9.2 %)	9 (7.6 %)	0.518
<b>Do you think you would probably finish your training program in the formal training period (6 years)?</b>										
Yes	13	14	2	29 (44 %)	15	6	1	22 (40.7 %)	51 (42.5 %)	0.699

(continued on next page)

Table 2 (continued)

	Male				Female				Sum N (%)	P- value
	University Hospital	Community	Private	Overall N (%)	University Hospital	Community	Private	Overall N (%)		
No	17	15	5	37 (56 %)	18	11	3	32 (59.3 %)	69 (57.5 %)	0.784

The p-value assesses the statistical significance of differences between male and female residents' responses Sum.

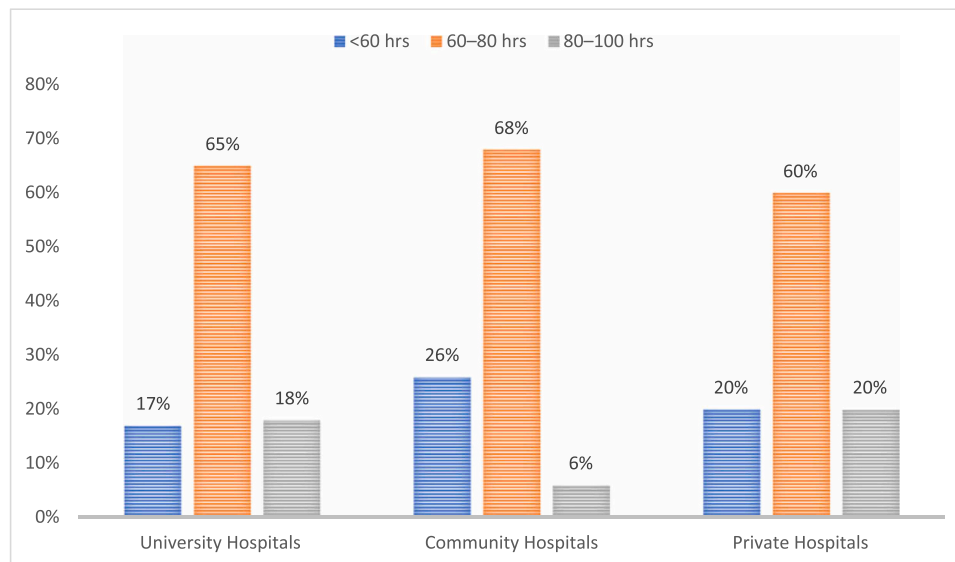


Fig. 1. Distribution of Weekly Working Hours Among Neurosurgical Residents by Hospital Type.

participants is not requisite. Documentation confirming the exemption is available and can be provided upon request. All methods were carried out in accordance with relevant guidelines and regulations.

### 3. Results

#### 3.1. Demographics, training experience, and perceived opportunities

The study surveyed 120 neurosurgery residents in Germany, with a distribution of 55 % male (n = 66) and 45 % female (n = 54) respondents (Table 1). The participants were spread across various training years: 25 % in years 1-2, 31 % in years 3-4, 26 % in years 5-6, and 18 % in training for over 6 years. A majority (69 %) were in a relationship or married, and 67 % had no children. The respondents worked in diverse hospital settings: 53 % in university hospitals, 38 % in community hospitals, and 9 % in private hospitals. Ethnically, the group was varied, with 54 % identifying as White, 27 % as Arabic, and smaller proportions as Hispanic (7 %), Asian (4 %), Black (4 %), and other ethnicities (5 %). They also represented different regions of Germany: 23 % from the North, 35 % from the South, 18 % from the East, and 24 % from the West.

In Table 2 of the survey, neurosurgery residents' satisfaction with their training was quantified, revealing moderate overall contentment. Specifically, 37 % of respondents reported moderate satisfaction with their training system, with a similar sentiment towards the working atmosphere. The primary sources of dissatisfaction included limited opportunities for conducting surgeries independently (39 %), lack of research experience (19 %), and experiences of poor treatment or discrimination (15 %). Psychological stress emerged as a significant challenge, identified by 25 % of residents as the most difficult aspect of their training. Additionally, a substantial 63 % of the respondents reported working between 60 and 80 h per week. 57.5 % of the residents doubted their ability to complete training within the designated six-year

period. Fig. 1 shows the distribution of working hours by hospital type, showing that between 60 % and 68 % of the residents in the three types of hospitals work between 60 and 80 h per week.

