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Knowledge, Attitudes, and Referral Practices Regarding Epilepsy Surgery Among Neurologists and Neurosurgeons in Türkiye: A Cross-sectional Survey

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Abstract

Objective: For patients with drug-resistant epilepsy, surgery can be life-changing. Yet referrals often come too late. This study aimed to assess the knowledge, attitudes, and referral practices of neurologists and neurosurgeons in Türkiye regarding epilepsy surgery in routine clinical care.

Methods: We ran a cross-sectional survey from June 1 to August 1, 2022. The questionnaire included a nine-item factual test drawn from publicly available board exam sources and six Likert-scale questions capturing attitudes. We also asked about referral volume, institutional setting, training background, and any previous collaboration with dedicated epilepsy centers. A total of 154 clinicians volunteered and were sent the survey link, of whom 116 responded. After discarding eight incomplete forms, we analyzed data from 108 specialists-72 neurologists and 36 neurosurgeons.

Results: The mean knowledge score was 6.31±1.34 out of 9. Neurologists came out ahead of neurosurgeons (6.49±1.35 vs. 5.94±1.26; p=0.044). Scores varied significantly by type of institution, with academic centers and training and research hospitals scoring the highest (p=0.003). We observed the largest knowledge gaps regarding the risk of serious complications (35.2% answered correctly), surgical candidacy when an magnetic resonance imaging is negative (37.0% answered correctly), and age-related eligibility rules (47.2% answered correctly). Having worked with an epilepsy center before was linked to a meaningfully better score (6.78±1.24 vs. 6.07±1.34; p=0.008). Of concern, about one in three respondents had not referred a single patient for surgery in the previous year, and only 12.0% had referred anyone within one year of the appearance of the indication. Knowledge score was not significantly associated with annual referral volume (Spearman ρ=0.14; p=0.151) or usual referral delay (ρ=-0.10; p=0.280).

Conclusion: The findings point to clear knowledge gaps and a pattern of delayed referral. Targeted education regarding qualification criteria for surgery, realistic complication risks, and the ideal timing of referral—alongside closer, sustained ties with specialized epilepsy centers—could facilitate earlier evaluation of patients.

Keywords: Drug-resistant epilepsy, epilepsy surgery, knowledge, neurologists, neurosurgeons, referral

INTRODUCTION

Drug-resistant epilepsy (DRE) affects about one out of every three people diagnosed with epilepsy. It brings with it not just continuing seizures but also physical injuries, a lower quality of life, cognitive and psychosocial decline, higher death rates, and significantly increased healthcare costs.[1,2] For patients who go through a proper surgical evaluation, the procedure can stop seizures completely and bring functional gains that are rarely, if ever, achieved by simply adjusting medication.[3-6] Yet despite strong evidence supporting surgery, referral for evaluation remains strikingly low, and when it does happen, it's often far too late.[4,7]

The timeliness of referral largely depends on the treating physician's ability to recognize medication failure and to initiate the next step. Guidelines from the International League Against Epilepsy recommend that patients should be sent for surgical evaluation as soon as drug resistance is established regardless of age, seizure type, brain imaging findings, or other medical conditions.[3] Even so, surveys of clinicians in countries like Canada, Italy, and the United States keep turning up the same problems: confusion about what "two drugs failed" really means, exaggerated fears of surgical risk, overly narrow ideas about who is a good candidate, and various bottlenecks in the referral system.[8-13]

Information from Türkiye has been limited, particularly regarding studies that include adult neurology and neurosurgery specialists. One recent study with pediatricians and pediatric residents found considerable uncertainty about when and where to refer, as well as ongoing safety worries.[14] Neurologists and neurosurgeons work closely together along the epilepsy care pathway, but very few studies have examined their knowledge and how they coordinate referrals.

With this in mind, we set out to map knowledge, attitudes, and referral practices regarding epilepsy surgery among neurologists and neurosurgeons working in Türkiye. We also explored how these measures varied by subspecialty, institution type, and prior involvement in dedicated epilepsy surgery programs.

