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ORIGINAL ARTICLE

The COVID-19 pandemic and neurology: A survey on previous and continued restrictions for clinical practice, curricular training, and health economics

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Abstract

Background and Purpose: The COVID-19 pandemic has significantly impacted health systems worldwide. Here, we assessed the pandemic's impact on clinical service, curricular training, and financial burden from a neurological viewpoint during the enforced lockdown periods and the assumed recovery by 2023.

Methods: An online 18-item survey was conducted by the European Academy of Neurology (EAN) NeuroCOVID-19 Task Force among the EAN community. The survey was online between February and March 2023. Questions related to general, demographic, clinical, work, education, and economic aspects.

Results: We collected 430 responses from 79 countries. Most health care professionals were aged 35–44 years, with >15 years of work experience. The key findings of their observations were as follows. (i) Clinical services were cut back in all neurological subspecialties during the most restrictive COVID-19 lockdown period. The most affected neurological subspecialties were services for patients with dementia, and neuromuscular and movement disorders. The levels of reduction and the pace of recovery were distinct for acute emergencies and in- and outpatient care. Recovery was slow for sleep medicine, autonomic nervous system disorders, neurorehabilitation, and dementia care. (ii) Student and residency rotations and grand rounds were reorganized, and congresses were converted into a virtual format. Conferences are partly maintained in a hybrid format. (iii) Affordability of neurological care and medication shortage are emerging issues.

Conclusions: Recovery of neurological services up to spring 2023 has been incomplete following substantial disruption of neurological care, medical education, and health economics in the wake of the COVID-19 pandemic. The continued limitations for the delivery of neurological care threaten brain health and call for action on a global scale.

For Affiliation refer page on 9

KEYWORDS
brain health, COVID-19, curricular training, health economics, lockdown period, neurological care

INTRODUCTION

The pandemic of coronavirus disease 2019 (COVID-19) emerged in late 2019 [1, 2]. Since then, infection with the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has caused >6.9 million deaths as of 30 August 2023 [3]. The pandemic stressed health care systems worldwide to a critical level and continues to be challenging even after the World Health Organization (WHO) declared an end to COVID-19 as a public health emergency on 5 May 2023 [4, 5]. The pandemic disproportionately affected low- and middle-income countries due to preexisting health care infrastructure limitations and economic hazards [6, 7]. These inequalities, together with race, gender, and geography, are associated with an increased risk of more severe COVID-19 course and sequelae [8, 9]. Moreover, inadequate access to prevention, diagnosis, and treatment of COVID-19 has hindered efforts to end the pandemic [7, 10, 11]. The European Academy of Neurology (EAN) made pleas to distribute SARS-CoV-2 vaccines evenly and to enable unrestricted access to COVID-19 diagnostics and therapy [12–14]. Despite the availability of vaccines against SARS-CoV-2, immunization hesitancy and global inequities in vaccine distribution still remain [15].

COVID-19 primarily affects the respiratory system but has also been associated with central and peripheral nervous system dysfunctions [16, 17]. The neurological manifestations of COVID-19 and complications of the SARS-CoV-2 vaccines further emphasize the importance of neurologists in the pandemic [18, 19]. A worldwide survey conducted at the end of the year 2020 reported a substantial disruption in care due to the restriction of neurological services [20]. The resource allocation often prioritized COVID-19 prevention and care at the cost of nonurgent services for patients with subacute symptoms and chronic neurological disorders. These included referrals to outpatient clinics, admission to wards, and the utilization of cross-sectoral neurological services. Cancelled and postponed outpatient consultations were only partly replaced with telehealth alternatives. Whether the observed disease progression among people with chronic neurological disorders during lockdown periods was related to the lack of regular medical care, social isolation, or other factors is a matter of ongoing research [21–24]. The hesitancy to seek medical help for acute conditions such as stroke or traumatic brain injury was another critical observation during lockdown periods [25, 26]. The pandemic also significantly impacted student and resident neurology training and continuous medical education (CME). New paths had to be taken, and some medical schools and congresses rapidly established virtual and web-based teaching activities and served as a hub for others [27–29]. Health care systems worldwide have faced considerable financial constraints due to the high resource demand, including personal protective equipment, ventilators, and medications [4, 5]. In addition, the worldwide trend of health care professionals quitting their jobs and partly moving to unrelated fields aggravated the already strained situation [30, 31]. The socioeconomic consequences of the pandemic extended to the individual level. People living with neurological conditions and their families faced increased financial burdens due to job loss, reduced income, and increased out-of-pocket health care expenses [32]. Resources have been diverted to developing and distributing COVID-19 vaccines and treatments, potentially delaying the advancement of novel therapies for neurological conditions [33]. Furthermore, supply chain disruption impacted the availability of medications.

Our study aimed to assess the clinical, educational, and economic burden of the COVID-19 pandemic during the most severe lockdown periods and the extent of restitution up to spring 2023 from a neurological viewpoint.