Table 3 reveals the frequency at which neurosurgery residents report experiencing a disparity in opportunities relative to their peers, with a breakdown by ethnicity and gender. 72 % of female respondents reported having fewer opportunities than their male colleagues, while 60 % of male colleagues acknowledged the same. Among these, 37 % of female respondents "Sometimes" felt disadvantaged in terms of opportunities, with most of these responses coming from White females. In comparison, only 21 % of male respondents occasionally felt they had fewer opportunities. This group comprised an equal number of Arabic and White respondents.

Furthermore, A disparity in perceived opportunities between male and female neurosurgery residents according to the type of hospital is underscored by the data presented in Fig. 2. 67 % of female respondents felt they had fewer opportunities than their male counterparts. This disparity was most evident in private hospitals, where all female respondents felt disadvantaged compared to 57 % of male respondents. In community hospitals, 70 % of female and 51 % of male respondents reported feeling fewer opportunities. Similarly, in university hospitals, 60 % of female respondents perceived fewer opportunities than 43 % of their male colleagues.

#### 3.2. Challenges in residency: emotional well-being and workload

An assessment of the emotional challenges faced by neurosurgery residents is shown in Table 4. (40 %) of respondents reported feeling frustration occasionally. In terms of depression, 28 % of residents experienced it occasionally, while a notable (53 %) reported frequent depression. Burnout appears to be a significant issue, with 30 % of residents feeling it occasionally, 36 % frequently, and 34 % never experiencing burnout.

**Table 3**  
Distribution of Perceived Training Opportunity Disparities Among Neurosurgery Residents by Gender and Ethnicity (How often do you feel you have fewer opportunities than your colleagues?).

	Male						Female						Sum N (%)	P-value		
	White	Arabic	Hispanic	Asian	Black	Others	Overall N (%)	White	Arabic	Hispanic	Asian	Black			Other	Overall N (%)
Sometimes	6	6	2	-	-	-	14 (21.2 %)	16	-	-	4	-	-	20 (37 %)	34 (28.3 %)	0.735
Often	3	6	1	-	-	-	10 (15.2 %)	8	1	4	-	-	-	13 (24 %)	23 (19.1 %)	0.768
Frequently	3	5	-	-	2	3	13 (19.7 %)	3	-	-	-	1	-	4 (7.5 %)	17 (14.3 %)	0.139
Always	1	-	-	-	1	-	2 (3 %)	1	1	-	-	-	-	2 (3.7 %)	4 (3.3 %)	1.000
Don't apply	12	11	1	-	-	3	27 (40.9 %)	12	2	-	1	-	-	15 (27.8 %)	42 (35 %)	0.516

The p-value assesses the statistical significance of differences between male and female residents' responses Overall.

### 3.3. Assessment of training and recommendations for improvement

Insights into the experiences of neurosurgery residents within various hospital environments, focusing on aspects such as surgical exposure, hands-on experiences, teaching quality, and research opportunities, are detailed in Table 5. It is revealed that 38 % of residents consider their surgical exposure as average, with another 28 % viewing it positively as good, a sentiment more commonly reported by those in university and community hospitals. In contrast, private hospitals received more poor and very poor ratings for surgical exposure. When it came to hands-on experiences, over half of the residents (51 %) considered it to be average. The quality of teaching within residency programs was viewed less favorably, with 38 % of respondents rating it as poor and 33 % as average. Research experience garnered notable dissatisfaction, with 32 % rating it as poor and 28 % as very poor, especially among community hospital residents.

Regarding suggestions for improving neurosurgery training programs, Table 6 illustrates that a 38 % of males and 37 % of female's residents advocate for shorter working hours and enriched educational content. A higher percentage of female residents (57 %) compared to male residents (33 %) emphasized the need for professional psychological support. Both male and female residents largely agreed on the clinical workload (managing 10 patients per resident at a given time) and the necessity of extensive surgical experience, including over 50 craniotomies and spine surgeries. Opinions on research experience varied, with some male residents prioritizing publishing as a first author, while a portion of female residents deemed co-authoring or not publishing as sufficient during training.

