Indian J Med Res 159, June 2024, pp 557-566
DOI: 10.25259/ijmr_30_23

Quick Response Code:

COVID-19 pandemic & neurosciences in India- the CoINstudy: Impact of the pandemic on research related to the neurosciences

M.M. Samim[1], Makarand Pantoji[2], Divya K.P.[5], Harsh Deora[3], Abhinith Shashidhar[3], Jitupam Baishya[6], Divyani Garg[7], Arunmozhimaran Elavarasi[8], Bhavya Pahwa[9], Urvakhsh Meherwan Mehta[2], Sai Krishna Tikka[10], Vaibhav Wadwekar[11], Souvik Dubey[12], Kshiteeja Jain[1], Binukumar Bhaskarapillai[4], L.G. Viswanathan[1] & Ajay Asranna[1]

Departments of [1]Neurology, [2]Psychiatry, [3]Neurosurgery & [4]Biostatistics, National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, [5]Department of Neurology, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, [6]Department of Neurology, Postgraduate Institute of Medical Education and Research, Chandigarh, [7]Department of Neurology, Vardhman Mahavir Medical College & Safdarjung Hospital, [8]Department of Neurology, All India Institute of Medical Sciences, [9]University College of Medical Sciences and Guru Teg Bahadur Hospital, New Delhi,[10]Department of Psychiatry, All India Institute of Medical Sciences, Bibinagar, Telangana ,[11]Department of Neurology, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry,[12]Department of Neurology, Bangur Institute of Neurosciences, Institute of Postgraduate Medical Education & Research and Seth Sukhlal Karnani Memorial Hospital, Kolkata, West Bengal, India

Received January 7, 2023

***Background & objectives*: We aimed to assess the impact of COVID-19-related disruptions on ongoing and future projects related to neuroscience research and young researchers in India.**

***Methods*: We conducted a countrywide online survey using a structured, self-administered questionnaire involving medical trainees, post-doctoral fellows, PhD students, early career faculty members and basic neuroscience researchers. The purpose was to assess the impact of the COVID-19 pandemic on the respondents' ongoing/planned research activities and capture their concerns related to future research.**

***Results*: Five hundred and four valid responses were analyzed. More than three-fourths of the respondents were in their early careers – 64.1 per cent were resident doctors, and 19.8 per cent were early career consultants. Maximum responses were received from respondents working in neurology (228; 45.2%), followed by psychiatry (192; 38.1%) and neurosurgery (49; 9.7%). More than three-fourths [83.5%, 95% confidence interval (CI): 0.8–0.867] of the respondents reported that the pandemic had affected their research. About one-third of the respondents (171; 33.9%) reported delays in completing research studies. Respondents adapted to the pandemic's circumstances by making methodological changes**

The field of neurosciences is ever-evolving, fuelled by a surge in interest and diversification in interdisciplinary research[1]. This trend is well-identified and reported among Indian investigator involved in

in their research (155; 30.8%). Most respondents (301; 59.6%) reported being diverted from their traditional work settings to COVID-19-related clinical services. Respondents conducting prospective studies and randomized controlled trials and those diverted to COVID-related services were significantly more likely to report the adverse research impact.

***Interpretation & conclusions*: In our survey, an overwhelming majority of the respondents reported that the pandemic adversely impacted their study. This trend was independent of sex, designation, and research output of individual subjects. The serious impact of the COVID-19 pandemic on neurosciences research warrants the attention and concerted efforts of the research supervisors, institutional heads, funding agencies and other stakeholders.**

Key words Pandemic - research impact - neuroscience research

neuroscience research[2,3]. India accounts for two per cent of the world's annual research papers related to neuroscience[4,5].

COVID-19 has caused global disruptions in health research, prompting numerous studies worldwide to investigate its impact on research-related aspects. The National Institutes of Health (NIH) surveyed 45,348 NIH-funded researchers, 50 per cent of whom said the epidemic negatively affected their careers[6]. Surveys from USA and Europe found a decrease in working hours[7]. Among 10,408 UK researchers surveyed, 40 per cent reported a reduction in working hours, with early career researchers being more likely to experience this decrease[8]. Gao *et al*[9] conducted surveys between April 2020 and January 2021 and found that although the immediate impact of the pandemic on scientists' research schedules appeared to have diminished, there was a decline in the initiation of new projects. In a survey by Rijs *et al*[10], 47 per cent opined that they would be left with less funding. Various studies have shown a disproportionate impact on women and parents involved in medical as well as non-medical research[9,11].

