

Insights from Epilepsy Healthcare Providers Amid a Neurologist Shortage during the COVID-19 Pandemic

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Objective: The global COVID-19 pandemic has profoundly affected healthcare. Puerto Rico (PR) faces a growing shortage of healthcare specialists that, compounded by the COVID-19 pandemic, has disrupted access to epilepsy care. This study assessed the impact of the pandemic and the exodus of healthcare specialists on epilepsy care from the perspective of healthcare providers.

Methods: We conducted a systematic search to identify neurologists practicing in PR during the study period using multiple sources, including government databases, professional associations, and publicly available online directories, with license verification performed through the Puerto Rico Department of Health. In addition, we distributed a survey on epilepsy care from January through May 2023 to obtain responses from actively practicing healthcare providers.

Results: In our cross-referenced search (N = 163), 23.9% of neurologists identified in PR appeared to be inactive or were untraceable, suggesting possible migration from the island. Active neurologists were unevenly distributed, with the highest concentrations in the metropolitan area and notably fewer practitioners in western and southern municipalities. Among the survey respondents providing epilepsy care, 75% were neurologists, and 58.3% provided both outpatient and inpatient care to people with epilepsy (PWE). Barriers to care included fear of viral infection (66.7%) and lack of access to technology (50%). Among PWE, COVID-19 infection was reported by 75% of healthcare providers, and one-third noted unmet patient care needs in their practices.

Conclusion: The pandemic has exacerbated existing barriers to care for PWE and the shortage of healthcare specialists in PR, underscoring the need to reform public policy and improve access to services across the island.

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Epilepsy is a neurological disorder characterized by both recurrent seizures resulting from abnormal neuronal activity and associated cognitive, psychological, and social consequences (1). Causes of epilepsy include genetic mutations, brain injuries, stroke, infections, and autoimmune diseases; diagnosis is guided by the International League Against Epilepsy criteria and recommendations (2,3). Although more than 20 anti-seizure drugs are available, about one-third of patients have drug-resistant epilepsy and may require surgical or neurostimulation therapies (4).

Globally, epilepsy affects approximately 50 million people (5), and in Puerto Rico (PR), estimates range from 35,000 to 80,000 individuals, representing at least 1% of the population (6–8). However, underreporting to the Department of Health (DOH) epilepsy registry suggests substantial data gaps. Additionally, PR faces a critical shortage of medical specialists: the physician workforce declined from 14,500 in 2009 to about 9,000 in 2020, and over 40% are expected to be near retirement age by 2027 (9–12). These shortages particularly affect neurological care in non-metropolitan regions.

This study aimed to identify neurologists actively practicing in PR and assess their geographic distribution to highlight disparities in epilepsy care. It also examined the impact of the COVID-19

pandemic on people with epilepsy (PWE) using a survey of healthcare providers.

Methods

Study design

A systematic search (2023–2025) was conducted to identify neurologists practicing in PR at the time of data collection. Data were obtained from the Puerto Rico DOH and professional associations, including the Sociedad Puertorriqueña de Epilepsia (Puerto Rican Epilepsy Society) and the Academia Puertorriqueña de Neurología (Puerto Rican Academy of Neurology), as well

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as BeHealth and public directories (SuperPages) (13). All names were cross-referenced and verified in October 2025 by the DOH Office of Regulation and Certification of Health Professionals (Junta de Licenciamiento y Disciplina Médica; Medical Licensing and Discipline Board: <https://orcps.salud.pr.gov/mbps/verificacion>). Duplicate and unverified entries were excluded, resulting in 163 neurologists, of whom 124 were active (valid license; full list in Supporting Information I) and 39 were inactive or untraceable. Each active neurologist was assigned to their municipality of practice to assess geographic distribution. The US National Provider Identifier (NPI) Registry (<https://npiregistry.cms.hhs.gov/search>) was additionally searched for inactive neurologists to identify those possibly practicing on the US or its territories other than PR.