METHODS

Survey development and dissemination

The EAN NeuroCOVID-19 Task Force developed a five-domain and 18-question online survey. Six questions were devoted to demographics and profession, eight evaluated the performance of clinical service and medical care, and two questions each were related to educational offerings and economic considerations. The exact wording of the questions is provided in the Supplementary File. The survey was entered into SurveyMonkey and announced in the EAN newsletter. The announcement can be found at https://shorturl.at/mzLT0. Two dedicated emails were sent to all EAN newsletter recipients. The survey was available online from 20 February 2023. The task force estimated a convenience sample of 400–500 completed surveys as representative of the EAN community. The participants could opt for a lottery to be considered for free congress registration.

Statistical analysis

Descriptive statistics and frequency analyses were used to evaluate survey results, employing Microsoft Excel (2021).

RESULTS

We stopped the survey on 21 March 2023, after 430 questionnaires were completed.

Most responses came from Europe (285, 66%), followed by Asia (69, 16%), Africa (35, 8%), South America (26, 6%), North America (12, 3%), and Australia (3, 1%). Per country, Italy (10.9%) was most represented, followed by the United Kingdom (4.9%) and Spain (4.4%). The share of women (56%) was slightly higher than for men. Most participants were between 25 and 44 years old (61%) and had

>15 years of practice (33.7%). The respondents were mainly hospital-based, with their primary fields of interest being stroke/vascular neurology, multiple sclerosis/neuroimmunology, and movement disorders. The least represented areas of interest were niche subspecialties such as the autonomic nervous system and neuroinfections. Table 1 and Figure 1 summarize demographic and professional characteristics of survey respondents. The number and percentage of responses given as N/A (no answer) for each question are shown in supplemental Tables S2 and S3.

Clinical activities: Differences for subspecialties

When asked about the most severe lockdown periods of the COVID-19 pandemic, the entire spectrum of neurological subspecialties experienced a cutback in clinical activities (Figure 2a). However, not all subspecialties were affected to a similar extent. Neuromuscular disorders, movement disorders, and dementia were the most impacted subspecialties, with >80% of the responses indicating a reduction of clinical activities ranging from 25% to 100%. By contrast, neurointensive care, neuroinfections, and neurological emergencies were the least affected, with no decline in clinical activities observed by 54%, 51%, and 41% of respondents, respectively. Since then, clinical activities reportedly recovered in all neurology subspecialties, but the recovery rates were also variable. The front-runners for a full recovery were neurological emergency (76%), neurointensive care (72%), and stroke/vascular neurology (71%), whereas subspecialties with ongoing limitations were neurorehabilitation (full recovery 50%), autonomic nervous system disorders (51%), and sleep disorders (51%; Figure 2b).

Pillars of medical care: Differences for inpatient, outpatient, and emergency services

Neurological inpatient, outpatient, and emergency services were affected differently during the most severe lockdown periods of the COVID-19 pandemic (Figure 3a). The consequences concerning the allocation of space were more pronounced for neurological outpatient services (complete loss of facility 13.4%), followed by inpatient and emergency services (total loss of beds 3.6% and 3.4%, respectively). Further pillars of medical care that were cut back during the lockdown periods included the number of doctors, nurses, and therapists. The latter group, comprising various specialists, including psychologists, occupational therapists, physiotherapists, and speech and language therapists, was the most affected, regardless of their regular work site. Nurses were next in reduced allocation to neurological services. Investigations and therapeutic options, including drug availability, were also frequently cut. In this regard, outpatient services were the most affected (reduction by 25% or more reported by 81.9%). There were also substantial effects on the emergency and inpatient services; a 25% or more reduction was reported by 80.0% and 80.3%, respectively.

TABLE 1 Demographic and professional data.

Characteristic	*n* (*N* = 430)	%
Female	244	57
Age		
18–24	6	1
25–34	137	32
35–44	125	29
45–54	79	18
55–64	56	13
65+	27	6
Years in practice		
Neurology resident	100	23
Neurologist of 5 years	106	25
Neurologist of 10 years	58	13
Neurologist of 15 years	21	5
Neurologist of >15 years	145	34
Place of work[a]		
University hospital	263	61
Public hospital	141	33
Private practice	62	14
Private hospital	58	13
Outpatient clinic	47	11
Research facility	33	8
Other	11	3
Main field of interest[b]		
Stroke/vascular neurology	175	41
Multiple sclerosis/neuroimmunology	118	27
Movement disorders	100	23
General neurology	91	21
Epilepsy	90	21
Headache and pain	90	21
Dementia/cognitive disorders	87	20
Neuromuscular disorders	71	17
Neurological emergency	45	10
Peripheral nephropathy	39	9
Sleep disorders	26	6
Neurocritical care	25	6
Other	25	6
Neurorehabilitation	24	6
Neuroinfection	19	4
Autonomic nervous system	10	2

[a]More than one possible choice.
[b]Up to three possible choices.