The intense focus on COVID-19 research diverted resources from other critical areas and has been termed "Covidization of research"[12]. Raynaud *et al*[13] conducted a meta-research study on publications in high-impact journals that showed an 18 per cent decrease in the production of non-COVID research compared to the dramatic rise in publications related to COVID-19. Similarly, other studies reported that one-third of respondents shifted their focus to COVID-19-related research[7].Riccaboni *et al*[14] found that COVID-19-related medical subject headings (MeSH) of published articles on PubMed witnessed a 6.5-fold increase, while publications with other MeSH terms dropped by 10-12 per cent. Clinical trial publications had been displaced and grants had been diverted from research areas unrelated to COVID-19.

These developments have negatively affected research related to neuroscience and its application to preventive and therapeutic strategies. Neuroscience research tends to be inherently complex and resource intensive, requiring inter-disciplinary collaboration, a combination of theoretical and experimental approaches and dedicated infrastructure. Hence, disruptions related to any of these factors can have a deleterious impact. Very few studies have formally analysed this aspect. The Resident and Research Fellow Section of the European Academy of Neurology was surveyed to analyze the effect of the COVID-19 pandemic on neurology training and research; 62 per cent of the 227 respondents stated that their residency programme's research efforts had been impacted, mostly attributable to the inability to undertake in-person visits[15].

Though the immediate threats of the pandemic have waned, the looming threats of such events and waves of infection remain. Systematically studying the impact of them on research can help develop strategies to mitigate these adversities in the future. This is particularly imperative for early career researchers since any negative effects of pandemic or similar catastrophic events can adversely affect their future career prospects. Through this study that we titled as the CoINstudy (COVID-19 pandemic and neurosciences in India study), we plan to assess the impact of COVID-19-related disruptions on neuroscience research with a structured questionnaire survey disseminated *via* online, electronic modes of communication. The specific objectives were to study the impact of the pandemic on ongoing or planned research activities, type of research, adaptations necessitated, and funding. We also aimed to understand the personal impact

on researchers, future concerns, and their views on presenting their research.

Material & Methods

The study was undertaken at the department of Neurology, National Institute of Mental Health and Neurosciences, Bengaluru between December 2022 and March 2023 after obtaining approval from the Institute Ethics Committee. Informed consent was sought before starting the survey. We adhered to the checklist for reporting results of internet E-surveys recommendations for describing the methodology and results of our survey[16].

Survey questionnaire: We designed a structured, self-administered online questionnaire to assess the impact of COVID-19 on ongoing and future research projects. Based on the information sought, we framed a combination of dichotomous (10 questions), multiple choice (23 questions), and open-ended questions (7 questions). The questionnaire had a total of 44 questions to satisfy the objectives—personal details (8 questions), academic history (4 questions), ongoing/ planned research activities (4 questions), the impact of COVID on research, and future concerns regarding neuroscience research (9 questions), personal impact on researchers (5 questions), research funding (6 questions), and views on participation and presentation in conferences/virtual meetings (8 questions). We used a Likert scale for four questions. Eighteen questions had an option of answering *via* open-ended questions in addition to multiple-choice questions. Fifteen questions vital to achieving the study's objectives were pre-identified by consensus among investigators and marked with an asterisk '*'. If any of these questions were left unattended, the data were considered inadequate and were not included in the final analysis. The average survey time was 8-10 min. The respondents could review their answers and change their responses before submitting the survey but not after clicking the "submit response" button.

Validation and pilot testing: Two neurologists, two neurosurgeons, and one psychiatrist reviewed the questionnaire for content and face validity. We pilot tested the questionnaire with 10 rounds of dummy completions and 15 people of various designations and departments to identify errors. Necessary changes were made to improve the clarity and coherence of the questions. An online link to the final questionnaire was prepared and tested with 10 dummy rounds to ensure an accurate collection of responses. Duplicate submissions having the same name, email id, and personal identifiers were removed.

Study population: The study participants included residents undergoing post-graduate training (MD, DM & DNB), post-doctoral fellows (PDFs), Ph.D. students, and faculty members/consultants working either in clinical settings or pursuing research in the fields related to neuroscience, *i.e.*, neurology, neurosurgery, psychiatry, neuro-anaesthesia, neuroradiology and neuropathology and those involved in active research. The participants were affiliated with various medical institutes, medical colleges, and government and private hospitals all over India. The participants who attained their last qualifying degree ≤5 yr from responding to the survey were defined as early career consultants. We excluded participants who pursued research projects outside the scope of neuroscience.