METHODS

Study Design and Participant Selection

Data for this cross-sectional survey were collected between June 1 and August 1, 2022, via national WhatsApp groups connecting neurologists and neurosurgeons in Türkiye. Specifically, we circulated the study invitation within two professional WhatsApp groups created for the 2020 national congresses: one for neurologists attending the Turkish Neurological Society congress and one for neurosurgeons attending the Turkish Neurosurgical Society congress. Overall, 154 specialists agreed to participate and received the link to the online survey.

To check for duplicate submissions, the survey requested each physician's full name and official registration number. A review of these entry pairs revealed no overlap, and all identifying information was subsequently removed before creating the final analytical dataset. Out of the 154 invited physicians, 116 submitted their responses. Excluding eight incomplete questionnaires, 108 fully answered forms remained, yielding a 70.1% effective completion rate (Figure 1).

To be eligible, respondents had to be board-certified -neurologists or neurosurgeons actively practicing in Türkiye. We grouped their workplaces into four categories: university medical centers, training and research hospitals, public state clinics, and private medical facilities. All fully completed questionnaires received within the data collection -period were included in the analysis; no formal power calculation was performed a priori to determine a target sample size.

MAIN POINTS

- This study identified moderate knowledge of epilepsy surgery among neurologists and neurosurgeons in Türkiye, with the greatest gaps involving serious complication risk, magnetic resonance imaging-negative candidacy, and age eligibility.
- Knowledge scores were higher among physicians working in academic institutions and among those who had previously collaborated with an epilepsy surgery center.
- Nearly one-third of participants had made no surgical referral in the previous year, and only 12.0% reported referral within one year.
- Targeted education and stronger referral networks may help reduce delays in surgical evaluation.

Survey Instrumentation and Endpoint Metrics

The questionnaire was put together by a panel of three neurologists and split into five thematic blocks:

1. Practitioner background and clinical profile.

2. A set of nine factual questions that tested core knowledge.

3. Six items meant to explore personal attitudes and clinical impressions.

4. Direct questions about current referral behavior.

5. Previous contact with epilepsy surgery educational content and care pathways.

The knowledge questions were adapted from publicly available board-certification prep materials. They covered key points: -the formal definition of DRE; the efficacy of surgery; the candidacy of patients with a normal magnetic resonance imaging (MRI); the diagnostic role of video-electroencephalography (EEG) monitoring; optimal timing for surgery; complication rates; the relevance of generalized epilepsy; cognitive changes after surgery; and age-based candidacy rules-.

For each knowledge item, respondents could pick "true," "false," or "unsure." Correct answers scored one point; wrong answers and "unsure" responses received zero points. That gave each person a total knowledge score ranging from 0 and 9. The full questionnaire and the scoring guide are provided in Supplementary Material 1. The original primary knowledge scoring rule was retained.

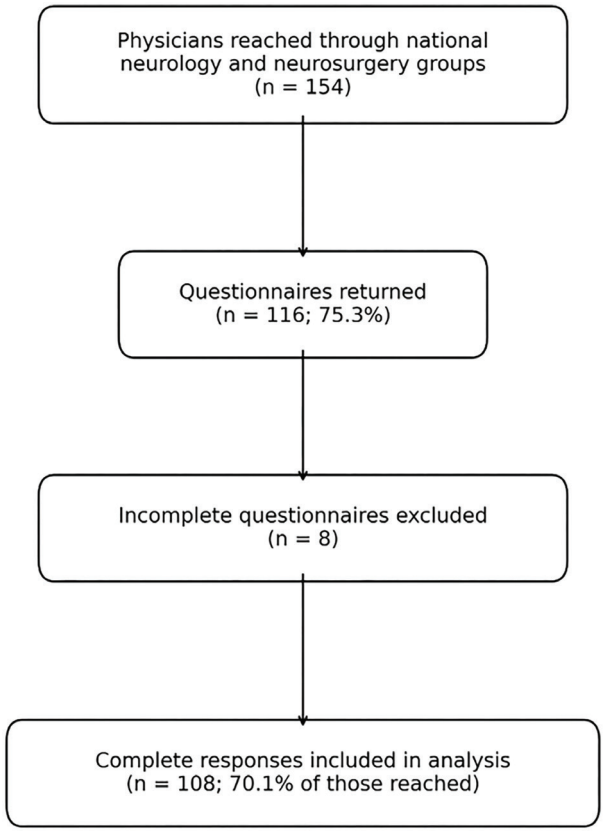


Figure 1. Participant flow through recruitment and analysis

To distinguish incorrect beliefs from acknowledged uncertainty, incorrect and "unsure" responses were summarized separately for each item (Supplementary Table 1).

