






Brain Drain: A Cross-Sectional Study Evaluating Migration Intentions of Neurosurgery Trainees in Pakistan

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Abstract

Background Pakistan has a significant proportion of medical graduates who intend to leave the country for better opportunities abroad, leading to a brain drain. However, the push and pull factors within neurosurgery remain unexplored, emphasizing the need for evaluation to enact policy changes.

Materials and Methods We conducted a nationwide survey across 22 College of Physicians and Surgeons of Pakistan accredited neurosurgery training centers in all provinces of Pakistan. SPSS version 26 and STATA 15 were used for data analysis.

Results We collected responses from 120 neurosurgery trainees across Pakistan. Trainees were categorized into two groups: those intending to leave (64%) and those intending to stay (36%) in Pakistan. A significant association was observed between the availability of fellowship training in the residents' hospital and the decision to leave or remain in Pakistan ($p=0.034$). About 67.5% of our respondents did not have any publication, and among the intention to leave group, a greater percentage had academic involvement, when compared with the stay group. A significant association ($p=0.012$) was also observed between the decision to leave or remain in Pakistan and the number of publications in nonindexed journals.

Conclusion There remains a need for improvement in the standard of training provided by neurosurgery programs across the country. Our study found that disparities in research and academic exposure, as well as the lack of fellowship opportunities, may serve as stimuli for residents to leave Pakistan.

Keywords

- ▶ migration intention
- ▶ brain drain
- ▶ trainees
- ▶ fellowship
- ▶ neurosurgery

Introduction

Developing nations such as Pakistan are faced with a vast array of challenges including poverty, political crises, and economic instability. In the setting of these dilemmas, "Brain

drain," or the emigration of highly skilled workers from the country of origin, has been purported as an additional hindrance to economic development. No doubt, it can be stated that the attrition of competent workers deprives a nation of its most valuable asset—human capital.¹ In the

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context of healthcare, the loss of medical personnel is an extremely pertinent issue, considering that there are major disparities and shortages in the supply of healthcare workers, especially in low- and middle-income countries (LMICs).² Pakistan is uniquely affected in these regards, as it generates approximately 30,000 medical graduates per annum but suffers from the loss of doctors to developed nations such as the United Kingdom and the United States.³ In terms of attrition, an estimated six million highly skilled professionals including healthcare workers have left Pakistan for abroad between 1971 and 2022 and these numbers may continue to rise if policy changes are not enacted.⁴

Various “push and pull” factors are presented as an explanation for the exodus of doctors and medical graduates from their countries of origin. Among pull factors, predominant reasons can be divided into occupational and those related to livability. In general, higher income, technological advancement, and superior training opportunities are cited as major drivers of departure. Furthermore, improved quality of life and political stability are also perceived as reasons for the intention to pursue training abroad.⁵ With healthcare personnel, the literature indicates that among graduating medical students, Pakistan’s healthcare infrastructure is considered unsatisfactory for postgraduate training and students perceive the quality of postgraduate training as superior in high-income nations in the West and Middle East.⁶

In Pakistan, access to surgical care is significantly restricted not only because of deficiencies within the healthcare system itself but also due to a paucity of human resources. No doubt, it is quite possible that aspiring surgeons are opting to migrate as a result of previously described factors, contributing to the diminution of the surgical workforce.⁷

The situation is even more precarious in surgical subspecialties such as neurosurgery. Indeed, the number of patients presenting with a need for neurosurgical care greatly outweighs the availability of specialists as indicated by the large proportion of the population served by a single neurosurgeon.^{8,9} While Pakistan has nationally accredited postgraduate neurosurgery training programs, evidence from the literature indicates that there is a need for standardization across these programs to ensure high-quality training at par with international guidelines.^{8,10}

The number of graduating residents intending to leave Pakistan for further training remains undetermined. It is also essential to explore the factors contributing to these intentions among postgraduate trainees, especially in specialties such as neurosurgery which are already overwhelmingly undermanned. Through our study, we intend to survey postgraduate neurosurgery residents from different programs in Pakistan, to gauge the barriers that may contribute to the brain drain of potential neurosurgeons. Our findings can help identify potential gaps in training that can be targeted to help increase the retention of graduated trainees.