Workforce distribution of active neurologists ($N = 124$) in PR was analyzed using 2 complementary geographic approaches. As the first approach, active neurologists were assigned to municipalities, and the absolute number in each municipality was calculated to identify clinical-service concentration and regional clustering. Municipal percentages were calculated by dividing the number of neurologists in each municipality by the total count. As the second approach, a municipal-level choropleth map was generated showing the population-adjusted number of neurologists per 100,000 residents using the US Census Bureau Puerto Rico Community Survey estimates. The number of neurologists per 100,000 residents was calculated by dividing the number of active neurologists in each municipality by the corresponding number of residents and multiplying by 100,000. A map illustrating the distribution was generated using *Datawrapper*, employing a continuous color gradient to represent density variations across municipalities.

In addition, a cross-sectional survey was conducted to assess the impact of the COVID-19 pandemic on epilepsy care in PR. The instrument (Supporting Information II) was adapted from a validated questionnaire from the American Epilepsy Society “Impact of COVID-19 on Epilepsy Care” survey (Appendix 1). Eligible participants were healthcare professionals residing and practicing in PR who were involved in epilepsy care. The self-administered questionnaire was distributed by the Puerto Rican Epilepsy Society between January and May 2023, with email invitations sent to neurologists, psychiatrists, and psychologists.

No data were collected by phone or direct email. Variables included in the survey were provider type, care setting, insurance type, geographic region, and pandemic-related factors, each assessed separately (seizure frequency, EEG use, medication shortages, and telehealth). Participants were assigned to one of five predefined geographic regions within PR: northern, southern, eastern, western, and metropolitan. The metropolitan region comprises the San Juan metropolitan area and surrounding municipalities characterized by a high population density. The northern, southern, eastern and western regions correspond to the primary geographic divisions of the island published by the Government of Puerto Rico, encompassing municipalities located within their respective areas relative to the central mountain range. Regional classification was applied consistently across all analyses, tables, and figures to facilitate comparison and interpretation of geographic trends in healthcare provider distribution. The

response rate among neurologists was calculated as respondents ($N = 9$) divided by all active neurologists ($N = 124$), multiplied by 100. Data were analyzed descriptively using Microsoft Excel. As a reference, a map included in Supporting Information III, obtained from the Centers for Disease Control and Prevention, shows the distribution of COVID-19 cases across the island up to the conclusion of our data collection in May 2023.

Ethical considerations

Participants provided electronic informed consent. No personal identifiers or incentives were used. The study was approved by the San Juan Bautista School of Medicine Institutional Review Board (protocol EMSJBIRB-4-2022).

Results

Active neurologists and their distribution in PR

In the absence of an official registry of healthcare professionals in PR, data from multiple sources identified 163 neurologists, the primary providers of epilepsy care on the island. Of these, 124 (76.1%) were confirmed by the DOH as actively practicing in PR, while 39 (23.9%) were untraceable or inactive according to the DOH registry. A cross-reference with the NPI database revealed that 10 of the 39 inactive neurologists (25.6%) were practicing in the US or its territories other than PR. The remaining 29 were either not found in either database or were identified as inactive/retired in both databases.