Sample size estimation: Assuming that 50 per cent of the young researchers' activities were affected by COVID-19, with five per cent absolute precision and 95% confidence level, the minimum required sample size was 385. After accounting for a non-response rate of 20 per cent, the sample size was 482 and rounded to 500.

Dissemination of survey: Eligible participants were approached *via* electronic mail and social media platforms. The public websites of individual colleges, personal acquaintances, and social media groups were used to recruit eligible participants. In case of no response, a reminder mail/message was sent after two weeks to elicit a response. No incentives were given, financial or otherwise, for filling out the survey forms. The survey results were accepted between December 2021 and March 2022.

Statistical methods: Data normality was checked using the Kolmogorov-Smirnov test. The Chi-square and Fisher's exact tests were used for quantitative analysis. The influence of various independent variables on the polychotomous outcome variable was checked using multinomial logistic regression, whereas bivariate logistic regression was used for binary outcome in the dependent variable.

Results

Demographic profile: A total of 526 responses were received. There were 22 incomplete responses and

Table I. Baseline characteristics of the respondents (n=504)

Variable	n (%)
Sex	
Male	291 (57.7)
Female	213 (42.3)
Designation	
Medical resident	323 (64.1)
Early career consultant <5 yr	100 (19.8)
PhD & academic researchers	37 (7.3)
Senior faculty/Consultant	44 (9.8.)
Specialty	
Neurology	228 (45.2)
Psychiatry	192 (38.1)
Neurosurgery	49 (9.7)
Other	35 (6.9)
Number of publications	
<5 publications	130 (25.7)
5–10 publications	35 (06.9)
>10 publications	36 (07.1)
No previous publication/unspecified	303 (60.1)
COVID-19 infection & related events	
Quarantined	311 (61.7)
Infected	193 (38.3)
COVID19-related disruptions at the workplace diverted to COVID19-related services	301 (59.7)
Ongoing involvement in research work	
Involved in a single study	426 (84.5)
Involved in multiple studies	78 (15.5)

two duplicate responses, which were excluded. Valid responses from 504 survey participants were analyzed. The demographic and research profile of the respondents is given in Table I. Consistent with our focus on early career researchers, more than three-fourths of the respondents were in their early career –64.1 per cent were resident doctors, and 19.8 per cent were early career consultants who were involved in research. The highest responses were received from respondents working in neurology (228; 45.2%), followed by psychiatry (192; 38.1%) and neurosurgery (49; 9.7%). Seven respondents (1.4%) were involved in research in basic neurosciences, six respondents (1.2%) were working in neuroradiology, five respondents (1%) in neuro-anaesthesia, and three (0.6%) in speech and language neurosciences. The survey mostly represented the researchers from clinical neurosciences background.

At the time of the survey, most of the respondents were conducting prospective studies (197; 39.1%) followed by retrospective studies (121; 24%), clinical surveys (110; 21.8%), cross-sectional studies (89; 17.7%), randomized controlled trials (45; 8.9%), and systematic reviews (7; 1.4%). While most respondents were engaged in neuroscience research, (101; 19.9%) respondents also said they were engaged in a COVID-based study unrelated to neurosciences. Most of these studies were non-funded projects (326; 64.7%). In contrast, 107 funded projects ongoing, 57 (11.3%) were funded by the host institution of the respondent, and external funding agencies were available for 60 (11.9%) studies.

Effect of COVID-19 on neuroscience research:

(a) Impact on ongoing studies: Most respondents agreed that COVID-19 had adversely affected their research. A majority (333; 66%) reported delays in completing research studies owing to the pandemic. The distributions of respondents reporting an adverse research impact and delays in research are given in Table II. Some respondents were involved in more than one research project. During analysis the entire sample was divided into two distinct groups; those pursuing single studies and those conducting multiple studies. For analysis of the impact of the pandemic, including whether respondents were affected or faced delays, we specifically considered those conducting single studies for subgroup analysis (n=426, 84.5%). This group comprises individuals involved in only one type of study, allowing us to assess the pandemic's effects on their research more accurately.

Those conducting randomized controlled trials, prospective and retrospective studies, and those diverted to COVID-related services were more likely to report delays in research (Table II). Delays were attributed chiefly to decrease in patient numbers (298; 59%) and restrictions related to testing (128; 25.4%). The reasons attributed to these delays among respondents of various designations, specialties, and types of studies are presented in Table III. Multiple logistic regression analysis revealed that delays in the research were significantly correlated with randomized controlled trials [odds ratio (OR) 2.68, 95% confidence interval (CI): 1.03-6.93, *P* value 0.042], prospective case-control studies (OR 1.57, 95 % CI: 0.97-2.56, *P* value 0.075) or those diverted to COVID-related services (OR 1.89, 95% CI: 1.24-2.88, *P* value 0.03).