The six attitude items were answered on a five-point Likert scale. Because these prompts addressed separate but related ideas—support for early referral, perceived bottlenecks, danger estimates, how participants rated their own knowledge, expected quality-of-life improvements, and geographic access to specialized care—we treated the overall sum (ranging from 6 to 30) as an exploratory composite endorsement index, rather than a formally validated psychometric instrument. Higher totals indicated stronger overall agreement with the combined statements. Because the items were not designed as a single favorable-versus-unfavorable attitude scale, no reverse-scoring was applied; the sum was interpreted only as an exploratory index of overall statement endorsement.

We also recorded several practice-related measures: the number of surgical referrals made during the previous year; the typical delay before a referral was initiated; weekly epilepsy patient volume; perceived geographic accessibility of specialized surgical centers; any formal training in epilepsy management; and prior collaboration with a dedicated surgical program.

Statistical Analysis

We summarized categorical variables using frequencies and percentages, while continuous measures were reported as means with standard deviations (± SD). We used Welch's independent-samples t-tests to compare knowledge scores between neurologists and neurosurgeons and between those with and without prior collaboration with an epilepsy surgery center. Differences across the four institutional categories were assessed with a one-way analysis of variance (ANOVA). Descriptive statistics captured item-level accuracy and referral patterns. All tests were two-tailed, and we considered p-values below 0.05 statistically significant. Analyses were performed with IBM SPSS Statistics (IBM Corp., Armonk, NY, USA). A post-hoc sensitivity analysis showed that, with our final specialty breakdown (72 vs. 36), the study had 80% power to detect a standardized mean difference of about 0.58 at a two-tailed alpha of 0.05. Institutional variance homogeneity was verified using Levene's test prior to running the primary ANOVA, after which post-hoc pairwise group differences were evaluated through Tukey's honestly significant difference (HSD). To measure the magnitude of the specialty-based effect, we derived Cohen's d.

Table 1. Participant characteristics and clinical exposure

Variable	Category	n	%
Specialty	Neurology	72	66.7
	Neurosurgery	36	33.3
Institution	University hospital	33	30.6
	Training and research hospital	33	30.6
	State hospital	23	21.3
	Private hospital	19	17.6
Prior collaboration with an epilepsy surgery center	Yes	36	33.3
	No	72	66.7
Formal epilepsy surgery education	Yes	42	38.9
	No	66	61.1

Non-parametric Spearman's rank correlations were used to assess how knowledge scores and the exploratory endorsement index correlated with ordinal referral volume and timing. Response options (correct, incorrect, unsure) were cross-tabulated for each knowledge item, and an exploratory chi-square analysis tested potential links between reported access barriers and clinicians' referral volume or latency.

Ethical Approval

The study protocol was approved by the Adıyaman University Non-Interventional Clinical Research Ethics Committee on March 15, 2022 (approval no: 2022/3-14). The work was conducted in accordance with the Declaration of Helsinki. Voluntary participation was emphasized throughout, with survey completion implying informed consent. Participant names and medical license numbers were collected solely for de-duplication and subsequently removed from the file prior to statistical analysis.

RESULTS

Participant Demographics and Backgrounds

The final sample included 108 physicians: 72 neurologists (66.7%) and 36 neurosurgeons (33.3%). University medical centers and training/research hospitals each contributed 30.6% of the cohort. Thirty-six participants (33.3%) reported a history of collaborative work with an epilepsy surgery center, and 42 (38.9%) reported receiving dedicated training in epilepsy surgery (Table 1).

Evaluated Knowledge and Clinical Perspectives

Across the whole group, the average knowledge score was 6.31±1.34 out of a possible 9, with a median of 6.5. The composite endorsement index on the six Likert-scale items came to 21.36±2.61 out of 30, though we emphasize that this aggregate was used only for description—it is not a validated, one-dimensional scale.