In the meantime, approximately 60% of respondents noticed that the number of physicians, nurses, therapeutic options, therapists, beds, wards, and outpatient facilities returned to normal (100%). Another 11%–19% of participants reported a 75% recovery for acute, inpatient, and outpatient health care elements.

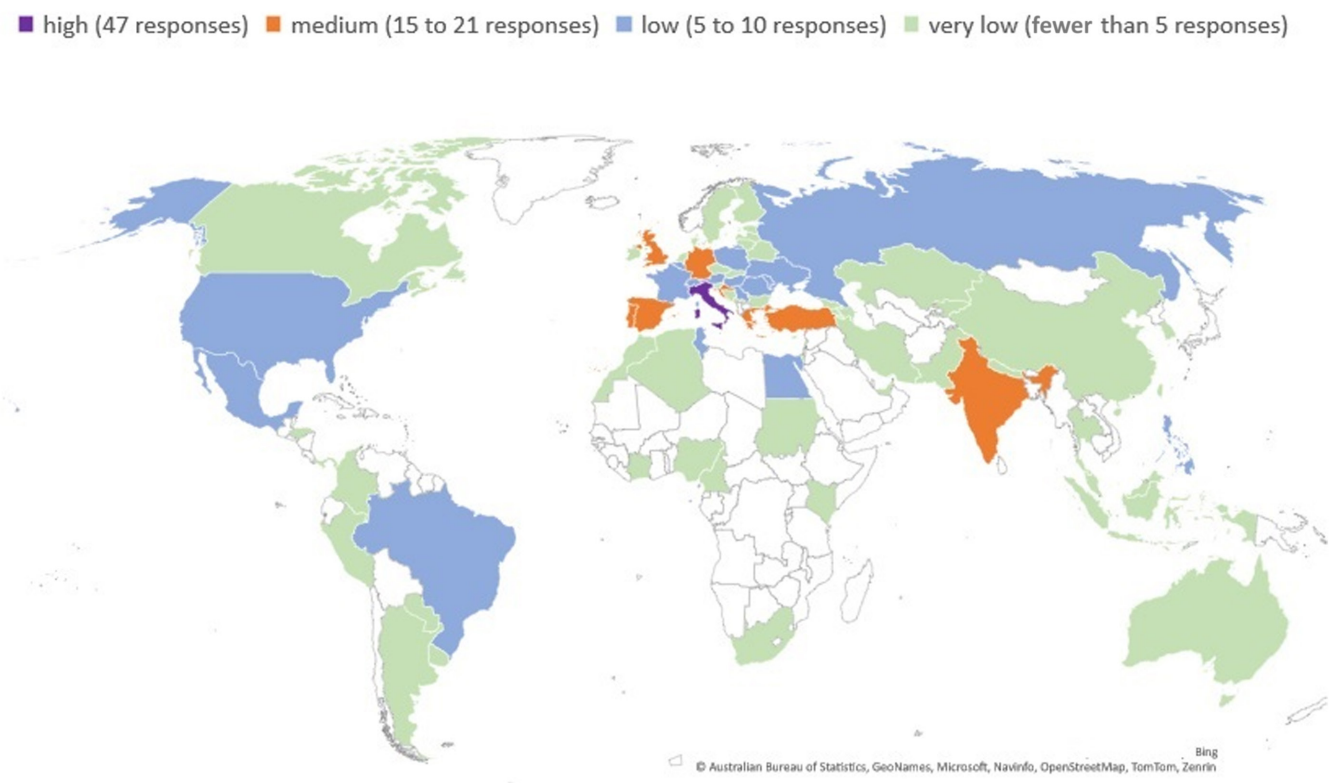

FIGURE 1 Worldwide distribution of participants.

Educational activities: Students, residents, CME, congresses/conferences

The most restrictive lockdown period was associated with reduced offerings for pre- and postgraduate educational activities in neurology compared to the pre-COVID-19 situation. The extent of the observed cutback was most pronounced for medical students, compared to residents and specialists (Figure 4a). A total suspension of student rotations, grand rounds, and conferences during the most arduous lockdown periods was reported by 41.9%, 33.5%, and 34.9%, respectively. In the meantime, the educational activities were taken up again (Figure 4b). Most respondents reported a full recovery of student and residency rotations, as well as grand rounds and CME activities, even though on-site conferences have been resumed in only 54.6% of cases.

Consequences for health economics and avoidance behaviour

We assessed the consequences for neurological patient care due to economic hardship (Figure 5). The respondents indicated that up to 80.8% of patients could not afford neurological treatment as a consequence of the COVID-19 pandemic. When asked about the loss of income for doctors and departments since COVID-19, only 14.9% and 8.9%, respectively, responded that they did not see such a reduction (answer "definitely not"). Treatment limitations due to lack of supply were reported to some degree by 93.5% of respondents. Moreover, a remarkably high rate of responses (63.6% totalled for possibly, probably, and definitely) indicated that patients missed appointments, for example, due to fear of infection.