Table II. Person and study-specific factors influencing research impact and delays in research (n=504)

Factors	COVID-19 pandemic impact on research			Faced delay due to the pandemic		
	Affected (n=421), n(%)	Not affected (n=83), n(%)	*P* value	Faced delay (n=333), n(%)	Didn't face a delay (n=171), n(%)	*P* value
Female gender	178 (42.3)	35 (42.2)	0.985	134 (40.2)	79 (46.2)	0.2
Designation						
Medical resident	275 (65.3)	48 (57.8)	0.085	212 (63.7)	111 (64.9)	0.489
Early career consultant <5 yr	76 (18.1)	24 (28.9)		62 (18.6)	38 (22.2)	
PhD & academic researchers	33 (7.8)	4 (4.8)		27 (8.1)	10 (5.8)	
Senior faculty/Consultant	37 (8.8)	7 (8.4)		32 (9.6)	12 (7)	
Specialty						
Neurology	186 (44.2)	42 (50.6)	0.059	148 (44.4)	80 (46.8)	0.573
Psychiatry	168 (39.9)	24 (28.9)		125 (37.5)	67 (39.2)	
Neurosurgery	35 (8.3)	14 (16.9)		33 (9.9)	16 (9.4)	
Other clinical neurosciences	24 (5.7)	2 (2.4)		19 (5.7)	7 (4.1)	
Other basic neurosciences	8 (1.9)	1 (1.2)		8 (2.4)	1 (0.6)	
Pre-pandemic research output						
No previous publications/Unspecified	254 (60.3)	49 (59)	0.358	192 (57.7)	111 (64.9)	0.367
<5 publications	113 (26.8)	17 (20.5)		91 (27.3)	39 (22.8)	
5–10 publications	27 (6.4)	8 (9.6)		23 (6.9)	12 (7)	
>10 publications	27 (6.4)	9 (10.8)		27 (8.1)	9 (5.3)	
COVID-19 infection and related events						
Quarantined (n=311)	260 (61.8)	51 (61.4)	0.034	212 (63.7)	99 (57.9)	0.122
Not quarantined (n=193)	161 (38.2)	32 (38.6)		121 (36.3)	72 (42.1)	
Infected	201 (47.7)	42 (50.6)	0.101	168 (50.5)	75 (43.9)	0.161
Not infected	220 (52.3)	41 (49.4)		165 (49.5)	96 (56.1)	
COVID19-related disruptions at the workplace						
Diverted to COVID-related services (n=301)	261 (62)	40 (48.2)	0.046	216 (64.9)	85 (49.7)	0.001
Not diverted to COVID-related services (n=203)	160 (38)	43 (51.8)		117 (35.1)	86 (50.3)	
Ongoing involvement in research work*						
Involved in a single study (n=426)	355 (84.3)	71 (85.5)	0.869	279 (83.8)	147 (86)	0.603
Involved in multiple studies (n=78)	66 (15.7)	12 (14.5)		54 (16.2)	24 (14)	
	Affected (n=355), n(%)	Not affected (n=71), n(%)	*P* value	Faced delay (n=279), n(%)	Didn't face a delay (n=147), n(%)	*P* value
Nature of ongoing research projects among single study type group (n=426)*						
Randomized controlled trial	28 (7.9)	5 (7)	0.808	27 (9.7)	6 (4.1)	0.04
Prospective case–control studies	130 (36.6)	16 (22.5)	0.023	106 (38)	40 (27.2)	0.032
Retrospective case–control studies	55 (15.5)	27 (38.1)	<0.001	39 (14)	43 (29.2)	<0.001
Clinical survey-based studies	70 (19.7)	13 (18.3)	0.871	56 (20.1)	27 (18.4)	0.702
Cross-sectional studies	59 (16.6)	8 (11.3)	0.29	42 (15)	25 (17)	0.675
Systematic reviews	13 (3.7)	2 (2.8)	0.159	9 (3.2)	6 (4.1)	0.061

*Only respondents with a single type of study were analyzed

Table III. Reasons for delays in research studies during the COVID-19 pandemic (n=333)