### 3.4. Subspecialty training, preferences, and learning resources

Table 7 provides an evaluation of the availability and adequacy of various neurosurgical specialties within the training programs as reported by the residents. Functional neurosurgery was reported as inadequately covered, particularly in university (62 %) and private hospitals (55 %), with over half in community hospitals stating its unavailability. Training in peripheral nerve surgeries was also seen as insufficient, especially in community (53 %) and university hospitals (40 %). Similarly, endovascular surgery training was deemed inadequate, with the highest gaps in university (52 %) and community hospitals (48 %). 45.6 % of respondents from private hospitals reported the unavailability of peripheral nerve as well as endovascular surgeries.

Subspecialty interests for post-training career paths among neurosurgery residents are presented in Fig. 3, highlighting a marked preference for neurosurgical oncology. This interest is particularly strong, with 63 % of female residents and 59 % of male residents expressing a preference for this field. Male residents showed a greater preference for spinal (14 %) and neurovascular (5 %) surgeries than their female counterparts. Conversely, female residents exhibited a higher interest in functional (7 %) and pediatric (9 %) neurosurgery, compared to a 3 % interest in each of these areas among male residents.

Fig. 4 shows the preferred sources of knowledge among neurosurgery residents, indicating their reliance on various educational materials. Most residents predominantly favor traditional learning materials, with 57 % opting for printed textbooks and 52 % for electronic books. Internet sources used often by 46 % of the residents. In terms of teaching methods, in-person teaching is sometimes preferred by 48 % of the respondents, while online teaching is occasionally utilized by 44 %. Notably, a considerable 41 % of residents reported that they never prefer printed journals as a source of knowledge.

## 4. Discussion

Our study offers valuable insights into neurosurgery residency training in Germany, revealing residents' dissatisfaction mainly due to restricted surgical exposure, scarce research opportunities, and poor

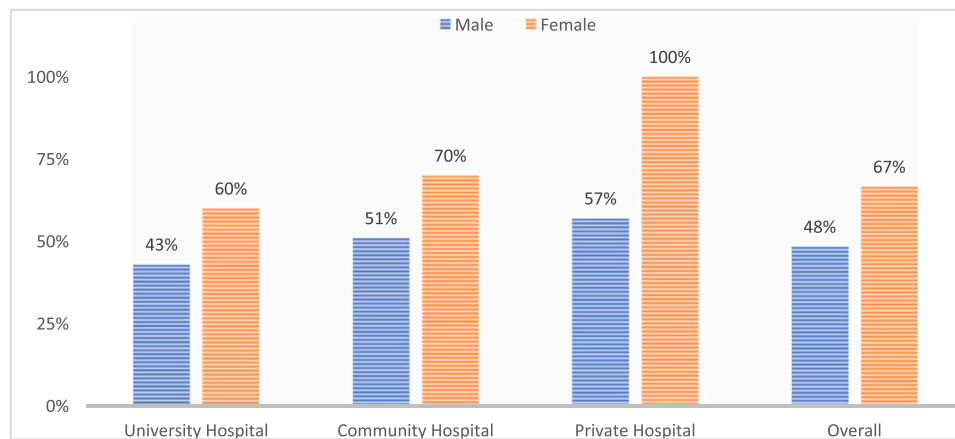


Fig. 2. Perceived Disparities in Training Opportunities by Hospital Type and Gender.

Table 4  
Frequency of Frustration, Depression, and Burnout Among Neurosurgery Residents by Gender.

	Male			Female			Overall			P-value
	Frequently	Occasionally	Never	Frequently	Occasionally	Never	Frequently	Occasionally	Never	
Frustration	28 (42.4 %)	34 (51.6 %)	4 (6 %)	35 (64.8 %)	14 (26.7 %)	5 (8.5 %)	63 (52.5 %)	48 (40 %)	9 (7.5 %)	0.769
Depression	18 (27.5 %)	33 (50 %)	15 (22.5 %)	16 (29.6 %)	30 (55.6 %)	8 (14.8 %)	34 (28.3 %)	63 (52.5 %)	23 (19.2 %)	0.662
Burnout	21 (31.8 %)	20 (30.4 %)	25 (37.9 %)	15 (27.8 %)	23 (42.5 %)	16 (29.6 %)	36 (30 %)	43 (35.8 %)	41 (34.2 %)	0.245

The p-value assesses the statistical significance of differences between male and female residents' responses.

work conditions. These issues, aligning with prior studies, highlight the urgent need for improvements in neurosurgical training, extending beyond Germany to the wider European context.