Methods

A cross-sectional survey was conducted among neurosurgery residents in Pakistan from April 2nd to April 20th, 2023.

This study received ethical approval from the Ethical Review Committee at Aga Khan University, Pakistan. Our study focused on neurosurgery trainees across all provinces of Pakistan as its target population.

Sample Size and Population

The sample size was calculated using OpenEpi.¹¹ There are an estimated 22 College of Physicians and Surgeons of Pakistan accredited neurosurgery training centers with 177 registered neurosurgery residents in training.¹⁰ Therefore, with a 95% confidence interval and 5% confidence limits, the maximum sample size required was 122 for neurosurgical trainees. Our study achieved a 98.36% response rate from our desired sample size.

Data Collection Tool

The questionnaire was prepared by a panel of experts from the department of neurosurgery as no validated survey existed for our targeted population. A review of the questionnaire by the panel ensured content validity. Reliability was evaluated through test–retest and Cronbach’s α . A pilot study involving 10 neurosurgery trainees was conducted for face validity and adjustments in response options were made for better clarity. The final comprehensive questionnaire encompassed participant demographics, training characteristics, academic opportunities, training satisfaction, and availability of fellowship training.

Sampling and Data Collection Strategy

This study utilized convenience and snowball sampling methods. The questionnaire was disseminated through an anonymous Google Form survey, accompanied by a consent form detailing the study’s objectives. Participant recruitment was facilitated through an ambassadorship program devised by the research team, which involved the recruitment of data collectors from across Pakistan. This program ensured an equitable distribution of data collectors across provinces. Various data collection strategies were implemented, including online dissemination through social media and in-person interactions. Emails were also dispatched to neurosurgery residency programs across the country, inviting them to partake in the study.

Statistical Analysis

IBM Statistical Package for Social Sciences (SPSS) version 26 and STATA 15 were used for statistical analyses. Descriptive statistics were used to report demographic characteristics. Normally distributed continuous data were presented as mean \pm standard deviation, while categorical data as counts and percentages (n ; %). Chi-squared tests were applied for unpaired categorical data comparisons, with statistical significance set at p -value less than 0.05. t -test was used when comparing mean ages among individuals intending to leave with those intending to stay.

Ethical Considerations

Participants were comprehensively briefed about the study’s objectives, procedures, and their rights, with a chance to seek

clarifications and receive the informed consent document. Participation was voluntary, granting participants the freedom to withdraw without consequences. For confidentiality, no participant names were collected, and identifying data was removed from survey responses. Data security was maintained through password encryption, with exclusive access limited to the principal investigator and co-investigators.

Results

We received responses from a total of 120 neurosurgery trainees across three provinces—Punjab (56.7%), Sindh (18.3%), Khyber Pakhtunkhwa (KPK) (19.2%), and the federal capital, Islamabad (ICT) (5.8%). Among our respondents, 70.8% were male, and 29.2% were female. Most trainees (81.7%) were affiliated with governmental institutions, while 18.3% were from private teaching centers. The mean age of respondents was 30.4 ± 4.1 . The trainees were divided into two groups: those intending to leave Pakistan for further training abroad and those planning to stay back. 64.1% of the trainees intended to migrate for further training. Refer to **Table 1** for detailed demographic characteristics of the respondents.

Among those intending to leave Pakistan, 55.8% earned between 50,000 and 100,000 Pakistani Rupee (PKR) compared with 44.2% intending to stay. The group intending to stay had a higher percentage earning between 100,000 and 150,000 PKR (48.8%) compared with the leaving group (40.3%). Monthly household income showed minimal variation between the two categories, except in the 100,000 to 150,000 PKR range, where a higher percentage of those intending to stay (48.8%) fell within this range compared with those aiming to leave Pakistan (37.7%). More details are described in **Table 1**.