Asked whether these issues changed back to pre-COVID-19 conditions in the meantime, the responses were indicative of improvement. Yet, worrisome answers reveal a high rate of patients who still cannot afford neurological care and ongoing treatment limitations due to lack of supply.

DISCUSSION

This worldwide survey among neurology trainees and mostly hospital-based neurologists evaluated COVID-19-related changes and their impact on neurological care, medical education, and health economics. The results provide insights into the situation both during the peak of the lockdown periods, when the goal was to prevent the spread of the infection, and in spring 2023, shortly before the WHO declared the end of the global health emergency.

The study clearly indicates that the COVID-19 pandemic significantly disrupted the delivery of neurological health care services during the most extensive COVID-19 restriction periods. The findings of our study reflect the consequences of allocating wards/beds, nonmedical facilities, and health care workers to the care of COVID-19 patients in specialized wards during the pandemic's peak, leaving fewer resources available to care for neurological patients. Appointments at outpatient clinics were replaced by telemedicine

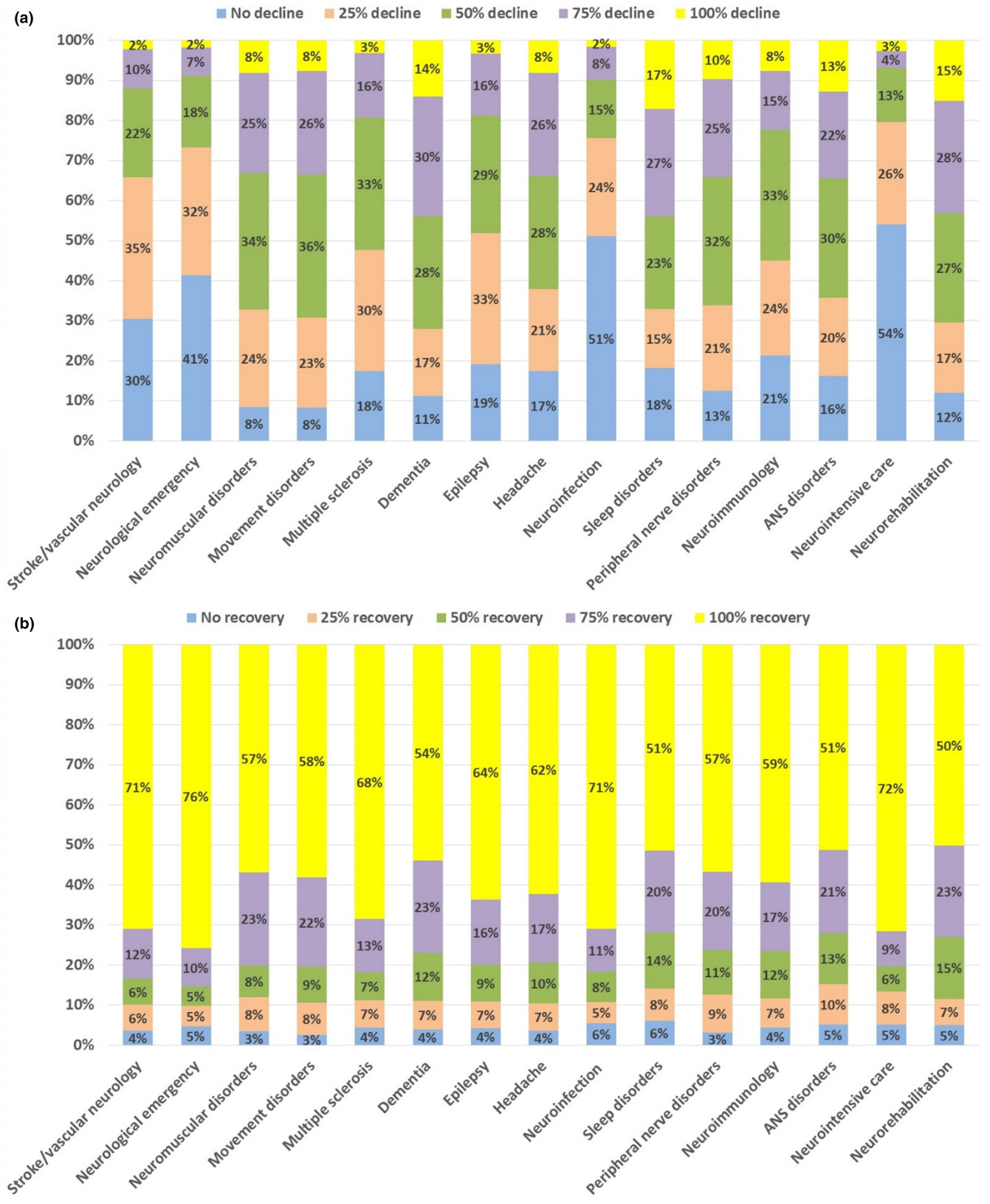

FIGURE 2 Clinical practice across neurological subspecialties, showing reductions during to the most severe COVID-19 lockdown period (a) and recovery of clinical activities in the meantime (b). ANS, autonomic nervous system.

