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ORIGINAL ARTICLE

Subspecialty training in clinical neurophysiology in Türkiye: A national survey on the educational process, challenges, and proposed solutions

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ABSTRACT

Objectives: This study aimed to evaluate the current status, encountered issues, and potential solutions regarding clinical neurophysiology (CNP) subspecialty training in Türkiye, based on the experiences of fellows and specialists.

Materials and methods: An online questionnaire was administered to 37 physicians who had completed or were enrolled in CNP subspecialty training in April 2025. The survey addressed topics including the training process, curriculum, theoretical and practical adequacy, technical infrastructure, availability of rotations, and employee rights. The data were analyzed using descriptive statistics.

Results: Most participants reported issues such as lack of standardization, insufficient technical infrastructure, short training duration, and significant variation in educational content between centers. Limited rotation opportunities and inadequate exposure to procedures such as ultrasonography, transcranial magnetic stimulation, and intraoperative neuromonitoring were also highlighted. Additionally, uncertainty regarding employment rights was identified as a factor negatively impacting the training process.

Conclusion: Subspecialty training in CNP in Türkiye needs to be strengthened in terms of content, implementation, and employment-related conditions. Updating the national curriculum with achievable goals, improving technical resources, and addressing uncertainties in post-training employment planning are essential for a sustainable and high-quality training model.

Keywords: Clinical neurophysiology, medical education, subspecialty training, survey study.

Subspecialty training in medicine is a structured process that aims to provide in-depth knowledge and skills in specific fields beyond general specialty training. In Türkiye, subspecialty training is conducted within the framework of the "Regulation on the Entrance Examination for Subspecialty Training," published in the Official Gazette on April 28, 2007 (No. 26506).[1] Admission to this process requires physicians to have completed their specialty training and to meet the necessary criteria, followed by placement through the Subspecialty Entrance Examination (YDUS) administered by the Measuring, Selection, and Placement Center (ÖSYM).[1] The exam for neurology is held once a year. Training is provided in university hospitals and training and research hospitals.[1]

Over time, amendments to the regulation have altered the eligibility criteria. While, initially, it was sufficient to have completed specialty training,[1,2] in 2018, completion of compulsory service after specialization was made a prerequisite. In 2023, this requirement was eased, allowing physicians who had completed at least half of their compulsory service to apply.[3]

As of 2024, there are 2,542 neurology specialists, 107 clinical neurophysiology (CNP) specialists, and 21 CNP fellows actively working in Türkiye.[4]

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These numbers indicate that CNP constitutes a subspecialty with a smaller physician population compared to general neurology, which underscores the importance of evaluating the structural characteristics of its training process.

Clinical neurophysiology is a discipline with both strong neurological and technical components, requiring a balanced acquisition of theoretical knowledge and practical skills. Therefore, maintaining educational quality and training competent specialists in the field is essential for long-term sustainability. However, in Türkiye, the number of available positions for this subspecialty has significantly fluctuated over the years, with a noticeable decline after 2022 (Figure 1, based on author-compiled data from ÖSYM quota lists between 2012 and 2024).[5] This decline poses a significant challenge to the sustainability of training and the ability to meet the need for qualified specialists.

As of 2022, subspecialty training positions in university hospitals have also been restructured under the Ministry of Health, replacing the previous model in which positions were managed under the Council of Higher Education (YÖK).[6] This shift has directly affected both institutional affiliation and employment rights.

In many countries, CNP training is offered through structured fellowship programs, and the curriculum, supervision systems, and competency examinations differ in some respects from the Turkish system. Considering these differences, it is crucial to identify both the strengths and areas for improvement in Türkiye's current training model.