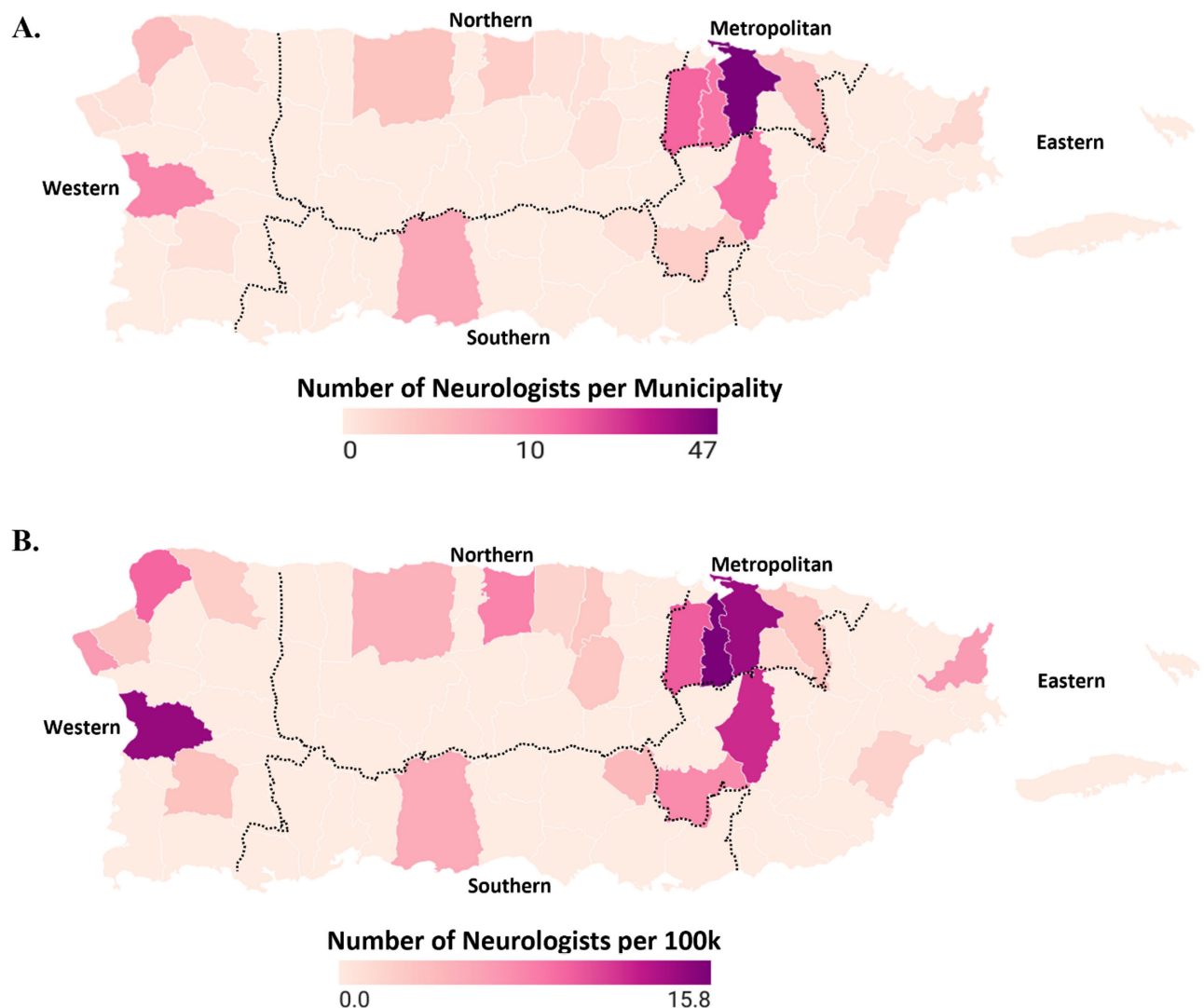
The geographic distribution of the 124 active neurologists across PR (Figure 1A) was predominantly concentrated in the northern region ($n = 83$; 66.9%), followed by the metropolitan region ($n = 20$; 16.1%), western region ($n = 17$; 13.7%), southern region ($n = 7$; 5.6%), and eastern region ($n = 2$; 1.6%). Notably, 5 neurologists were listed as practicing in 2 municipalities; for regional analyses, each clinician was assigned to a single municipality and counted only once. The highest neurologist-to-population ratios (Figure 1B) were observed in the metropolitan areas, particularly San Juan and surrounding municipalities, followed by notable concentrations in Mayagüez and Ponce.

Impact of COVID-19 on people with Epilepsy

Twelve healthcare professionals, including 9 neurologists, 2 psychologists, and 1 general practitioner, completed the survey on epilepsy care during the COVID-19 pandemic. The neurologist response rate was 7.3% (9/124). The largest proportion of respondents practiced in the metropolitan region (33%), with no responses from the eastern region (Table 1).

Among surveyed providers ($N = 12$), 75% reported caring for PWE diagnosed with COVID-19. The perceived impact of infection was rated as moderate (50%), mild (33.3%), or severe (16.7%) (Figure 2A). Of the respondents, 41.7% reported new-onset seizures among infected PWE, with generalized tonic-clonic seizures being the most common type (16.7%), followed by focal seizures and focal-to-bilateral tonic-clonic seizures (each 8.3%). Seventy-five percent of respondents reported no change in seizure frequency (Figure 2B). Among those reporting variable seizure responses, contributing factors stated by the providers included preexisting risk factors (33%) and viral inflammation (16.7%)