	Reasons for delays					
	Consent refusal (n=69)*, n(%)	Decrease in patient number (n=298), n(%)	Testing restrictions (n=128), n(%)	Loss of follow-up (n=42), n(%)	Funding constraints (n=2), n(%)	Methodological changes (n=155), n(%)
Designation						
Medical resident	33 (47.8)	187 (62.8)	85 (66.4)	18 (42.9)	01 (50)	92 (59.4)
Early career consultant <5 yr	17 (24.6)	57 (19.1)	24 (18.8)	14 (33.3)	1 (50)	32 (20.6)
PhD & academic researchers	6 (8.7)	24 (8.1)	11 (8.6)	4 (9.5)	0 (0)	17 (11)
Senior faculty/Consultant	13 (18.8)	30 (10.1)	8 (6.3)	6 (14.3)	0 (0)	14 (9)
Specialty						
Neurology	32 (46.4)	134 (45)	57 (44.5)	39 (92.9)	0 (0)	63 (40.6)
Psychiatry	24 (34.8)	112 (37.6)	51 (39.8)	0 (0)	0 (0)	65 (41.9)
Neurosurgery	3 (4.3)	33 (11.1)	13 (10.2)	0 (0)	1 (50)	11 (7.1)
Other clinical neurosciences	10 (14.5)	18 (6)	6 (4.7)	3 (7.1)	1 (50)	14 (9)
Other basic neurosciences	0 (0)	1 (0.3)	1 (0.8)	0 (0)	0 (0)	2 (1.3)
Nature of ongoing research projects						
Randomized controlled trial	8 (11.6)	34 (11.4)	11 (8.6)	1 (2.4)	0 (0)	19 (12.3)
Prospective case–control studies	27 (39.1)	134 (44.9)	62 (48.4)	20 (47.6)	1 (50)	63 (40.6)
Retrospective case–control studies	14 (20.3)	60 (20.1)	28 (21.9)	13 (31.0)	0 (0)	32 (20.6)
Clinical survey-based studies	19 (27.5)	70 (23.5)	27 (21.1)	11 (26.2)	0 (0)	49 (31.6)
Cross-sectional studies	9 (13)	43 (14.4)	22 (17.2)	4 (9.5)	0 (0)	49 (31.6)

*Several respondents may have encountered one or more issues causing delays in their research. The reported may not align directly with the number of affected respondents, as some individuals were engaged in multiple projects

(b) Adaptations necessitated by the COVID-19 pandemic: About one-third of the respondents (155; 30.8%) adapted to the pandemic circumstances by making methodological changes in their research. This involved a reduction in the sample size of their study (n=122; 24.2%) and converting physical follow-up to virtual follow-up (n=116; 23%). Fifty respondents (9.9%) had to stop their study prematurely, 47 (9.3%) had to change their topic completely, and 22 (4.4%) respondents changed the subject of their research to a topic related to COVID-19. The distribution of methodological changes made among respondents of various designations, specialties and types of studies can be found in Table IV.

(c) Impact on grants and funds for research projects: About 110 respondents (21.8%) reported failed grant applications. However, only a minority (n=23; 20.9%) attributed this to pandemic-related reasons. Fifty-one respondents (10.1%) reported delays in releasing funds, while 27 (5.4%) reported cancellation of funds after the onset of the pandemic.

(d) Concerns regarding ongoing research: Most respondents (350; 69.4%) expressed concerns regarding ongoing research studies due to the impact of the pandemic. Specifically, these concerns pertained to patient recruitment (n=240; 47.6%), timely completion of surveys (n=171; 33.9%), and reliability of the data due to methodological changes that were needed (n=133, 26.4%) to collect data.

Personal impact of COVID-19 on researchers: At the time of the survey, 243 (48.2%) respondents reported having been infected by COVID-19 at some point, while 311 (61.7%) had been quarantined. One-third of the respondents (157; 31.2%) felt that this impacted their research, while 73 (14.5%) thought it may have affected their research to some degree. Most respondents (301;59.6%) reported being diverted from their regular work settings to COVID-19-related clinical services. Approximately one-third of the respondents (158; 31.3%) reported that they had comparatively less time for research activities during the pandemic. Most respondents reported no difference

Table IV. Various methodological changes that were made in conducting research studies during the pandemic