In Türkiye, subspecialty training in CNP is conducted according to the core curriculum defined by the Medical Specialty Board Curriculum Development and Standards Committee (TUKMOS).[7] This curriculum aims to standardize both the content of training and the expected levels of knowledge, skills, and competencies. Subspecialty training in CNP is structured as a two-year program following neurology residency training.[7]

The curriculum is designed to ensure proficiency in electrophysiological techniques used in the diagnosis and treatment of nervous system disorders. In this context, trainees are expected to achieve independent competency in various clinical applications in addition to gaining theoretical knowledge. The TUKMOS outlines both clinical and interventional competencies and explicitly defines the levels of proficiency (e.g., ability to guide the patient, perform interventions, or carry out procedures independently). Suggested teaching methods for each competency are also specified, including structured educational activities, hands-on training, and self-directed learning.[7]

The training process covers a wide clinical spectrum, including epilepsy, motor neuron diseases, peripheral nervous system disorders, and sleep disorders. It also involves core electrophysiological techniques such as electroencephalography (EEG), electromyography

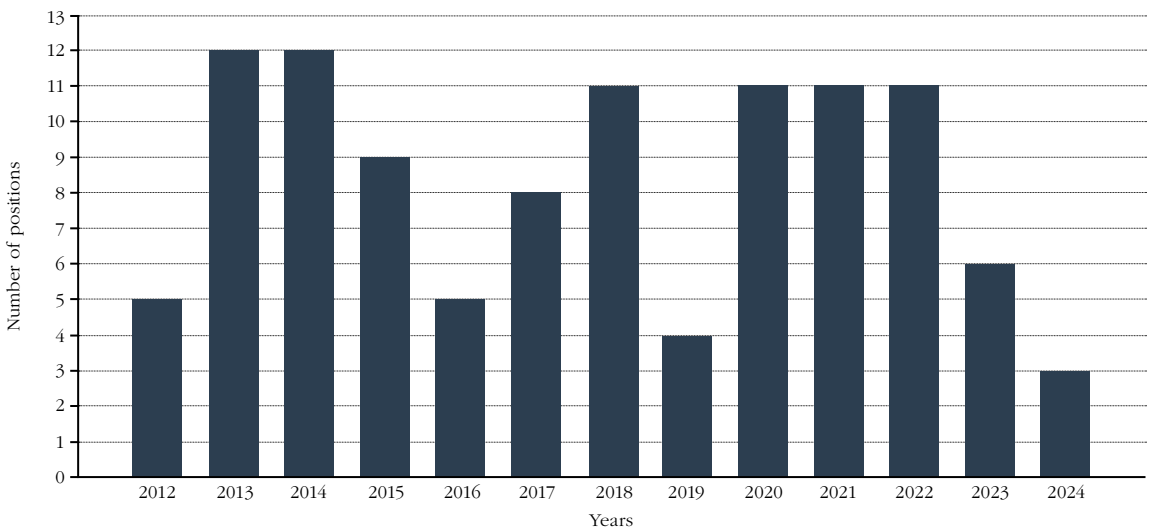

Figure 1. Number of subspecialty training positions in clinical neurophysiology (2012-2024).

(EMG), and evoked potentials (EPs). Interventional competencies include nerve conduction studies, needle EMG procedures, electrophysiological evaluation of movement disorders, botulinum toxin injections under EMG guidance, and intraoperative neuromonitoring (iOM).[7]

However, the degree to which this curriculum is uniformly implemented across training centers, the extent to which trainees acquire these competencies, and the level of standardization in teaching methods remain among the key research questions addressed in this study.

Clinical neurophysiology training exhibits significant structural differences across countries. In Europe, it is recognized as a direct specialty in some countries (such as Finland and Spain), while in many others, it is structured as a fellowship following neurology residency. The modular training system proposed by the European Chapter of the International Federation of Clinical Neurophysiology defines EEG, EMG/nerve conduction studies, and EPs as core training modules. Additional modules include sleep studies, neuromodulation, iOM, and peripheral nerve and muscle ultrasonography.[8]

This system outlines standardized competency requirements for core procedures (e.g., 1000 EEGs and 750 EMGs) and provides a flexible yet guided model for advanced techniques.[8] In contrast, Türkiye's current training curriculum lacks clearly defined numerical targets regarding procedure counts or durations, leading to discrepancies in training intensity between centers.