Figure 1. Geographic distribution of active neurologists in Puerto Rico using a standardized regional framework. A) Distribution of active neurologists (N = 124) by municipality in Puerto Rico. This map illustrates the geographic distribution of neurologists based on the number practicing in each municipality. Municipalities with higher concentrations appear in darker shades. Overlaid regional boundaries delineate the predefined geographic regions (northern, southern, eastern, western, and metropolitan), highlighting clustering patterns and major service hubs without adjusting for population size. B) Active neurologists per 100,000 population by municipality in Puerto Rico. This choropleth map displays neurologist availability adjusted for municipal population. Darker shades represent higher neurologist-to-population ratios, ranging from 0.0 to 15.8 per 100,000 residents. The regional framework (northern, southern, eastern, western, and metropolitan) is shown to facilitate interpretation of geographic disparities in workforce distribution and to identify regions with potential shortages despite the presence of neurologists in absolute numbers.



Inpatient EEG utilization decreased among 25% of providers, while another 16.7% reported discontinuation of continuous EEG monitoring (Supporting Information IV Figure S1). The criteria used by healthcare providers to classify impact in PWE as mild, moderate, or severe are provided in Supporting Information V.

For PWE, key barriers to epilepsy care during the pandemic included fear of COVID-19 infection (66.7%), lack of access to technology (50%), and transportation problems (25%) (Figure 2C). Provider challenges included restricted access to in-person

outpatient/inpatient visits (58.3%), non-emergency procedures (33.3%), fear of COVID-19 infection (25%), and regulatory barriers (25%) (Figure 2D). Medication shortages were reported as temporary by 16.7% of respondents. Telehealth use varied: 16.7% used it frequently, 33.3% sometimes, 25% rarely, and 25% never. By May 2023, 41% of providers reported returning to pre-pandemic practice levels, while others anticipated full recovery within 3 to 12 months. Definitions of pre-pandemic, pandemic, and post-pandemic periods based on World Health Organization (WHO) criteria appear in Supporting Information V.

Table 1. Demographic data and geographic distribution of the cohort of healthcare providers that anonymously completed the questionnaire from January to May 2023 (N = 12)

	N	%	Northern region	Metro region	Southern region	Western region	Eastern region#
<i>Type of provider</i>							
Adult neurologist	7	58.3	✓	✓	✓	✓	
Pediatric neurologist	2	16.7		✓			
Psychologist	2	16.7		✓			
General practitioner	1	8.3			✓		
<i>Type of setting</i>							
Inpatient & outpatient	7	58.3		✓	✓	✓	
Only outpatient	5	41.7	✓	✓	✓	✓	
Only inpatient	0	0					
<i>Type of medical insurance</i>							
Private	7	58.3	✓	✓	✓	✓	
Public	5	41.7		✓	✓	✓	

#No participants from this region.

Discussion

This study identified 163 neurologists across PR, of whom 124 (76.1%) maintained active practices and 39 (23.9%) were inactive or unverified. Of these 39, we confirmed that 10 (25.6%) were identified as practicing in the US or its territories other than PR based on NPI registry information. The remaining 29 neurologists may be retired or may have relocated to the US, or its territories other than PR, although their current practice status may not be fully reflected in the NPI registry due to incomplete, delayed, or non-updated affiliation information. These findings highlight the ongoing migration patterns and data-reporting gaps affecting the neurology workforce. Furthermore, these results are consistent with prior reports showing that physician emigration, which began before the COVID-19 pandemic, has continued and may have accelerated in recent years (9,14).

To provide a comprehensive assessment of neurologist workforce distribution, we mapped both the absolute number of neurologists per municipality and the population-adjusted rate per 100,000 residents, mirroring reporting practices used by the American Academy of Neurology. Of the 124 neurologists, just over two-thirds (66.9%) were concentrated in the northern region. In contrast, the southern, western, and central areas were far less represented, with the eastern region showing the least representation overall. Spatial analysis revealed pronounced clustering of neurological services in urbanized areas with higher socioeconomic development.

This clustering pattern highlights potential disparities in access to specialized neurological services in rural and southeastern municipalities.