Factors	Methodological changes				
	Premature termination (n=50)*, n(%)	Topic changed (n=47), n(%)	Converted to retrospective (n=42), n(%)	Physical to virtual (n=116), n(%)	Changed to COVID19-related study (n=22), n(%)
Designation					
Medical resident	28 (56)	35 (74.5)	28 (66.7)	73 (62.9)	17 (77.3)
Early career consultant <5 yr	14 (28)	6 (12.8)	10 (23.8)	18 (15.5)	1 (4.5)
PhD & academic researchers	3 (6)	2 (4.3)	3 (7.1)	12 (10.3)	1 (4.5)
Senior faculty/Consultant	5 (10)	4 (8.5)	1 (2.4)	13 (11.2)	3 (13.6)
Specialty					
Neurology	24 (48)	16 (34.0)	14 (33.3)	49 (42.2)	6 (27.3)
Psychiatry	17 (34)	19 (40.4)	17 (40.5)	42 (36.2)	10 (45.5)
Neurosurgery	6 (12)	11 (23.4)	8 (19)	16 (13.8)	6 (27.3)
Other clinical neurosciences	2 (4)	1 (2.1)	3 (7.1)	9 (7.8)	0 (0)
Other basic neurosciences	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Nature of ongoing research projects					
Randomized controlled trial	5 (10)	9 (19.1)	6 (14.3)	14 (12.1)	5 (22.7)
Prospective case-control studies	22 (44)	21 (44.7)	18 (42.9)	42 (36.2)	10 (45.5)
Retrospective case-control studies	12 (24)	10 (21.3)	-	8 (6.9)	-
Clinical survey-based studies	16 (32)	14 (29.8)	6 (14.3)	45 (38.8)	9 (40.9)
Cross-sectional studies	8 (16)	6 (12.8)	-	11 (9.5)	1 (4.5)
COVID-19 infection and related events					
Quarantined	31 (62)	34 (72.3)	29 (69)	73 (62.9)	17 (77.3)
Infected	20 (40)	34 (72.3)	26 (61.9)	53 (45.7)	17 (77.3)
COVID19-related disruptions at the workplace					
Diverted to COVID-related services	36 (72)	34 (72.3)	23 (54.8)	70 (60.3)	17 (77.3)

*The reported numbers may not directly correspond to the number of affected respondents, as some individuals were involved in multiple projects

in the time available for research (n=235; 46.6%), while 105 (20.8%) had more time to pursue research due to the reduced clinical workload compared to the pre-pandemic times.

Impact of COVID-19 on presentation of research: Several conferences were cancelled or postponed during the initial phase of the pandemic. The medical community adapted to the scenario by shifting to an online mode of meetings with virtual talks, posters, and platform presentations. We assessed the experience of respondents with virtual conferences using a Likert Scale. One-third of the respondents (164; 32.5%) reported presenting their research at a virtual conference, and 358 (71%) attended a virtual conference as a delegate, most of whom reported a pleasant experience. Many respondents felt it was easier to present their research during the pandemic than during pre-pandemic times, mostly attributable to the convenience of virtual conferences (183; 36.3%). The commonest cited reasons for difficulties in the presentation were cancellation/postponement of conferences (87; 17.3%), delay in completing studies (56; 11.1%), and funding issues (20; 4%).

Similarly, several webinars and online discussion platforms were conducted for continued medical education during the pandemic. Approximately one-third of the respondents (157; 31.2%) affirmed that it helped their research, 169 (33.5%) felt that it somewhat helped in their research, and 81 (16.1%) thought that it was not helpful.

Future concerns on neuroscience research: Many respondents (241; 47.8%) felt that most of the research

in the future would be in the online format, like surveys, due to COVID-related logistic issues. Others (183; 36.3%) felt concerned about publication, as most publications would be centred around COVID-19 research. One hundred and twenty six (25%) of the respondents predicted a delay in procuring ethical approval for studies. More respondents (145; 28.8%) foresaw a decrease in funding opportunities for research related to the neurosciences in the future, whereas 38 (7.5%) respondents felt the funding opportunities would remain the same.

Discussion

In our survey of 504 participants involved in research related to neurosciences in India, an overwhelming majority reported that the pandemic adversely impacted their study. This trend was independent of sex, designation, and past research output of the participants. Respondents conducting randomized controlled trials, case-control studies or those diverted to COVID-related services were more likely to report pandemic-related delays in research. As per author knowledge this is the first such survey from the region and provided valuable insights.

Gao *et al*[9] performed a survey-based analysis among American and European scientists across a wide range of scientific fields. They found that there was an overall decline in research productivity that was evaluated in terms of total work time (5%), new publications (9%), new submissions (15%), and new projects (36%)[7]. However, specific analyses on neuroscience researchers were not available. We saw a similar decline in the productivity of our respondents. Although they were primarily healthcare workers, the decrease in the research seemed to be homogenous all over the globe. About 60 per cent of the respondents reported being diverted to COVID-19-related clinical services, and one-third of the respondents in our study reported time constraints for research activities.