In the USA, CNP training is offered as a one-year subspecialty program. Although EEG and EMG remain the core components of the curriculum, recent years have seen the inclusion of procedures such as intraoperative monitoring, autonomic testing, and polysomnography. Meanwhile, newer subspecialties such as epilepsy, neuromuscular medicine, and sleep medicine, each overlapping with CNP in certain competencies, have grown rapidly in both training positions and popularity. Despite these developments, CNP still maintains a substantial number of fellows and continues to attract interest among neurology residents.[9]

One notable aspect of international models is that training curricula are standardized not at the institutional but at the regional or national level, with clear targets supported by procedure counts. These practices help ensure educational quality and reduce competency discrepancies among graduates.

This study aimed to evaluate the current status of CNP subspecialty training in Türkiye based on the experiences of fellows and specialists. Additionally, it sought to propose solutions by highlighting the strengths and areas for development through comparisons with training models in Europe and the USA.

MATERIALS AND METHODS

This descriptive, cross-sectional survey study was designed to evaluate the perspectives of physicians who had completed or were undergoing CNP subspecialty training in Türkiye, focusing on their experiences with the training process and the challenges encountered. The study was conducted in April 2025 and included a total of 37 CNP fellows and specialists working in various institutions. Of the participants, 75.7% were subspecialists who had completed their training, while 24.3% were fellows in training.

The data were collected through a structured questionnaire developed by the researcher and distributed online via the Google Forms platform (Alphabet Inc., Mountain View, CA, USA). The survey was shared within a communication group consisting of approximately 80 CNP specialists and fellows in Türkiye and was voluntarily completed by 37 participants. The questionnaire included a total of 25 questions addressing experiences and evaluations related to CNP training. Most of the questions were close-ended (Likert-type and multiple-choice), and qualitative data were also gathered through open-ended comment sections.

No personal data were collected in this survey; all responses were evaluated anonymously. Participation was voluntary, and the introductory section of the online questionnaire informed participants that their responses would be anonymous and used solely for research purposes. Therefore, no formal ethics committee approval was deemed necessary for this descriptive survey study.

Statistical analysis

The collected data were analyzed using descriptive statistics with Google Sheets. Categorical variables were summarized as frequencies and percentages.

RESULTS

A total of 37 participants completed the survey, of whom 75.7% were CNP subspecialists, and

24.3% were current fellows. Among them, 35.1% were affiliated with university hospitals, 37.8% with training and research hospitals, 18.9% with city hospitals, and 8.2% with state, private, or affiliated hospitals. Eight out of nine fellows were working in university hospitals. Of the 13 participants affiliated with university hospitals, 61.5% were currently in training.

Of the participants, 51.4% found the current two-year training period sufficient, while 40.5% considered it insufficient. The remaining 8.1% stated that the adequacy of the duration varied depending on the institution or that some training modules could not be fully covered due to time constraints.

The most frequently reported training components considered insufficient were ultrasonography, transcranial magnetic stimulation (TMS), iOM, botulinum toxin injections guided by EMG, and polysomnography. In contrast, EEG and EMG training, considered core practices, were reported to be more adequately provided across most institutions (Figure 2).

Opportunities for interinstitutional rotations in these areas were found to be limited. While 62.2% of participants reported no access to such opportunities, 32.4% stated that interinstitutional rotations were available.

The most frequently cited issue in the training process was the variation in training programs between institutions, reported by nearly 80% of participants. This was followed by insufficient technical equipment, limited training duration, lack of supervisors, and workload intensity that limited dedicated time for education (Figure 3).

The most commonly reported technical deficiencies were a lack of technical staff, absence of polysomnography equipment, and insufficient training materials. Deficiencies in EEG and EMG devices were reported less frequently.