Training program characteristics are summarized in **Fig. 1**. More trainees in the “intending to leave” group (88.3%) did not have cadaveric workshops in their institutes compared with the “intending to stay” group (81.4%). Cranial model-based simulation training was only available to 22.5% of the total respondents. A greater percentage of respondents intending to leave Pakistan (81.8%) did not have access to cranial model-based simulation training compared with the group intending to stay (69.8%). This difference was not significant, however. Across different teaching modalities, a significant difference was not observed between the two groups. Among those who intended to leave, 22.1% did not have morbidity and mortality meetings (MnMs) available as a teaching modality compared with 4.7% among those intending to remain in Pakistan ($p = 0.01$). Similarly, with regard to tumor board meetings (TBMs), 41.6% of trainees in the leaving group did not have TBMs, compared with 25.6% in the staying group.

When comparing trainees' research work, we found that only 32.5% had at least one publication and a statistically significant association ($p = 0.012$) was observed between the intention to leave or remain in Pakistan and the number of publications. Among trainees intending to leave, 46.8% had

5 to 10 nonindexed publications, compared with those intending to stay (27.9%). Additional details are provided in **Table 2**.

Among the trainees, 37.5% reported supervised hands-on experience involving 10 to 20 surgeries per month, while 45.8% had less exposure, performing procedures on fewer than 10 cases per month. Work hours were also compared across both categories. About 67.5% of trainees intending to leave reported working 50 to 100 hours per week. However, 24.7% were working between 100 and 150 hours. Among those intending to stay, 14.0% were working from 100 to 150 hours, and the majority 69.8% were working 50 to 100 hours per week. Surgical exposure and work hour information have been stated in **Supplementary Table S1**.

As seen in **Supplementary Table S2**, in the “intend to stay” group, 60.5% of trainees had access to fellowship training in their institute. However, this number dropped to 40.3% in the “intend to leave” category. Our analysis revealed a statistically significant association ($p = 0.034$) between the availability of fellowship training in the trainees' hospital and their decision to remain in Pakistan. A greater percentage (16.3%) of trainees in the “intend to stay” group did not wish to pursue further subspecialty training in contrast to those intending to leave Pakistan (2.6%). Moreover, regarding exposure to subspecialties, both groups majorly responded with no exposure or inadequate exposure and no significant difference was seen in the two groups.

When inquired about the preferred duration of general surgery training in the neurosurgery program, 36.4% of those intending to leave Pakistan agreed that 1 year was sufficient. In comparison, only 20.9% of those intending to remain stated the same. About 37.2% of the respondents intending to stay affirmed that general surgery is a necessary component of the training pathway, whereas a lesser percentage (16.9%) in the leaving group concurred.

Discussion

Our study assessed the driving forces behind neurosurgery residents' intentions to pursue post-residency fellowship training abroad. While training abroad does not necessarily imply that the individual will permanently emigrate, the literature indicates that this is the case for most physicians due to motivating factors such as a scarcity of job opportunities and increasing demand for doctors in host nations.^{12,13} Our study found differences in the responses of those intending on migrating from Pakistan and those staying especially in terms of research experience and choice of subspecialty to pursue a fellowship.

Postgraduate neurosurgery training is offered by both public and private institutions in Pakistan; however, our study observed that a greater percentage of respondents from the government sector intended to leave Pakistan for fellowship training in comparison to those who wished to remain. This may reflect discontent among trainees with the training set up in public institutions. Factors such as increased patient inflow resulting in higher working hours and

Table 1 Respondent demographics, year of training, monthly salary, and household income