Previous reports had pointed to a disproportionate impact of the pandemic on women researchers, as they were more likely to be involved in childcare[17,18]. Some analyses had shown a decline in research and publications among women academics compared to their male peers[8,17,18]. Though no such difference was noted in our study, our observations on this topic were uncertain as we did not collect information on the care giving responsibilities, marital status, and familial conditions of the respondents.

About 20 per cent of the respondents were also engaged in a COVID-based study unrelated to neurosciences. In contrast, a minority (22; 4.4%) changed the subject of their research to a COVID-19-related topic, reflecting an adaptation to changing research interests.

Study designs that required patient interaction, like randomised controlled trials and prospective studies, were significantly delayed (Table III), with inadequate patient recruitment being the chief reason. Methodological changes were necessitated in one-third of the studies, mainly a reduction in the sample size, conversion to virtual follow-ups, and conversion of prospective studies to a retrospective design. Neurology and psychiatry were the most affected specialties (Table II). These findings aligned with the expectations and hinge on the nature of the studies, where not all adaptations might be viable, posing a potential risk of discontinuation. Though the magnitude of the pandemic's effect on the patients' mental health was immense, it was difficult to initiate new studies during the pandemic. Among the reasons for facing research delays, neurosurgery had a disproportionately higher number of respondents with difficulty in getting patient data due to decreased patient visits (68 *vs.* 58% in others) as elective surgeries were deferred[19].

Although methodological changes were inevitable, they could impact the quality of research and confound observations and results. They may have long-term implications on the research quality of studies during the pandemic and should be acknowledged while interpreting the results of published studies. Our survey showed that patient recruitment was one of the chief reasons for delays which necessitated various adaptations mentioned above. Though virtual follow-ups have increased, they are still very low compared to developed nations like the USA, where >80 per cent of the follow-up visits could be successfully converted to virtual[20].

Researchers worldwide have experienced delays in the release of funds or even cancelation of funds. Though most research projects in the current survey were not funded (64.7%), 15 per cent of the respondents reported funding delays in the current study. About 28.8 per cent of the respondents felt that funding opportunities might decrease. Funding agencies have an important role to play in alleviating these fears. The NIH and other funding organizations extended the time window for eligible trainees and early career

grant applicants, and institutions changed the deadlines for faculty evaluations and tenure decisions. The NIH also extended post-doctoral research funding by an additional year and provided additional funding for data losses and financial assistance for child and elder care. Bridge funds and additional awards were released to help researchers performing COVID-19-related research and those who were unable to work towards grant renewals[21,22].

About 71 per cent of the respondents in our study reported having attended an online conference as a delegate, while a third of them presented their research online. Most of them had a positive experience. However, the opinion was divided on whether virtual/hybrid conferences should replace in-person meetings in the future. The ease of presentation and reduced costs due to the online mode of meetings must be weighed against the hands-on experience and better networking opportunities offered by in-person conferences. In this respect, hybrid conferences offer a great solution by increasing the choices available to researchers.

Similarly, webinars are an important adaptation for continued medical and scientific education. In this study, most respondents (326; 64.7%) reported that webinars positively helped their research. A recent study[20] has shown that webinars benefitted respondents from Africa more than those in Europe. It is probable that the respondents from developed countries previously had access to a larger number of scientific meetings, which were now less accessible.

Some implications from the current study may be relevant to the future, even as the pandemic phase of COVID-19 appears to be ending. The lessons from the adaptations to study methodologies necessitated by the pandemic need to be factored in while designing new studies, like planning a strategy for a smooth transition to online modes of patient recruitment and evaluation in the event of a future pandemic scenario. Institutions should invest in the initiation and maintenance of infrastructure and training of personnel for more effective virtual interactions. Building online databases, improving remote access of data and providing software applications for better online communication to researchers is another important step. Policies that include relaxing the criteria or time window for grant applications, recruitments, thesis submission and faculty evaluations, especially those who had to be diverted to clinical duties, can ensure greater equity and provide a level playing field for those affected disproportionately. Funding agencies can take note of the concerns of researchers involved in neuroscience research and ensure that a balance is maintained in resource allocation.