When the adequacy of theoretical and practical education was assessed using a Likert scale, responses regarding theoretical training showed a wide distribution, while practical training was generally rated as sufficient (Figures 4a, b).

Regarding working hours and on-call duties, 70.3% of participants stated that these factors had neither a positive nor a negative effect on the training process, while 21.6% reported a negative impact.

In terms of academic productivity during fellowship, 40.5% of participants reported having produced three or more publications, whereas 16.2% stated they had no opportunity to engage in research or publication activities.

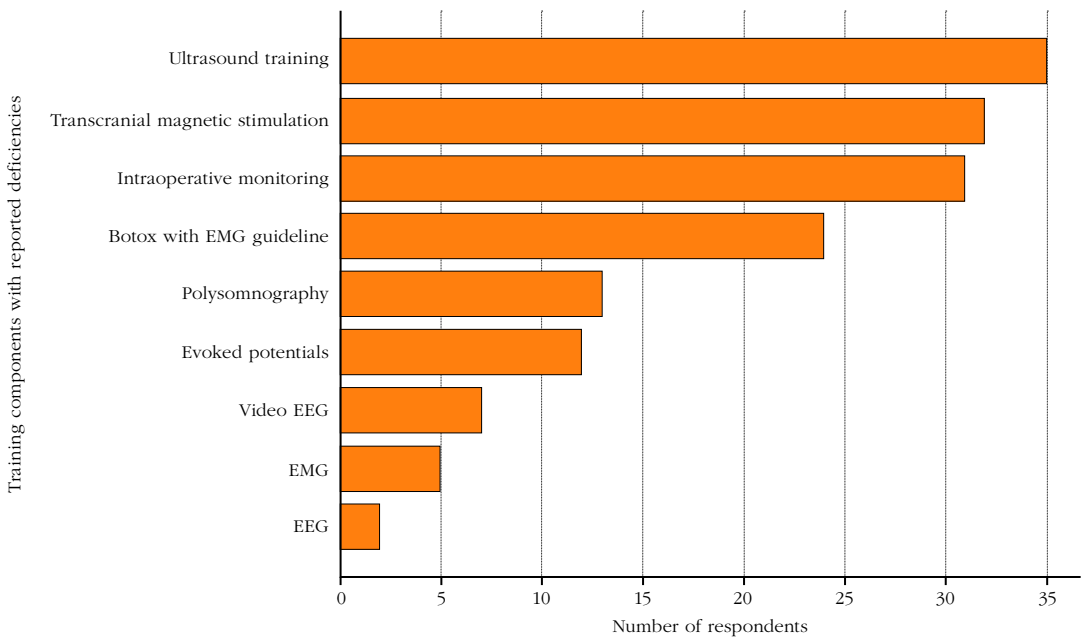

Figure 2. Training components reported as inadequate.

EMG: Electromyography; EEG: Electroencephalography.