Variable	Intention to leave, n (%)	Intention to stay, n (%)	Total	p-Value
Age (mean ± SD)	30.38 ± 3.95	30.53 ± 4.63	30.43 ± 4.19	0.461
Gender				
Female	22 (28.6)	13 (30.2)	35 (29.2)	0.848
Male	55 (71.4)	30 (69.8)	85 (70.8)	
Province of training				
Islamabad	4 (5.2)	3 (7.0)	7 (5.8)	0.117
KPK	13 (16.9)	10 (23.3)	23 (19.2)	
Punjab	41 (53.2)	27 (62.8)	68 (56.7)	
Sindh	19 (24.7)	3 (7.0)	22 (18.3)	
Sector of training				
Government	65 (84.4)	33 (76.7)	98 (81.7%)	0.298
Private	12 (15.6)	10 (23.3)	22 (18.3%)	
Year of training				
Fellow	2 (2.6)	0 (0.0)	2 (1.7)	0.223
Instructor	2 (2.6)	2 (4.7)	4 (3.3)	
Other	3 (3.9)	5 (11.6)	8 (6.7)	
PGY1	9 (11.7)	10 (23.3)	19 (15.8)	
PGY2	16 (20.8)	8 (18.6)	24 (20.0)	
PGY3	17 (22.1)	5 (11.6)	22 (18.3)	
PGY4	12 (15.6)	7 (16.3)	19 (15.8)	
PGY5	11 (14.3)	2 (4.7)	13 (10.8)	
PGY6	5 (6.5)	4 (9.3)	9 (7.5)	
Current monthly salary (PKR)				
100,000–150,000	31 (40.3)	21 (48.8)	52 (43.3)	0.486
150,000–200,000	2 (2.6)	1 (2.3)	3 (2.5)	
50,000–100,000	43 (55.8)	19 (44.2)	62 (51.7)	
<50,000	1 (1.3)	2 (4.7)	3 (2.5)	
Monthly household income (PKR)				
100,000–150,000	29 (37.7)	21 (48.8)	50 (41.7)	0.607
200,000–300,000	20 (26.0)	9 (20.9)	29 (24.2)	
300,000–400,000	12 (15.6)	4 (9.3)	16 (13.3)	
400,000–500,000	1 (1.3)	1 (2.3)	2 (1.7)	
<100,000	0 (0.0)	1 (2.3)	1 (0.8)	
>500,000	14 (18.2)	7 (16.3)	21 (17.5)	

Abbreviations: KPK, Khaybar Pakhtunkhwa; PGY, postgraduate year; PKR, Pakistani Rupee; SD, standard deviation.

inadequately funded services make healthcare delivery difficult for surgical trainees in government-funded centers.^{14,15} Trainees from the private sector comprised a lower percentage of the group opting to leave Pakistan when compared with those intending to remain. The possibility of increased resident satisfaction in private teaching hospitals cannot be excluded, since these setups are known to provide better working conditions and greater salaries when compared with their government counterparts.¹⁶ Access to simulation-based training and advanced modalities such as stereotactic surgery might be limited in public

institutions due to reduced government funding, an issue the private sector is not affected by. To date, there are no studies examining how variations in the quality of training across these two sectors may contribute to brain drain, justifying further exploration of this topic.

When we consider the push and pull factors associated with brain drain, finances are reported as a major contributor, especially among medical students. Interns immediately after graduation from medical school do not earn a significant amount, earning approximately USD250 per month.¹⁷ Moreover, among those who intended to leave Pakistan,