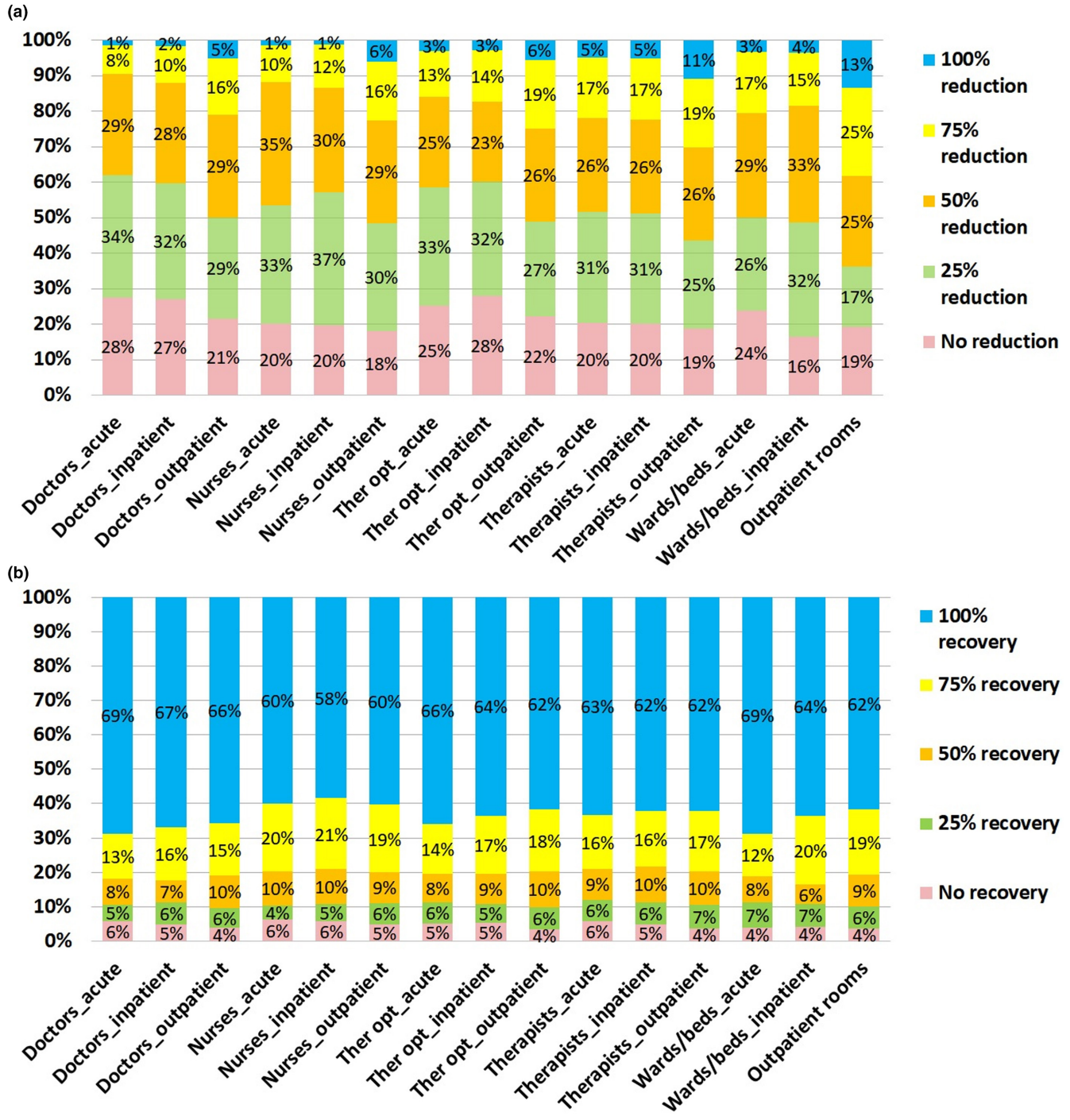

FIGURE 3 Neurological care at the emergency unit, and inpatient and outpatients facilities, showing reductions due to the most severe COVID-19 restrictions (a) and recovery of clinical activities in the meantime (b). Ther opt, therapeutical options.

consultations or more frequently cancelled due to the lack of personnel, space, and time [34, 35]. Similar observations during the pandemic's peak have been made, for instance, in Italy [36].