The areas where understanding was strongest included post-surgical cognitive changes (91.7% correct), the role of generalized epilepsy in candidacy (88.0%), the diagnostic value of video-EEG (88.0%), and the definition of DRE (86.1%). In contrast, the most striking knowledge gaps comprised three misconceptions: that serious complication rates typically exceed 10% (35.2% correct), that patients with normal MRI scans are not surgical candidates (37.0% correct), and that epilepsy surgery is restricted to children (47.2% correct) (Table 2 and Figure 2). When non-correct responses were analyzed separately, the MRI-negative surgical candidacy item had 38 incorrect responses (35.2%) and 30 unsure responses (27.8%), while the serious-complication item had 41 incorrect responses (38.0%) and 29 unsure responses (26.9%). Full item-level distributions are shown in Supplementary Table 1.

Neurologists scored significantly higher than neurosurgeons (6.49±1.35 vs. 5.94±1.26; p=0.044). Knowledge also differed markedly by institutional setting (p=0.003). The highest scores came from university hospitals (6.70±1.21) and training/research hospitals (6.67±1.43), followed by state hospitals (5.83±1.19) and private clinics (5.58±1.17) (Table 3 and Figure 3). The specialty difference was modest in magnitude (Cohen's d=0.41). Levene's test did not indicate unequal variances across institution groups

(p=0.375). Tukey HSD showed that knowledge scores were higher in university hospitals than in private hospitals (mean difference =1.12; p=0.015) and in training/research hospitals than in private hospitals (mean difference =1.09; p=0.019); the remaining pairwise comparisons were not significant.

Finally, physicians who had worked together with an epilepsy surgery center achieved notably higher knowledge scores than those without such experience (6.78±1.24 vs. 6.07±1.34; p=0.008) (Table 3 and Figure 4).

Referral Practices and Care Accessibility

An analysis of actual referral activity over the preceding year showed that 32 physicians (29.6%) did not send a single patient for surgical evaluation. A larger group of 42 clinicians (38.9%) referred one to two patients, while 27 (25.0%) referred three to five patients. Only 7 respondents (6.5%) facilitated more than five referrals.

Timing also varied widely. Only 13 participants (12.0%) reported to us that they usually make a referral within the first year after identifying drug resistance. The majority waited longer: 42 (38.9%) were referred after one to three years, 39 (36.1%) after three to five years, and 14 (13.0%) after more than five years. Moreover, a substantial proportion of the sample, 45 respondents (41.7%), reported difficulty accessing specialized epilepsy surgery centers (Table 4). Knowledge score was not significantly associated with annual referral volume (Spearman ρ=0.139; p=0.151) or with usual referral timing (ρ=-0.105; p=0.280). The exploratory endorsement index was not associated with the knowledge score (ρ=-0.057; p=0.557) or with referral timing (ρ=-0.069; p=0.480), but showed a weak positive association with annual referral volume (ρ=0.233; p=0.015). Perceived difficulty of access was not significantly associated with referral volume (χ^2=2.20; p=0.531) or with referral timing (χ^2=5.25; p=0.154).

Table 2. Correct-response rates for knowledge items

Item	Knowledge domain	Correct, n (%)
Q4	Definition of drug-resistant epilepsy	93 (86.1)
Q5	Expected seizure-free rate	80 (74.1)
Q6	MRI-negative surgical candidacy	40 (37.0)
Q7	Role of video-electroencephalography	95 (88.0)
Q8	Timing of surgical evaluation	90 (83.3)
Q9	Serious complication risk	38 (35.2)
Q10	Generalized epilepsy candidacy	95 (88.0)
Q11	Postoperative cognitive change	99 (91.7)
Q12	Age eligibility	51 (47.2)

Percentages are based on 108 complete responses. Item labels summarize the tested domain and do not reproduce the questionnaire wording verbatim