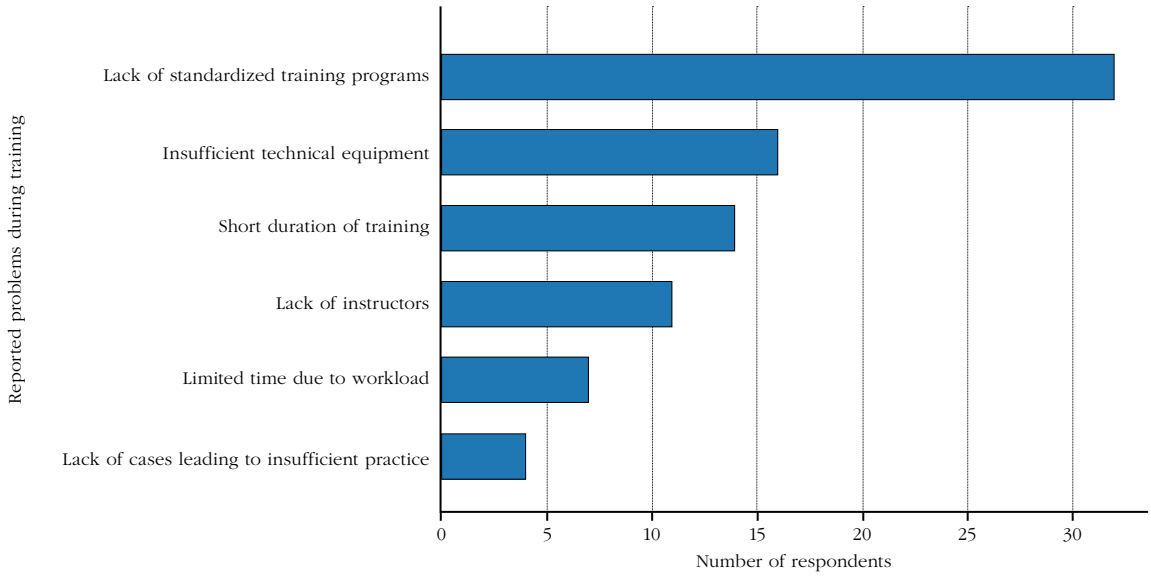

Figure 3. Challenges encountered.

The adequacy of training positions was rated on a scale from 1 to 5. More than half of the participants (n=18, 48.6%) rated the positions as "1=very inadequate."

A significant portion of participants indicated a mismatch between their job descriptions and salary status during the training period. This issue was prominent among those who were previously employed under university-affiliated (YÖK) positions.

Additionally, open-ended responses provided by participants included personal opinions and experiences, although these were excluded from the main text to maintain clarity and focus.

DISCUSSION

This study stands out as one of the first national surveys aiming to contribute to the limited body of data on CNP subspecialty training in Türkiye. Previous national survey-based studies have primarily focused on other neurology subspecialties, such as neurocritical care training, highlighting structural and practical challenges faced by trainees.[10]

The findings indicated that CNP subspecialty training in Türkiye had areas for improvement, both structurally and in practice. Most participants shared similar opinions regarding the content of the training, limited opportunities for rotation, and interinstitutional variability, suggesting that the training process could benefit from being supported by clearer, measurable objectives.

When looking at international practices, the model proposed by the European Chapter of Clinical Neurophysiology defines core modules (EEG, EMG, and EP) and complementary modules (e.g., sleep studies, TMS, iOM, and

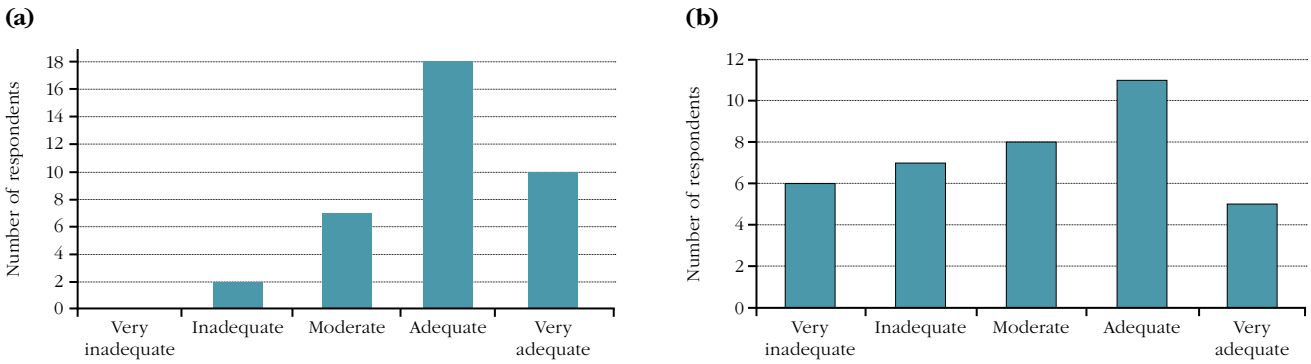

Figure 4. Perceived adequacy of **(a)** practical **(b)** theoretical training.

ultrasonography), with procedural competencies supported by quantitative targets.[8] This approach facilitates oversight of the training and helps reduce variability in postgraduation competency. The lack of such standardization in Türkiye may explain the differences in perceived training quality reported by participants.