Neurology patient care is traditionally based on face-to-face engagement and includes a neurological examination, and patients with chronic neurological diseases are used to regular follow-ups. Although telemedicine, email, and phone calls were used to maintain patient care to a certain extent, it is conceivable that people living with neurological disorders perceived medical care as inappropriate at the onset and during the height of the pandemic [37]. Delayed diagnosis, treatment interruption, or unrecognized treatment side effects in these conditions could have detrimental consequences, including disease progression and death [38, 39]. Several studies highlighted how quarantine and other containment measures were associated with an acute worsening of clinical symptoms in people living with dementia and an increase in the caregivers' burden [40–42]. On the other hand, our survey disclosed that patients also cancelled their appointments at the

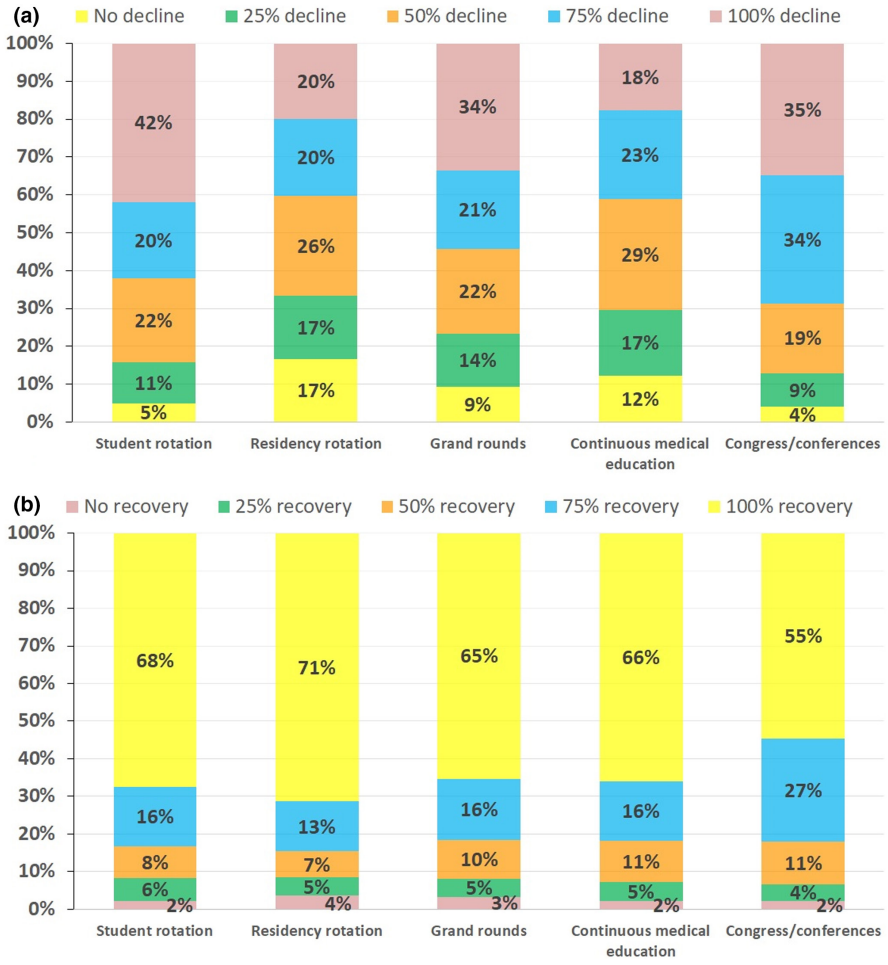

FIGURE 4 Educational activities, showing reductions during the most severe COVID-19 restrictions (a) and recovery of educational activities in the meantime (b).

pandemic's peak, most likely due to fear of infection on the way to and within the health care facility.

Although we found evidence for a general decline in clinical activities in all neurological subspecialties, the extent of service cutbacks differed among neurology fields. The areas that experienced the most dramatic drops in clinical service were dementia, movement disorders, and neuromuscular conditions. In contrast, the responses indicated that services for managing neurological emergencies, neuroinfections, and critically ill patients were less compromised. Nonetheless, the literature suggests delays in door-to-needle times for acute stroke and subsequent detrimental consequences concerning outcome [42]. In addition, there was a high rate of concordance that patients were hesitant to seek acute medical care for milder and unspecific symptoms. A German study evaluated the lockdown period in 2020 and found a constant number of patients with emergent symptoms presenting to the emergency room but changes in care-seeking behaviour [43]. In line with this, a Canadian study reported a 20% drop in stroke codes in 2020 compared to 2019, whereas the number of admissions remained constant. The patients who did not seek emergent medical care mainly had stroke mimics and minor strokes, indicating patient-related factors driven by the fear of contracting SARS-CoV-2 during transportation and ambulatory and hospital care [44].