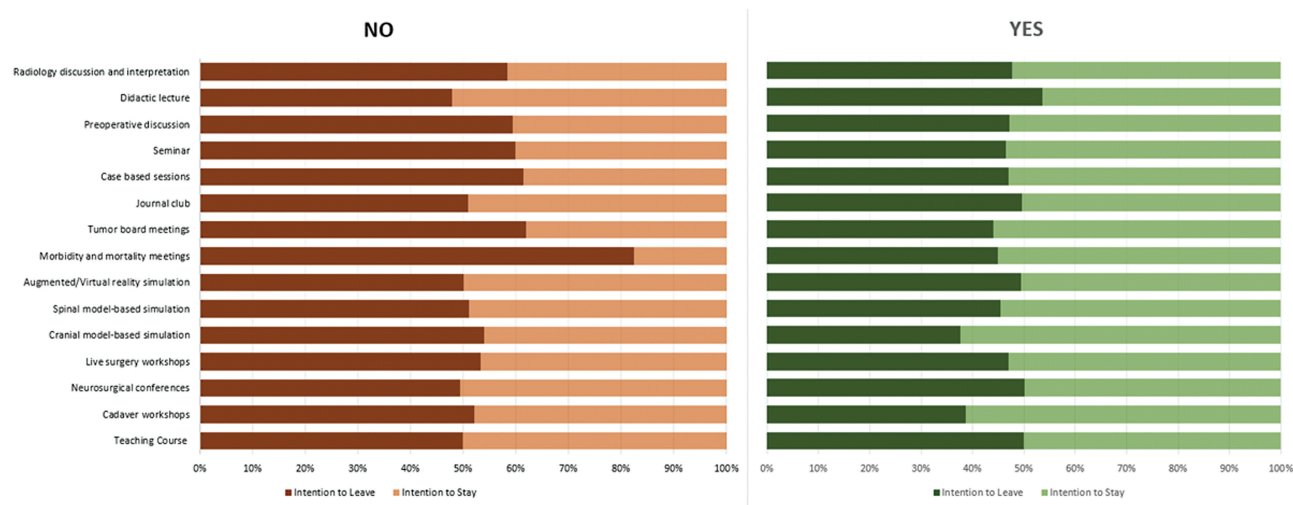


Fig. 1 Training program educational activities stratified by respondent's intention to migrate from Pakistan or stay.

Table 2 Respondent research experience based on number of publications and journal indexing

No of publications	PubMed indexed journal, n (%)	Non-PubMed indexed journal, n (%)	
<5	29 (9)	48 (40)	
5–10	9 (7.5)	6 (5)	
More than 10	1 (0.8)	1 (0.8)	
None	81 (67.5)	65 (54.2)	
	Intend to leave, n (%)	Intend to stay, n (%)	p-Value
<5	19 (24.7)	10 (23.3)	0.459
5–10	7 (9.1)	2 (4.7)	
More than 10	0 (0.0)	1 (2.3)	
None	51 (66.2)	30 (69.8)	
<5	36 (46.8)	12 (27.9)	0.025
5–10	1 (1.3)	5 (11.6)	
More than 10	1 (1.3)	0 (0.0)	
None	39 (50.6)	26 (60.5)	

most respondents were earning within the lower-tier salary options. These findings must be considered in the context of socioeconomic factors such as the ability to live comfortably, the number of earners, and the ability to afford the costs of moving abroad. In a country like Pakistan, where the cost of living is rising substantially due to inflation,¹⁸ low salaries can increase distress among physicians. Furthermore, financial compensation is especially important for physicians since training consumes both time and money. A perceived lack of financial compensation has been correlated with physician attrition in the past,¹⁹ and for trainees, this may result in an increased likelihood of emigrating to nations that offer better salaries.

In the United States, general surgery is covered in rotations during the first year (postgraduate year 1), whereas in certain Asian nations such as Indonesia and the Philippines, up to 2 years are reserved.²⁰ We evaluated whether our residents considered this training in Pakistan necessary as a

requisite for neurosurgery residency. One year of training was deemed sufficient by the majority of respondents, with a higher percentage of those intending to leave affirming this statement. Therefore, the long training period combined with extensive prerequisites could be a possible reason for the migration of neurosurgery residents.

The quality of training offered is dependent on a variety of factors including access to advanced learning modalities, for example, simulations, availability of mentorship, research, and hands-on surgical experience. Concerns regarding the quality of postgraduate training are often cited as a reason for undergraduate medical students to leave Pakistan.^{6,21} These concerns probably stem from a host of factors. While the national accrediting body, "The College of Physicians and Surgeons Pakistan" has defined a curriculum for postgraduate programs, there remains an absence of oversight regarding its uniform implementation across different institutions. There is also a lack of standardized competency-based evaluation, with

programs relying on the dated apprenticeship-based model.²² We evaluated the quality of training using three major components of the residency programs in our survey: activities to augment training, academic sessions, and research.