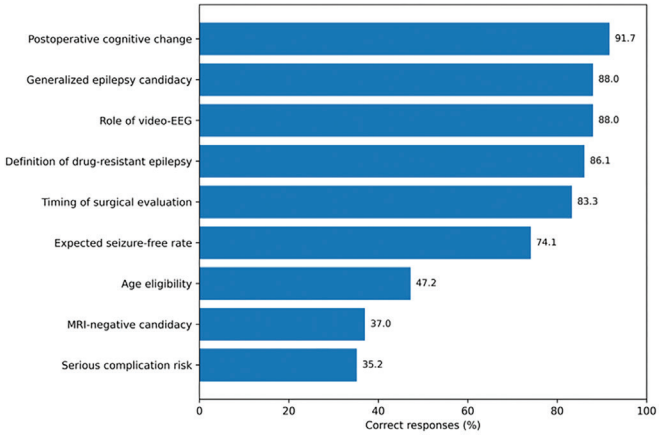


Figure 2. Correct-response rates for the nine epilepsy surgery knowledge items
EEG: Electroencephalography

DISCUSSION

This cross-sectional study demonstrates modest factual knowledge alongside consistently delayed and often very limited referral practices among neurologists and neurosurgeons across Türkiye. The most significant knowledge gaps centered on inflated fears about surgical complications, poor recognition that patients with a normal MRI can still be surgical candidates, and confusion about age boundaries for eligibility. Nevertheless, knowledge scores failed to correlate significantly with either the frequency or delay

Table 3. Subgroup comparisons of knowledge score

Comparison	Group	n	Mean ± SD	p-value
Specialty	Neurology	72	6.49±1.35	0.044
	Neurosurgery	36	5.94±1.26	
Institution	University hospital	33	6.70±1.21	0.003
	Training and research hospital	33	6.67±1.43	
	State hospital	23	5.83±1.19	
	Private hospital	19	5.58±1.17	
Prior collaboration	Yes	36	6.78±1.24	0.008
	No	72	6.07±1.34	

Welch independent-samples t-tests were used for two-group comparisons; one-way analysis of variance was used for institution categories. Post-hoc Tukey HSD: university vs. private, p=0.015; training/research vs. private, p=0.019; all other institution pairwise comparisons, p>0.05
SD: Standard deviation, HSD: Honestly significant difference

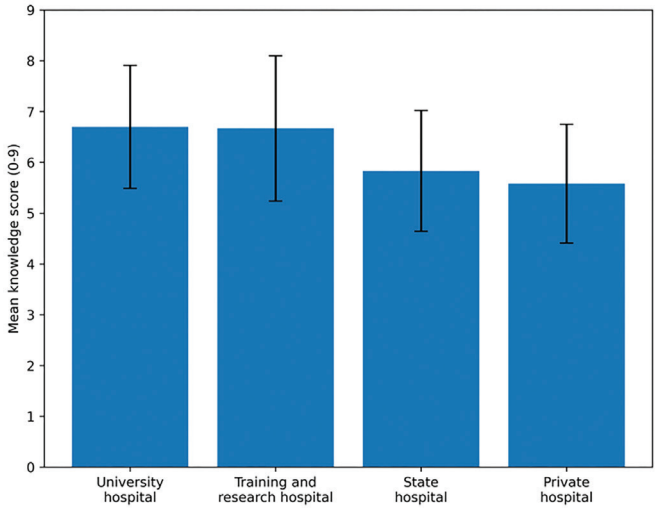


Figure 3. Mean knowledge scores by institutional setting. Error bars indicate standard deviations

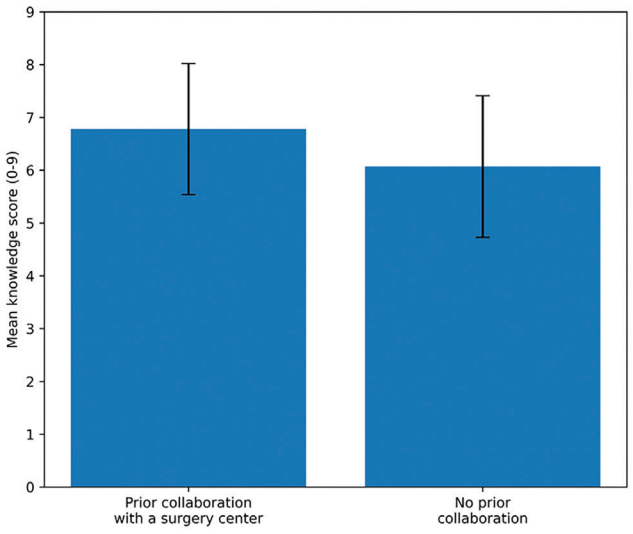


Figure 4. Mean knowledge scores according to prior collaboration with an epilepsy surgery center. Error bars indicate standard deviations