Ultrasonography, one of the most frequently reported deficiencies in this survey, is not currently included in the TUKMOS curriculum,[7] although it is recommended as a core module in international guidelines.[8] Therefore, it was included in the survey; however, due to its lack of standardization in both national and international practice, it has yet to become widely integrated into training programs. This reflects the absence of a unified approach to incorporating ultrasonography, although current trends suggest it should receive greater emphasis in future curricula.

Transcranial magnetic stimulation, although available in many centers at the equipment level, was also reported as an underutilized training component. This may be due to the limited availability of advanced techniques, such as paired-pulse protocols and repetitive TMS. This gap between equipment availability and actual practical use highlights the need to focus not just on technical presence but also on functional capacity. International guidelines emphasize this need, recommending standardized and competency-based TMS training across CNP curricula.[11]

Clinical neurophysiology is a specialty heavily centered on technical procedures. Therefore, training quality is influenced not only by theoretical content but also by the diversity of technical infrastructure and the frequency of practical exposure. The survey results showed that access to certain procedures was limited in some centers and that technical capacity had become one of the main factors shaping the training process. In this regard, strengthening technical infrastructure and increasing procedural diversity through interinstitutional rotations may help standardize the training experience.

More than half of the participants rated the available positions for subspecialty training as "very insufficient." This finding highlights a critical issue concerning the sustainability of training programs and the planning of specialist physicians in line with healthcare needs.

Finally, the findings related to employment conditions suggest that working with fellow-level salaries during subspecialty training may negatively affect the professional identity of physicians who have already completed residency. This reflects a lack of clarity in the transitional status between fellowship and full specialist roles. A regulation published in the Official Gazette in 2023 introduced increased base pay for fellows and subspecialists, which represents a partial improvement.[12] However, alongside the importance of ensuring this regulation's long-term sustainability, the restructuring of the physician salary system into a unified, equitable, and comprehensive model remains a frequent topic in current policy discussions.

This study had some limitations. First, the relatively small sample size may limit the generalizability of the findings. Second, reliance on self-reported survey responses could introduce reporting bias. Finally, demographic information such as age and gender was not collected in order to preserve participant anonymity within this relatively small cohort, which may limit the ability to assess representativeness.

In conclusion, the findings of this study demonstrate that CNP subspecialty training offers a significant opportunity for professional development. However, the study also revealed several areas in need of improvement with respect to standardization and training conditions. Variability in training content and practices across institutions leads to inequality among fellows and may limit the overall effectiveness of the training process. Discrepancies between the curriculum goals and the duration of training, along with deficiencies in technical infrastructure and limited access to certain procedures, were identified as key factors affecting training quality. In this context, several recommendations can be made to enhance the quality of training. First, standardization of the CNP curriculum across all institutions should be ensured. Training conditions should be improved in centers with inadequate technical infrastructure, and if this is not feasible, fellows should be offered rotation opportunities at more qualified centers. The balance between the expected competencies and the duration of training should be reassessed, and continuous evaluation and feedback mechanisms should be strengthened throughout the process. The imposition of an additional compulsory service obligation following subspecialty training has emerged as a source of

concern among participants, negatively impacting future motivation. Reintroducing mandatory service for physicians who have already completed specialty training raises questions about professional satisfaction and perceived status. To ensure a more sustainable and encouraging training process, it is crucial to define economic and social rights that align with the level of responsibility and professional expectations.

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Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Was responsible for the study design, data collection, analysis, and manuscript writing: C.D.İ.; Provided academic guidance in the planning and interpretation of findings and contributed to the development of the manuscript: H.Ö.Ş. Both authors confirm that this study is original, conducted in accordance with ethical principles, and approved for submission.

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