Many respondents indicated a shortage of medicines, equipment, and devices during the most severe restriction periods that are still ongoing. The drug scarcities relevant to neurological care include anticonvulsive drugs, thrombolytic agents, antiplatelet medication, and contrast agents [45–47]. The demand related to the significant number of severely ill COVID-19 cases, preexisting issues with the supply chain, and closed factories due to lockdowns resulted in a shortage of drugs for neurological patients early in the pandemic. The reason for the continued pharmaceutical shortage is multifaceted and ranges from manufacturing and quality problems, transportation delays, and drug discontinuation to even social-media-generated trends leading to increased demand [48]. The consequences of drug shortages are well studied; they cause an increase in errors, use of poor substitutions, out-of-pocket expenses, and adverse events, including higher mortality rates [49, 50].

Since then, the number of new COVID-19 infections, particularly of those with severe courses, has declined in the general population, easing the need for restrictions worldwide. However, the neurological care offer has not yet recovered to pre-COVID-19 levels. Our survey evaluating the situation in March 2023 disclosed that approximately one third of personnel and resources dedicated to neurological patients remained below their magnitude before COVID-19. Moreover, the responses point at neurorehabilitation,

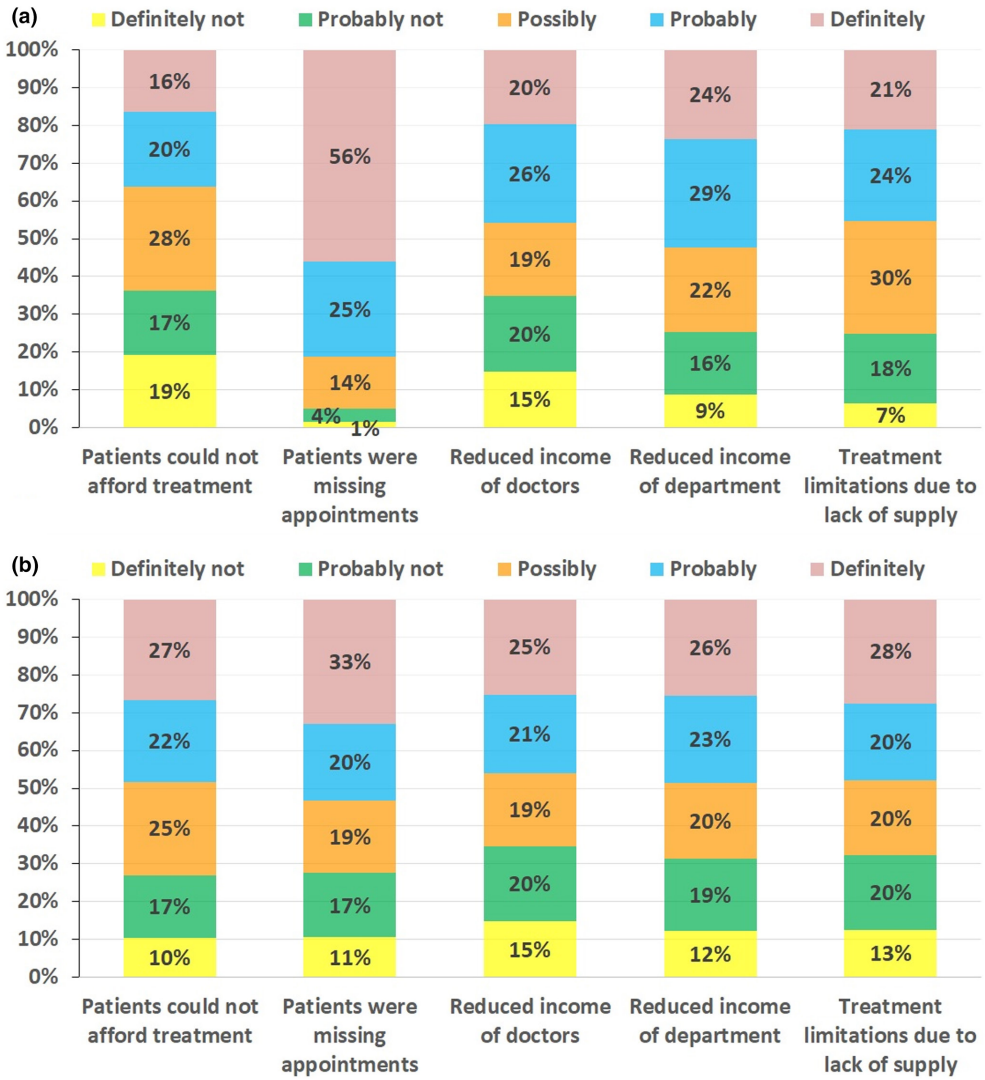

FIGURE 5 Economic consequences for neurological health care during the most severe COVID-19 restrictions (a) and recovery in the meantime (b).

sleep medicine, autonomic nervous system disorders, and dementia as the areas with a particularly protracted recovery. The reasons that these subspecialties are having issues with reuptake at pre-COVID-19 frequency is likely to be manifold. Some changes may result from economic hardship in the health care business and a decline in the necessary workforce, both in the wake of the pandemic and as a consequence of preexisting trends [30, 31, 51].