Table 4. Referral practices and perceived access

Variable	Category	n	%
Referrals in the previous year	None	32	29.6
	1-2 patients	42	38.9
	3-5 patients	27	25.0
	>5 patients	7	6.5
Usual time before referral	<1 year	13	12.0
	1-3 years	42	38.9
	3-5 years	39	36.1
	>5 years	14	13.0
Perceived access to surgery centers	Difficult	45	41.7
	Not difficult/other	63	58.3

of referrals. Thus, while knowledge gaps and delayed transfers co-occur, treating this overlap as proof that limited knowledge directly drives referral patterns would be unwarranted. The Likert-scale items we included provide context regarding institutional barriers and personal attitudes, but they do not constitute a validated psychometric instrument; therefore, that portion of the data should be regarded as exploratory.

The difference in knowledge scores between neurologists and neurosurgeons, although statistically significant, was modest (Cohen's d=0.41). That's not particularly surprising. Neurologists manage multiple drug trials sequentially, so they observe the transition to DRE unfolding in real time. Neurosurgeons, by contrast, often become involved later, after medical options have been exhausted. This gap should not considered a shortcoming specific to a single specialty. Both groups are central to patient selection, pre-surgical counseling, and the initial referral step, and the overall numbers suggest that there is considerable scope for educational improvement for both groups.

Much more striking was the divide associated with the institutional setting. Physicians working in university hospitals and tertiary training/research centers consistently outperformed colleagues based in public state hospitals or private clinics. This institutional disparity may reflect tertiary and academic settings offering routine exposure to video-EEG monitoring, presurgical terminology, and multidisciplinary case rounds, as well as access to dedicated epilepsy surgery units. Unmeasured in the present study, these operational variables should be regarded as plausible hypotheses that require future evaluation rather than as confirmed mechanisms.

These item-by-item results track closely with what has been reported internationally. A nationwide Canadian study found that many neurologists were still applying arbitrary seizure-frequency thresholds or had trouble accurately identifying the two-drug criterion for DRE.[8] An Italian survey similarly showed widespread misunderstandings and a tendency to overestimate surgical risks.[11] In work focusing on the New York metropolitan area, almost all neurologists viewed surgery as safe, yet only 56.9% actually followed guidelines by referring after two failed medication trials.[12] A national survey from Pakistan documented even sharper under-referral and a general hesitation to bring up surgical options with patients.[13] Closer to home, a recent Turkish pediatric survey echoed these messages, pointing to broad uncertainty around safety and timing.[14] Taken together, the literature indicates a consistent finding: endorsement of surgery in principle rarely translates into timely clinical action. Recent work reinforces the multifactorial nature of referral barriers. Hill et al.[15] identified knowledge, self-efficacy, practice environment, and coordination with epilepsy centers as relevant factors in neurologists' referral decisions. A systematic review similarly found recurring barriers involving knowledge, attitudes, communication, and referral coordination.[16] A nationwide Mexican survey reported gaps in DRE criteria and awareness of referral centers,[17] while Tokumoto et al.[18] demonstrated substantial facility-level differences in epilepsy care and referral in Japan.

The behavioral data from our study only reinforce this persistent implementation gap. Roughly a third of respondents had not referred a single patient in the previous year; only 12.0% managed a referral within a 12-month window; two-thirds had never worked directly with an epilepsy surgery facility. Past collaboration with a specialized epilepsy unit was associated with higher knowledge performance; however, determining whether collaboration drives knowledge or whether highly knowledgeable clinicians actively seek such partnerships remains beyond the scope of a cross-sectional study.

Structural accessibility warrants separate scrutiny, given that 41.7% of respondents identified difficulties accessing dedicated surgical facilities. While exploratory chi-square analyses showed no significant association between access hurdles and referral volume or timing, this high prevalence indicates that structural barriers to access should be considered alongside knowledge gaps. Consequently, overcoming these barriers requires pairing professional education with structural enhancements such as regional care pathways, telehealth options, and standardized inter-center communication channels.