Traditional teaching methods were employed in a majority of institutes, but cadaveric workshops specifically were offered by very few programs. This issue has been identified in the past as well, with benchmarking studies emphasizing the absence of this essential learning modality.²³ Therefore, even now, steps need to be taken to include such modalities in the curriculum. Cadaveric specimens serve as an excellent substitute for the intraoperative environment because they allow the trainee to replicate the surgical technique including positioning, and experience the delicate feel of dissecting actual brain tissue.²⁴

Also rather concerning was the underutilization of simulation-based activities. Simulation-based training carries immense potential since a simulated environment allows trainees to practice procedures persistently and provides leeway to make errors and learn from them.²⁵ Even though simulation-based training can increase trainees' confidence and provide an immersive experience, it comes with a hefty cost²⁶ which institutions in low-income countries like Pakistan may not be able to afford. The use of augmented reality, spine-model, and cranial-model simulations was reported by only a minority of respondents and similar proportions were observed among trainees who intend to leave Pakistan and those who intend to stay. However, a slightly greater percentage without access to these modalities was present in the former group. While our study found no significant associations for these comparisons, the percentage differences are sufficient to warrant further exploration of these facets in larger cohorts, which may yield statistically meaningful results. Thereby it is important to consider the presence of technologically advanced modalities in programs abroad as an impetus to the exodus of residents from Pakistan.^{27,28}

The availability of different types of academic sessions was also explored in our study. Our results indicate that most trainees had access to different types of sessions including "morbidity and mortality" meetings (MnMs), TBMs, and journal clubs. However, among residents who wished to leave Pakistan, a significantly greater proportion did not have MnM conferences when compared with those who wanted to remain. The importance of MnMs in facilitating quality improvement and improving patient safety is well established. In any training program, exploration of patient mortality can serve as a learning experience for physicians, preventing errors that could potentially cause harm.²⁹

The neurosurgery research landscape in Pakistan is still nascent, with recent literature indicating modest increments in the quality and number of publications across the country, albeit from a few high-output centers.³⁰ Involvement in research-related activities such as international conferences is still minimal among trainees, however.³¹ When the proportions of journal publications were compared between the "leave" and "remain" groups, we found a similar distribution for research publications in PubMed-indexed journals. However, for un-indexed journals, we observed that those

intending to leave had a greater number of publications overall compared with those who did not want to leave. LMICs like Pakistan have limited research capacity due to inadequate funding and a lack of prioritization.³² The scarcity of resources required to partake in clinical or translational research in Pakistan can drive potential academics away from the country in search of opportunities abroad.

No doubt, for any training program, hands-on surgical experience is essential in augmenting the proficiency of trainees. Adequate exposure is necessary for trainees to acquire competency in performing different procedures. More importantly, adequate exposure to a diverse variety of cases and hands-on experience is associated with greater satisfaction.³³ Our study indicates that both trainees intending to leave and remain had similar exposures. The percentage of unsupervised hands-on experience was much lower in both groups, that is, most trainees operated on less than 10 cases. These findings support previous surveys evaluating neurosurgery training, which indicate that trainees find clinical training to be insufficient.¹⁰

Literature indicates that excessive working hours and an increased workload are associated with burnout and productivity loss among neurosurgeons.³⁴ Prolonged working hours have also been identified as a source of concern among medical graduates and potentially a push factor driving brain drain.²¹ Increased working hours and low salaries have a synergistic effect, as both are often cited as reasons by physicians considering emigration to a new country.³⁵ Increased working hours can contribute to stress, and negatively impact the quality of care. Our findings indicate that residents who had greater than 150 working hours preferred leaving the country for fellowship training. A significant association ($p = 0.012$) was observed between working hours and the intention to leave or remain. The tendency to burnout was evaluated separately in our study and had similar results across both groups. The majority tended to agree that the workload associated with training contributed to burnout (–Fig. 2).