4.1. Challenges in neurosurgery training: limited exposure, educational gaps, and research disparities

Our survey indicates nearly half the participants were female, mirroring the increasing presence of women in German neurosurgery. Despite a rise in board-certified neurosurgeons and more women entering the field, they still make up only 20–30 % of the total [4,9]. The growth in neurosurgery residents and practitioners in Germany is linked to private practice expansion and the Working Time Directive, which caps working hours, necessitating more residents to sustain services [4, 10].

The moderate satisfaction with neurosurgery training in Germany stems from limited surgical exposure, notably due to scarce opportunities for independent surgeries. This issue is exacerbated by a 115 % increase in board-certified neurosurgeons since 2000, outpacing the mere 1 % population growth, leading to fewer cases per surgeon. Furthermore, the absence of a centralized training authority and the decentralized nature of training programs place the onus on individual departments, causing disparities in surgical case allocation among residents. This is evidenced by 14 % of survey respondents feeling they receive fewer opportunities than their peers. Bottom of Form Additionally, 58 % of residents express concerns about fulfilling their training within the designated six-year timeframe. Another key issue is the scant exposure to subspecialties like peripheral nerve, functional, and vascular neurosurgery. A 2008 study by Steiger et al. highlighted minimal caseloads in these areas within German neurosurgical departments, particularly noting the scarcity of functional neurosurgery in non-university settings [11]. Economic constraints, limited surgical expertise, and shifts towards interventional neuroradiology reducing as well cerebrovascular surgery needs are contributing factors [12]. A collaborative rotation program across departments, possibly overseen by a central body, could enhance exposure and skill development in these critical yet overlooked subspecialties. This data aligns with the results of

a survey conducted by the European Association of Neurosurgical Societies (EANS) Training Committee across European Union countries, revealing only moderate satisfaction with hands-on surgical experience among neurosurgery residents [13]. Similarly, these observations are in line with studies from other global regions, such as South Korea, where research has highlighted only moderate satisfaction with the neurosurgical training system [14]. In both contexts, the primary source of dissatisfaction is attributed to limited surgical experience. Another factor contributing to resident dissatisfaction is the lack of research opportunities during the training period. Furthermore, A part of residents' dissatisfaction are the limited research opportunities, with university hospital residents experiencing moderate satisfaction, unlike their peers in community and private hospitals with lower satisfaction. Kilinic et al. found that German university hospital neurosurgery residents publish significantly fewer articles (2.9 per resident) compared to their U.S. counterparts (9.2 per resident) [15]. Additionally, the average h-index for German residents is 1.1, lower than the U.S.'s 2.4, indicating a disparity in academic output [15,16]. Effective research exposure and mentorship within neurosurgical departments are essential for enhancing trainees' research interest and academic productivity [17, 18].

The quality of teaching for neurosurgery residents in Germany has been a major area of concern. This issue appears to be widespread across neurosurgical programs, as evidenced by data from the EANS Training Committee, which indicates moderate to below moderate satisfaction with clinical education among residents, which suggests a systemic challenge within neurosurgical education [13]. The shift from traditional to online educational formats, during the post COVID-19 era, primarily through webinars [3], has not adequately addressed the gap in formal training. Moreover, the decentralized nature of Germany's neurosurgical training program contributes to a lack of uniformity and structure in educational content. A significant difference from the USA is the absence of standardized written assessments in Germany, which impedes the objective evaluation of theoretical knowledge acquisition among residents [19]. This situation leaves the assessment process to individual departments, leading to variability and subjectivity in teaching quality evaluation.

**Table 5**  
Evaluation of surgical exposure, teaching activities and research expositions according to the experience of the residents in their hospitals.

	Excellent			Good			Average			Poor			Very poor								
	UH	CH	PH	UH	CH	PH	UH	CH	PH	UH	CH	PH	UH	CH	PH						
	Sum			Sum			Sum			Sum			Sum								
How do you rate the quality of surgical exposure in your training program?	7	3	1	11	18	15	1	34	27	16	2	45	8	11	4	23	3	1	3	7	(5.8 %)
				(9.1 %)				(28.3 %)				(37.5 %)				(19.3 %)					
How do you rate your own hands-on experience in surgery during your training?	2	2	-	4	16	10	4	30	32	24	5	61	12	10	1	23	1	-	1	2	(1.6 %)
				(3.3 %)				(25 %)				(50.8 %)				(19.3 %)					
How do you assess the teaching in your training program?	4	3	-	7	11	10	4	25	23	13	3	39	23	20	3	46	2	-	1	3	(2.5 %)
				(5.8 %)				(20.8 %)				(32.5 %)				(38.4 %)					
How do you assess the research experience including research teaching/conducting?	7	-	2	9	10	2	-	12	20	7	1	28	18	18	2	38	8	19	6	33	(27.5 %)
				(7.5 %)				(10 %)				(23.3 %)				(31.7 %)					

\*(UH= University Hospitals, CH= Community Hospitals, PH= Private Hospitals).