Since 2009, more than 8,000 physicians have left PR, nearly half the island’s medical workforce (6). This exodus has been associated with prolonged wait times, reduced access to care, and increasing uncertainty about the healthcare system’s long-term sustainability (15). Although government initiatives such as Law 60-2022 aimed to retain clinicians using tax incentives,

these efforts have been insufficient to reverse migration trends. Broader systemic reforms—including equitable federal funding (16), expansion of accredited residency and fellowship programs (17), and strategies addressing professional isolation, bureaucratic inefficiencies, and limited career growth—are essential to stabilize the healthcare workforce (10,18–20). As noted by Santini-Domínguez et al. (18) and Varas-Díaz et al. (10), the convergence of fiscal constraints, inequities in federal support, and an aging specialist population has intensified the crisis.

The survey portion of this study provides a preliminary view of epilepsy care during the COVID-19 pandemic. Although the response rate among neurologists (7.3%) was modest, such rates are common in clinician-based surveys (1,21,22). Moreover, not all neurologists in PR

provide direct care for PWE, further narrowing the eligible population. Despite the limited sample, the data provide insights into barriers and adaptations within a strained healthcare system.

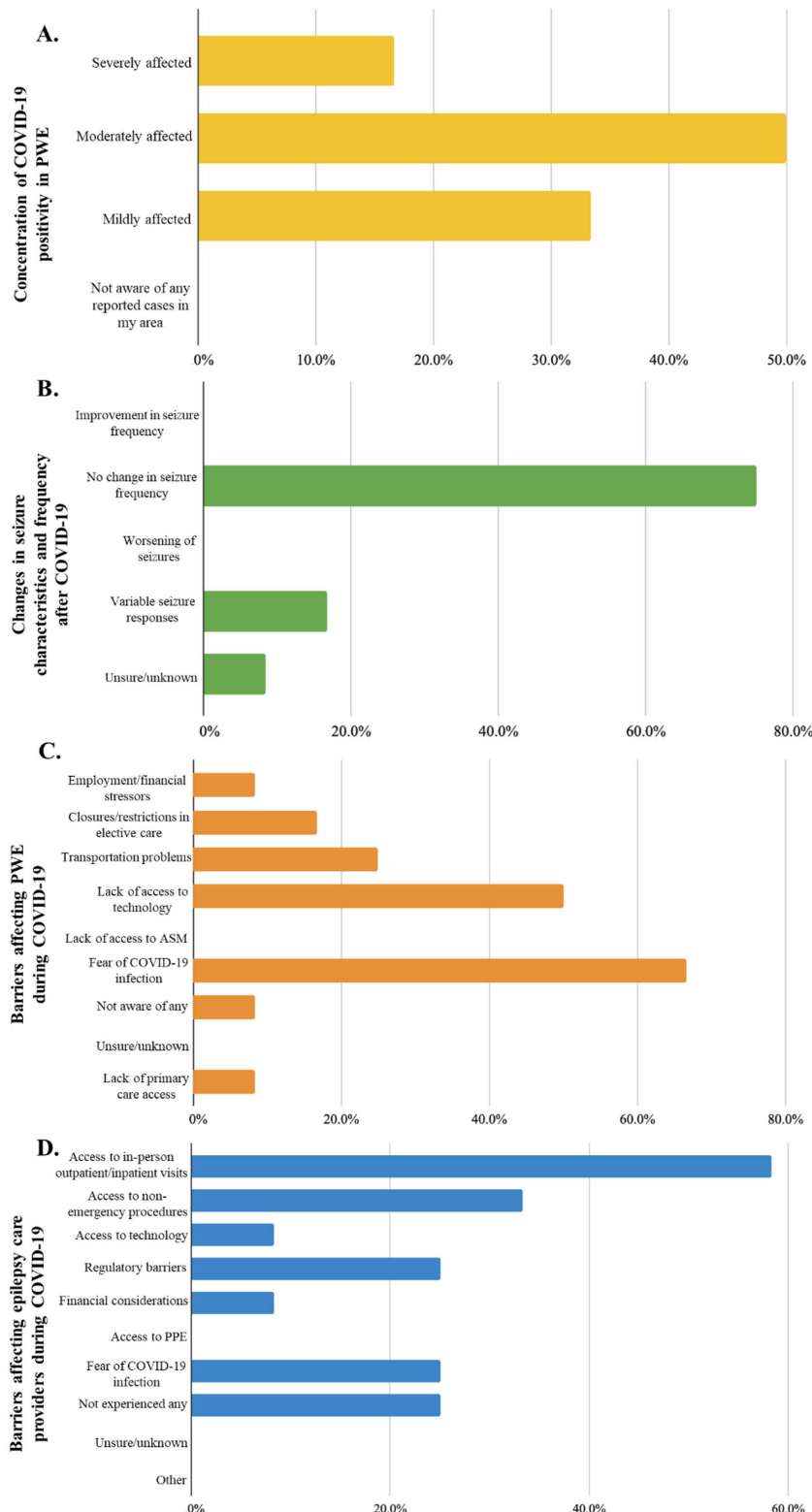
Among respondents, 75% reported treating PWE diagnosed with COVID-19. Of these, 41.7% observed new-onset seizures—primarily generalized tonic-clonic—while 75% reported no overall change in seizure frequency. These results differ from international reports describing increased seizure frequency linked to stress, sleep disruption, or neuroinflammation (23,24), but align with findings by Leitingner et al. (25), who observed no increase in seizure incidence among COVID-19–diagnosed patients. Thus, providers in PR did not perceive widespread worsening of seizure control during the pandemic.