For these reasons, future educational efforts need to focus on concrete decision-making thresholds rather than solely on broad awareness. The failure of two properly chosen and tolerated antiseizure medications should trigger an immediate referral for

a full surgical evaluation no delays.[2,3] Curricula should explicitly demystify non-lesional MRI-negative epilepsy, provide realistic complication rates, clarify that adult and older candidates can be suitable, and stress that a referral for an assessment is not the same thing as a final commitment to operate. Structured clinical pathways, teleconsultation, and regular joint case conferences would substantially benefit state and private hospitals that currently lack routine contact with specialized surgical centers.

Study Limitations

When interpreting the outcomes of this research, several limitations must be acknowledged. First, because the survey relied on voluntary enrollment and was disseminated via professional WhatsApp networks, selection bias is plausible, meaning that the study cohort may not perfectly mirror the entire population of neurosurgeons and neurologists operating across Türkiye. Second, geographic data were not collected, which precludes a definitive assessment of regional representation. Additionally, the aggregate sample size was relatively small for detailed subgroup analyses. Furthermore, the objective knowledge questionnaire was compiled and adapted from open-source board-certification study materials rather than an established psychometric tool; consequently, formal evaluations of test reliability and item discrimination indices were omitted. Similarly, the six Likert-scale statements were intended for exploratory analysis, addressed several distinct themes, and were not formally validated as an attitude scale. Additionally, data concerning patient referral behaviors depended entirely on self-reports rather than on verification through official clinical databases or hospital registries. Finally, the cross-sectional design precludes causal inference; clinicians with greater knowledge may simply be more proactive in seeking collaborative links with epilepsy surgical facilities. A notable constraint is that reliable census data covering active national specialists are missing; consequently, determining what percentage of the broader pool of neurologists and neurosurgeons our sample constitutes is not feasible.

Conversely, this study features notable methodological advantages. It successfully captured and combined the distinct professional viewpoints of both neurosurgeons and neurologists, measured clinical comprehension at the individual-question level, evaluated the role of institutional settings and care delivery environments, and obtained complete, usable data from 108 practitioners. The strong internal coherence of these observations, paired with their close parallels to findings from diverse international medical frameworks, underscores their utility for shaping future educational programs and structural system improvements.

CONCLUSION

Medical specialists in neurology and neurosurgery throughout Türkiye demonstrate a moderate grasp of factual data regarding epilepsy surgery, yet actual patient referrals continue to be subject to extensive delays. The primary knowledge gaps involve overestimating the risk of complications, failing to recognize the eligibility of individuals with normal MRI scans, and misunderstanding age boundaries. Affiliation with university or tertiary teaching hospitals, alongside a history of working in tandem with specialized epilepsy surgery centers, is closely linked to higher knowledge performance. Because knowledge score itself was not significantly associated with referral volume or timing, future efforts should address both educational gaps and structural barriers to access rather than assuming a single mechanism for delayed referral.

Ethics

Ethics Committee Approval: The study protocol was approved by the Adıyaman University Non-Interventional Clinical Research Ethics Committee on March 15, 2022 (approval no: 2022/3-14).

Informed Consent: Voluntary participation was emphasized throughout, with survey completion implying informed consent.

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Generative artificial intelligence tools were used for language editing, assistance with statistical analysis, manuscript formatting, preparation of tables, and creation of data visualizations and figures based on the study results. Artificial intelligence was not used to generate, modify, or fabricate study data.

Footnotes

Authorship Contributions

Concept: A.B.E., A.Z.A.T., Design: A.B.E., A.Z.A.T., Data Collection or Processing: A.B.E., Analysis or Interpretation: A.B.E., A.Z.A.T., Literature Search: A.B.E., A.Z.A.T., Writing: A.B.E., A.Z.A.T.

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Supplementary Material 1 Link: https://d2v96fxpocvxx.cloudfront.net/688d2d00-d207-464d-89b6-73f393f4f50c/content-images/a8af6765-17d4-4efc-91b3-056db748e295.pdf

Supplementary Table 1 Link: https://d2v96fxpocvxx.cloudfront.net/688d2d00-d207-464d-89b6-73f393f4f50c/content-images/546b31a9-4b5d-460a-ab31-6ec735d07fdd.pdf

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