#### 4.2. Psychological well-being, working hours, and the quest for balanced neurosurgical training

Burnout is a significant challenge in neurosurgical residency, with 36 % of our survey respondents experiencing it frequently, aligning with Zaed et al.'s findings of a 48 % burnout rate in similar demographics [7]. Factors like high workload, limited leisure time contribute to this issue and lack of professional support [20], whereas a sense of achievement could compensate and lessen burnout, as seen in a Chinese study [21]. Furthermore, Psychological stress, marked by depression and frustration, is exacerbated by factors like lack of career satisfaction and a negative work environment [22]. High frustration and depression rates among surgical residents [23], coupled with the stigma around seeking help [24], emphasize the need for addressing mental health in surgical training. On the other hand, recent data from the European Union underscore a general worrying rise in stress levels among its youth, attributable to a complex blend of factors. These span the traditional hurdles of young adulthood to the significant effects of loneliness and intense social pressures [25]. Hence, the escalation in burnout and psychological stressors observed among young neurosurgical residents may also reflect this broader trend. It is well-established that enhancing mentorship programs, offering psychological support, and tackling the root causes of these challenges can significantly improve the psychological well-being of residents [26].

The majority of neurosurgery residents report working 60–80 h per week, surpassing the limits set by the European Working Time Directive (EWTd), which mandates an average of 48 h per week [5]. Efforts to comply with the EWTd are underway, but several challenges hinder progress. These include economic constraints, magnified by the COVID-19 pandemic, faced by hospitals in hiring additional residents [27], which could also impact the quality of training programs, including operating time. Additionally, there is the challenge of recruiting new medical doctors in certain regions of the country [28]. However, 80 % of the respondents acknowledged that the extended working hours negatively impact their social life and family relationships. Moreover, nearly half of the respondents called for more authoritative intervention to regulate working hours during the training period. In recent decades, the implementation of working time restrictions in the UK and USA, intended to improve work-life balance for surgical residents, has led to a series of unintended and counterproductive outcomes. Research conducted by Wilson et al. [29], and Jarman et al. [30] reveals a significant decrease in the number of operations performed by residents, with reductions reported between 20 % and 50 %. Such limitations in hands-on surgical experience are further compounded by a decline in educational opportunities, as evidenced by studies from Gopal et al. [31], Bhangu and Hartshorne [32], and Feanny et al. [33], which document fewer educational sessions, missed consultant rounds, and reduced participation in teaching activities. Furthermore, the new labor agreement in Germany further limits working hours and number shifts worked by residents, which may exacerbate the challenges for residents to gain adequate surgical experience within the traditional 6-year period. Our research shows that 57.5 % of the interviewed residents already believe they will not complete their training within the formal timeframe. The impact of this agreement needs to be thoroughly evaluated, and it may necessitate discussions on adapting the training program to ensure residents can achieve the required competencies in a timely manner. While time restrictions may ostensibly enhance work-life balance, they do not inherently equate to increased career satisfaction or fulfillment. The resultant decrease in surgical experience and educational richness can, paradoxically, lead to heightened frustration, stress, and a psychological unwillingness to engage fully with the profession. Such outcomes underscore the need for a more nuanced approach to balancing work demands with educational and personal development needs. The willingness to engage in academic work, which often has to be done during free time due to clinical work commitments, can also