Barriers to care for PWE were primarily related to fear of COVID-19 infection (66.7%), lack of access to technology (50%), and transportation problems (25%), consistent with global observations (26, 27). Telehealth adoption remained limited—only 16.7% used it regularly—despite evidence that remote consultations improve accessibility and patient satisfaction (26). These findings suggest a need for expanded digital infrastructure and training to enhance continuity of epilepsy care in future emergencies.

This study has several limitations. The small sample size and provider-only perspective limit generalizability, and its cross-sectional design offers only a snapshot in time. Nevertheless, this work provides a valuable baseline for understanding the geographic distribution of neurologists and the systemic barriers affecting PWE in PR.

In conclusion, this study documents a continuing decline in PR’s neurological workforce and significant regional disparities in epilepsy care. The COVID-19 pandemic exacerbated existing challenges but also underscored the adaptability of local providers. Addressing clinician migration, workforce maldistribution, and technological inequities is essential to ensure equitable, sustainable neurological care for the Puerto Rican population.

Figure 2. Barriers to care for PWE during the COVID-19 pandemic (n = 12), from the perspective of healthcare providers. A) COVID-19 positivity among PWE. B) Changes in seizure presentation among COVID-19-positive PWE. C) Barriers affecting PWE. D) Barriers affecting epilepsy healthcare providers. Abbreviations: ASM, anti-seizure medication; PPE, personal protective equipment; PWE, persons with epilepsy.



Appendix

Original published survey can be accessed at https://pmc.ncbi.nlm.nih.gov/articles/instance/7653649/bin/Appendix_1-AES_COVID_Survey_Questions.pdf

Resumen

Objetivo: La pandemia global de COVID-19 afectó significativamente los servicios de salud, agravando la creciente escasez de especialistas médicos en Puerto Rico (PR) y limitando el acceso al cuidado de la epilepsia. Este estudio evaluó el impacto de la pandemia y la migración de especialistas sobre el cuidado de personas con epilepsia (PCE) desde la perspectiva de los proveedores de salud. **Métodos:** Se realizó una búsqueda sistemática para identificar neurólogos activos en PR utilizando datos gubernamentales, asociaciones profesionales y directorios públicos, con verificación de licencias mediante el Departamento de Salud de Puerto Rico. Además, entre enero y mayo de 2023 se distribuyó una encuesta a proveedores de salud involucrados en el cuidado de PCE. **Resultados:** De los 163 neurólogos identificados inicialmente, el 23.9% resultó no localizable o inactivo, sugiriendo una posible migración fuera de la isla. Los neurólogos activos mostraron una distribución desigual, concentrándose principalmente en el área metropolitana y con menor presencia en municipios del oeste y sur de PR. Entre los encuestados, el 75% eran neurólogos y el 58.3% ofrecía atención ambulatoria y hospitalaria. Las principales barreras para el cuidado incluyeron el temor a la infección viral (66.7%) y la falta de acceso a tecnología (50%). Además, el 75% reportó casos de infección por COVID-19 entre PCE, y un tercio identificó necesidades clínicas no satisfechas. **Conclusión:** Estos hallazgos demuestran que la pandemia exacerbó las barreras existentes y la escasez de especialistas en PR, destacando la necesidad urgente de mejorar el acceso y fortalecer las políticas públicas de salud.

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