Pre- and postgraduate training and CME offerings were grossly or even totally suspended at the peak of the COVID-19 lockdown. Bedside teaching is essential for attracting future neurologists and for giving them an understanding of the capabilities and responsibilities of our discipline. Likewise, medical student rotations were almost entirely stopped during lockdown periods. This was an understandable measure, as the health care system came to limits at many levels, and social distancing measures needed to be implemented for the safety of patients, students, and health care workers. Digital educational formats sometimes entirely replaced in-person teaching activities [52]. Continuing with a mixed model seems advantageous, particularly for niche subspecialties, which are usually underrepresented in clinical curricula [53]. The COVID-19 restrictions also significantly impacted residents' rotations. Our results align with a recent European survey reporting that 41.9% of residents were confronted with suspended or delayed (63.4%) classes, and reduced time spent with neurological patients because of reassignments to clinical work in COVID-19 units [54]. Moreover, a systematic review of the pandemic's impact on neurology residency revealed increased stress levels among trainees, which points to the need for psychological support [55]. A cutback in postgraduate training is not specific to neurology and was observed across other specialties. The rapid reestablishment of postgraduate teaching in person and rotations reflects the importance of bedside teaching and learning. Congresses and conferences are now often organized in a hybrid format, which reduces travel times and expenses and does have certain additional advantages [28, 56]. Some clinical and scientific activities, however, remain in a virtual form. Employers and payers need to be aware of the spectrum of the newly established digital health care and education formats and allocate sufficient funds and time.

The COVID-19 pandemic has had and continues to have far-reaching effects on the global economy. Our survey disclosed direct consequences for neurological health care. The responders were aware of the financial hardship for patients to maintain neurological care, and reduced income for doctors and revenue for departments in the wake of the pandemic. Depending on the health care system, the lower number of patients in emergency wards and outpatient clinics translated to direct and indirect economic consequences for the health care system. In the meantime, the financial crisis also hit patients and caregivers, consequently affecting brain health. The reasons neurologists' income and departments' revenues remain lower than in the pre-COVID-19 period are likely to be diverse. First, we show that diagnostic and therapeutic services for neurological patients in various subdisciplines are still not at full pace, and therefore, remuneration is lower. Second, our responders indicate that one third of the patients cannot afford treatment, which likely impacts on the follow-up frequency. Third, the public health system is globally in a crisis. The health care workforce had already been in turmoil before the pandemic, and the number of physicians and nurses remaining in public hospitals substantially diminished in the course of the pandemic [30, 31, 51]. This trend could hamper the reestablishment of certain neurological services to pre-COVID-19 levels. On the other hand, the pandemic made an unprecedented hole in the budget, and spending reviews may not prioritize expenses for some neurological subdisciplines. These premises may be, for instance, a significant reason for the slow recovery of neurorehabilitation services, as disclosed in our survey. The transformation of neurorehabilitation clinics to COVID-19 care facilities has left a lasting impact due to delayed delivery of required services and expanded waiting lists for patients with neurological conditions.

Our study has limitations, and the findings need to be reassessed in independent surveys and followed up. The survey provided a global view based on responses from primarily hospital-based neurology trainees and neurologists with a broad spectrum of expertise. The number of respondents, however, does not allow a subanalysis for countries or neurological subspecialties. The respondents provide their impressions, not only from their medical but also from the patient's perspective. The survey represents the EAN community distribution and has limited coverage in the African and Asian continents. Lockdowns, associated restrictions, and recovery may have been distinct in countries of the world. Also, it can be anticipated that the situation from early 2023 will have undergone further transitions in the meantime and should be reassessed. Another limitation may be the bias due to the uneven distribution of the subspecialties and the assumption that some respondents may have been from the same institution. However, the range of neurology subspecialties covered is quite comprehensive and again reflects the clinical expertise within the EAN community.

CONCLUSIONS

Our study showcased the significant impact of severe COVID-19 lockdown periods on professional, educational, and economic aspects of neurological health care. Although curricular training recovered in the meantime and CME is continued in a hybrid format, there are remaining gaps in health care for people with neurological disorders. Some neurological subspecialties are having more difficulties in recovering, which may also be related to prepandemic health care underfunding due to the consequences of the worldwide economic crisis. Insufficient attention to brain health can exert a substantial financial and developmental toll on all global populations and economies. The observed continued limitations for the delivery of neurological care threaten brain health and call for action on a worldwide scale. As a first step, our findings must be confirmed locally and then discussed with the responsible authorities and bodies.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

FUNDING INFORMATION

The EAN provided the open access fee. No other funding was received.

ETHICS STATEMENT

The study is based on an online survey, and did not involve healthy people or patients. Thus, no ethical approval was required.

DATA AVAILABILITY STATEMENT

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

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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