**Table 6**  
Recommendations from the neurosurgery residents.

	Male				Female				P-value
	Univ. Hosp.	Community	Private	Overall	Univ. Hosp.	Community	Private	Overall	
Improvement priority in training program:									
Excessive training time	17	7	1	25 (37.8 %)	10	3	0	13 (24.0 %)	0.509
Poor contents of training “education”	5	8	2	15 (22.8 %)	14	4	2	20 (37.0 %)	0.704
Poor training environment	4	6	3	13 (19.7 %)	2	6	2	10 (18.6 %)	0.484
Insufficient training time due to few opportunities for surgery by oneself	4	8	1	13 (19.7 %)	7	4	0	11 (20.4 %)	0.788
Need of psychological support/ guidance?									
yes	5	12	5	22 (33.4 %)	12	9	2	23 (43.5 %)	0.933
No	25	17	2	44 (66.6 %)	21	8	1	30 (56.5 %)	0.628
Authorities’ intervention to control the working hours?									
Yes	14	19	4	37 (56.1 %)	17	10	4	31 (57.4 %)	0.604
No	16	10	3	29 (43.9 %)	16	7		23 (42.6 %)	0.754
Number of craniotomies needed during residency?									
>50 cases	20	13	4	37 (56.0 %)	15	9	1	25 (46.2 %)	0.551
30–50 cases	6	10	2	18 (27.3 %)	6	8	2	16 (29.6 %)	0.829
10–30 cases	4	4	1	9 (13.7 %)	7	-	-	6 (11.2 %)	0.805
<10 cases	-	2	-	2 (3.0 %)	5	-	1	5 (9.2 %)	0.468
Unnecessary	-	-	-	-	2	-	-	2 (3.8 %)	-
Number of spine operations needed during residency?									
>50 cases	22	22	5	49 (76.3 %)	24	16	2	42 (77.7 %)	0.798
30–50 cases	6	3	2	11 (17.7 %)	7	1	2	10 (18.6 %)	0.887
10–30 cases	2	-	-	2 (3.0 %)	2	-	-	2 (3.7 %)	-
< 10 cases	-	2	-	2 (3.0 %)	-	-	-	-	-
Unnecessary	-	-	-	-	-	-	-	-	-
Number of vascular operations needed during residency?									
>50 cases	9	9	1	19 (28.7 %)	5	5	1	11 (20.2 %)	0.421
30–50 cases	8	8	4	20 (30.3 %)	7	9	2	18 (33.2 %)	0.800
10–30 cases	7	5	2	14 (21.3 %)	11	2	-	14 (25.8 %)	0.932
< 10 cases	3	5	-	8 (12.2 %)	8	-	1	9 (15.5 %)	0.914
Unnecessary	3	2	-	5 (7.5 %)	2	1	-	3 (5.3 %)	0.561
Appropriate number of patients per resident									
10 patients	23	14	4	41 (61.0 %)	19	12	3	34 (62.9 %)	0.761
10–20 patients	7	15	2	24 (34.0 %)	14	5	-	19 (35.2 %)	0.779
20–30 patients	3	-	1	4 (5.0 %)	-	-	1	1 (1.9 %)	0.348
30–40 patients	-	-	-	-	-	-	-	-	-
>40 patients	-	-	-	-	-	-	-	-	-
Appropriate academic achievement during residency?									
Unnecessary	2	5	-	7 (10.6 %)	6	3	3	12 (22.2 %)	0.398
co-authorship in the 1 or 2 papers	8	7	3	18 (27.2 %)	6	5	1	12 (22.2 %)	0.406
first authorship regardless of clinical article or case report	7	8	2	17 (25.8 %)	11	4	-	15 (27.8 %)	0.866
Publish of one clinical article or two case reports in a peer-reviewed journal	-	-	1	1 (1.6 %)	3	1	-	4 (7.4 %)	0.348
first authorship in at least one clinical article	13	9	1	23 (34.8 %)	7	4	-	11 (20.4 %)	0.381

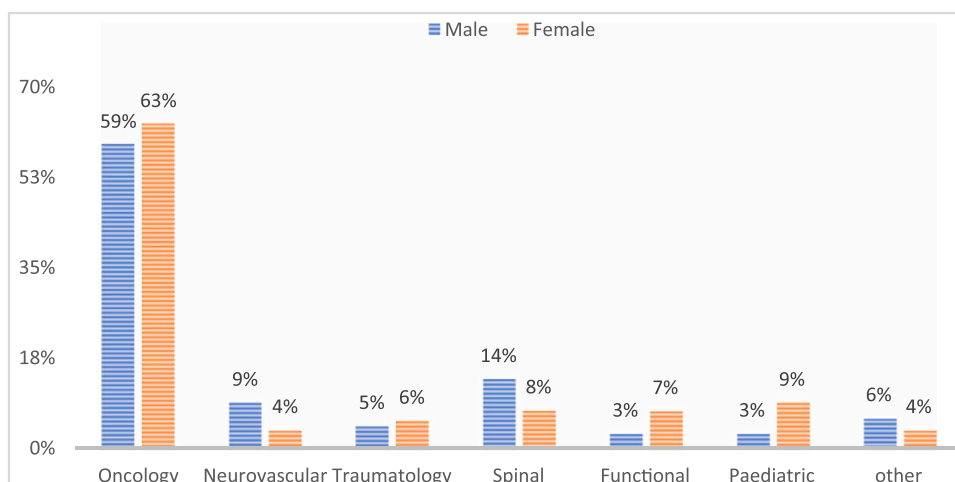
The **p-value** assesses the statistical significance of differences between male and female residents’ responses Overall.