Fellowship training was available at the parent institution of 47.5% of respondents. However, we did not inquire regarding the type of fellowship provided. Interestingly, among respondents who wished to pursue training abroad, the majority reported their hospital did not provide fellowship training. The opposite was observed in those who wished to remain in Pakistan. Most respondents from our sample intended to specialize further, and without avenues to access subspecialty training through fellowships within Pakistan, moving abroad is the only option. Inadequacy of exposure to various subspecialties during the course of training was also identified. This deficit in opportunities for subspecialty training exists in most LMICs since training requires access to specialized equipment and a workforce with the necessary proficiencies.³²

Limitations

Our study was limited due to its cross-sectional design. We only included doctors enrolled in training during the study period; hence, our sample size was small that may explain

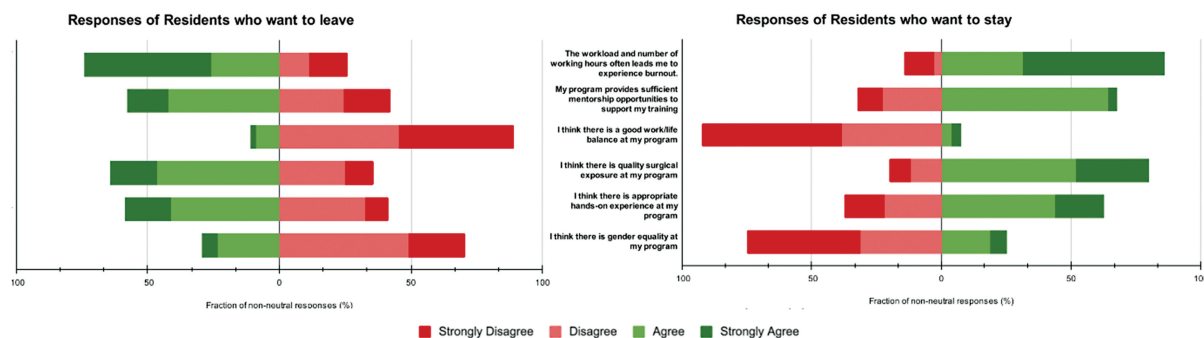


Fig. 2 Percentage of responses regarding training experience and work–life balance stratified by intention to migrate from Pakistan or remain.

the absence of significant associations across different characteristics. Second, trainees' decisions may evolve during their training due to various factors; our design could not account for these changes. It is imperative to delve deeper into how viewpoints on leaving Pakistan transform over time. While our study identifies certain factors tied to trainees' decisions to leave, we did not directly inquire about this aspect. Consequently, the impact of individual factors on decision-making remains elusive. Furthermore, it is possible that factors external to training such as the presence of family members abroad, family dynamics, professional connections, and concerns regarding the sociopolitical climate may have affected the residents' decision to leave or remain. These factors were not accounted for in our study as it only intended to look at program-related characteristics; nevertheless, they are important confounders that should be explored in subsequent studies.

Conclusion

Our findings suggest that a majority of the respondents wished to pursue further subspecialty based fellowship training but did not have access to local training programs. As neurosurgery practice becomes ever more specialized, it is imperative that programs develop subspecialty infrastructure so that trainees are less likely to pursue training abroad. More importantly, brain drain is a multidimensional issue that necessitates changes in policy including the restructuring of training programs so that they are more focused, and standardization of curricula across the country. Our research also opens avenues for the exploration of how overarching influences beyond the training program, like political landscape, economic stability, and future job prospects contribute to the loss of postgraduate trainees from Pakistan.

Ethics Approval and Consent to Participate

Our study was approved by Aga Khan University Ethical Review Committee.

Consent for Publication

All authors have approved the results, reviewed the manuscript, and consented for publication.

Availability of Data and Materials

Datasets are available from the corresponding author upon reasonable request.

Note

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

Authors' Contributions

M.S. and A.A. conceptualized the study and designed the methodology for the study. H.A.I., and M.A.A.K. contributed significantly to the analysis and interpretation of the data. H.A.I. contributed significantly to data collection and data acquisition. M.A.A.K. wrote the initial manuscript and H.A.I., A.A., and A.E. made final edits to the manuscript. All authors reviewed the final manuscript and approved its submission for publication.

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Conflict of Interest

None.

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