significantly impact the work–life balance. While achieving academic goals can provide a psychological sense of accomplishment, it may also reduce personal free time. Further research on this topic is needed to improve the overall experience of trainees. Strategies such implementing flexible working hours, which entail minimizing disruptions such as mandatory breaks according to a standard schedule, during extended

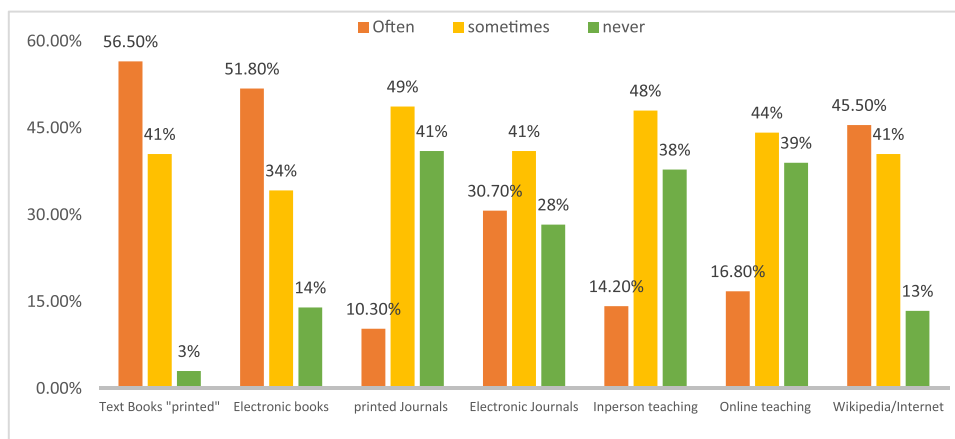
learning opportunities and surgical exposure, and embracing more adaptable recovery periods, reducing bureaucracy, and bolstering mentorship and guidance could mitigate the adverse effects on training quality, thereby supporting both the well-being and professional growth of surgical residents.

**Table 7**  
Availability of different categories of neurosurgery in the training programs of the residents.

	University Hospital			Community Hospital			Private Hospital		
	Not available in my program	Inadequate	Adequate	Not available in my program	Inadequate	Adequate	Not available in my program	Inadequate	Adequate
Endovascular	10 (15.8 %)	33 (52.4 %)	20 (31.8 %)	15 (32.6 %)	22 (47.8 %)	9 (19.6 %)	5 (45.4 %)	3 (27.3 %)	3 (27.3 %)
Functional	0	39 (62 %)	24 (38 %)	25 (54.3 %)	15 (32.7 %)	6 (13 %)	3 (27.2 %)	6 (54.5 %)	2 (18.3 %)
Minimally invasive Spine	6 (9.5 %)	14 (22.2 %)	43 (68.3 %)	6 (13 %)	15 (32.7 %)	25 (54.3 %)	2 (18.1 %)	3 (27.4 %)	6 (54.5 %)
Tumors	1 (1.5 %)	19 (30.3 %)	43 (68.2 %)	15 (32.6 %)	9 (19.6 %)	22 (47.8 %)	2 (18.3 %)	4 (36.3 %)	5 (45.4 %)
Peripheral nerve	21 (33.3 %)	25 (39.8 %)	17 (26.9 %)	14 (30.4 %)	24 (52.3 %)	8 (17.3 %)	5 (45.6 %)	3 (27.2 %)	3 (27.2 %)



**Fig. 3.** Preferred areas of subspecializing of the residents after completing their training program.



**Fig. 4.** Preferred sources of knowledge for the neurosurgery residents.

**4.3. Career aspirations and future training directions**

Regarding future career aspirations among neurosurgery residents, a majority express interest in pursuing a specialization in neurosurgical oncology, followed by a minority inclined towards spinal neurosurgery. Currently, there are no structured neurosurgical fellowship programs in Germany. After residency, trainees gain expertise in specific subspecialties by participating in activities related to these fields. This includes operations and polyclinic visits to acquire the necessary skills. This trend is significant for planning future structural fellowship

positions in neurosurgery on a national level. On the other hand, it appears that the limited exposure to other subspecialties in training programs, such as peripheral nerve, functional, cerebrovascular and pediatric neurosurgery, may influence residents' decisions against pursuing these fields in the future. Recent statistics from US, where there are established long running fellowship programs, showed that spine was the most popular subspecialty, followed by pediatrics and oncological neurosurgery [34].

#### 4.4. Limitations

This study, one of the largest surveys on neurosurgery residents in Germany with 120 responses present strengths and some limitations. One of the strengths of our study, compared to others in the literature [1], is that it provides a comprehensive analysis of the various factors affecting satisfaction with the training program in Germany. Additionally, it looks in depth other aspects, including disparities between genders and ethnicities, assesses the subjective psychological challenges faced by residents, and incorporates their recommendations for improving the training program. The cross-sectional nature of the survey restricts our ability to monitor changes over time, which is crucial for understanding evolving trends in residency experiences. The study's sample size is small relative to Germany's total number of neurosurgical residents, primarily due to decentralized data collection, as the German Society of Neurosurgery has only 350 residents as participants, limiting representation and generalizability. The relatively low response rate may lead to response bias. Furthermore, sampling bias is considered one of the study's limitations. The 1.5-year data collection period, extended by sending reminders to participants to gather more data, and the reliance on self-reported data may introduce biases. While the quantitative data offers structured insights, the absence of qualitative elements like in-depth interviews limits the depth of understanding regarding the residents' personal experiences and viewpoints. Additionally, the overlap of the study period with the COVID-19 pandemic could have distinctly impacted factors such as work hours, stress levels, and burnout, possibly skewing the results. Despite its scale, the study may not fully capture the diverse experiences and opinions of majority of the neurosurgery residents in Germany, and the survey recruitment methods could have introduced selection bias.

#### 4.5. Conclusion

In conclusion, this comprehensive study sheds light on the multifaceted challenges and aspirations of neurosurgery residents in Germany. Key findings indicate moderate satisfaction with training programs, influenced by factors such as limited surgical exposure, insufficient research opportunities, and variability in teaching quality. The study underscores the impact of extended working hours on residents' personal lives, with a substantial proportion reporting burnout and psychological stress. The COVID-19 pandemic may have further complicated these challenges. Notably, the survey reveals a growing interest among residents in neurosurgical oncology, while also highlighting the need for enhanced exposure to underrepresented subspecialties like peripheral nerve and vascular neurosurgery. These insights call for a more structured and supportive training environment, including the implementation of standardized assessments and improved mentorship programs. Addressing these issues is crucial for fostering a more balanced and effective neurosurgical training landscape in Germany. Further studies are needed to better understand and track the evolving dynamics of neurosurgical training and its impact on residents. Recommendations arising from our study are presented in Box 1 (**Supplement Content 3**).

#### Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Mazin Omer, Kathrin Machetanz, Anna C. Lawson McLean, Mamoun Ahmed, Mohamed Fadlalla, Jeyhun Farzullayev, Stefanie Maurer, Akram A. Alhamdan and Thuy Linh Nguyen. The first draft of the manuscript was written by Mazin Omer, revised by Jürgen Beck and Jussi P. Posti. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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#### CRediT authorship contribution statement

**Mamoun Ahmed:** Methodology, Data curation. **Mohamed Fadlalla:** Resources, Methodology, Data curation. **Jeyhun Farzullayev:** Methodology, Formal analysis, Data curation. **Stefanie Maurer:** Data curation, Conceptualization. **Akram A. Alhamdan:** Methodology, Data curation, Conceptualization. **Thuy Linh Nguyen:** Methodology, Data curation, Conceptualization. **Jürgen Beck:** Writing – review & editing, Supervision. **Jussi P. Posti:** Writing – review & editing, Supervision. **Mazin Omer:** Writing – original draft, Conceptualization. **Kathrin Machetanz:** Data curation. **Anna C. Lawson McLean:** Data curation, Conceptualization.

#### Conflict of Interest

The authors declare that they have no conflict of interest.

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.clineuro.2024.108477](https://doi.org/10.1016/j.clineuro.2024.108477).

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