In our study, most of the responses were from residents who were also engaged in clinical duties in the COVID wards, and the respondents were those who volunteered, which could have led to a selection bias. Furthermore, many participants were from one centre, which is also one of the premier centres for neuroscience research in India. We suspect that the real percentage decline in neuroscience research may be much more than the reported results in our study since many institutes had to pause research activities due to the pandemic, and this survey is lacking in that representation. Similarly, most respondents had a clinical neuroscience background, and this survey does not represent the impact on basic neuroscience research. The total number of participants who received the survey request was not known since they were shared through social media groups and their reach was difficult to quantify. Hence, the response rates and external validity are not entirely clear. The reliability of the questionnaire was not assessed extensively using measures like Cronbach's alpha. Despite these limitations, we believe that this study was an essential step toward quantifying the extent to which various aspects of neuroscience research had been affected by the pandemic and helped in exploring strategies and designing corrective processes to adapt to future pandemics.

***Financial support & sponsorship*:** None.

***Conflicts of Interest*:** Preliminary data of this study was presented as a poster at IANCON 2022, New Delhi, and a brief analysis of the complete participant dataset as a poster at the World Congress of Neurology 2023 in Montreal, Canada.

***Use of artificial intelligence (AI)-assisted technology for manuscript preparation*:** The authors confirm that there was no use of Artificial Intelligence (AI)-Assisted Technology for assisting in the writing of the manuscript and no images were manipulated using AI.

References

1. Yeung AWK, Goto TK, Leung WK. The changing landscape of neuroscience research, 2006-2015: A bibliometric study. *Front Neurosci* 2017; *11* : 120.
2. Bala A, Gupta B. Mapping of Indian neuroscience research: A scientometric analysis of research output during 1999-2008. *Neurol India* 2010; *58* : 35-41.

3. Dubey D, Sawhney A, Atluru A, Amritphale A, Dubey A, Trivedi J. Trends in authorship based on gender and nationality in published neuroscience literature. *Neurol India* 2016; *64* : 97-100.
4. Shahabuddin SM. Mapping neuroscience research in India – a bibliometric approach. *Curr Sci* 2013; 104 : 1619-26.
5. Madhugiri VS. Publication performance and research output of Neurology and Neurosurgery training institutes in India: A 5-year analysis. *Neurol India* 2015; 63 : 338-46.
6. National Institutes of Health.*The impact of the COVID-19 pandemic on the extramural scientific workforce – Outcomes from an NIH-led survey*. Available from: *https://nexus.od.nih.gov/all/2021/03/25/the-impact-of-the-covid-19-pandemic-on-the-extramural-scientific-workforce-outcomes-from-an-nih-led-survey/*, accessed on May 16, 2023.
7. Myers KR, Tham WY, Yin Y, Cohodes N, Thursby JG, Thursby MC, *et al*. Unequal effects of the COVID-19 pandemic on scientists. *Nat Hum Behav* 2020; *4* : 880-3.
8. Vitae releasing the potential researchers. *The impact of the Covid-19 pandemic on researchers in universities and research institutes*. Available from: *https://www.vitae.ac.uk/impact-and-evaluation/the-impact-of-the-covid19-pandemic%20on-researchers-in-universities-and-research-institutes*, accessed on May 16, 2023.
9. Gao J, Yin Y, Myers KR, Lakhani KR, Wang D. Potentially long-lasting effects of the pandemic on scientists. *Nat Commun Nature* 2021; *12* : 6188.
10. Rijs C, Fenter F. The academic response to COVID-19. *Front in Public Health* 2020; 8.
11. Squazzoni F, Bravo G, Grimaldo F, García-Costa D, Farjam M, Mehmani B. Gender gap in journal submissions and peer review during the first wave of the COVID-19 pandemic. A study on 2329 Elsevier Journals. *PLoS One* 2021; *16* : e0257919.
12. Pai M. Covidization of research: what are the risks? *Nat Med* 2020; *26* : 1159-1159.
13. Raynaud M, Goutaudier V, Louis K, Al-Awadhi S, Dubourg Q, Truchot A, *et al*. Impact of the COVID-19 pandemic on publication dynamics and non-COVID-19 research production. *BMC Med Res Methodol* 2021; *21* : 255.
14. Riccaboni M, Verginer L. The impact of the COVID-19 pandemic on scientific research in the life sciences. *PLoS One* 2022; *17* : e0263001.
15. Cuffaro L, Carvalho V, Di Liberto G, Klinglehoefer L, Sauerbier A, Garcia-Azorin D, *et al*. Neurology training and research in the COVID-19 pandemic: a survey of the Resident and Research Fellow Section of the European Academy of Neurology. *Eur J Neurol* 2021; *28* : 3437-42.
16. Eysenbach G. Improving the quality of web surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004; *6* : e34.
17. Harper L, Kalfa N, Beckers GMA, Kaefer M, Nieuwhof-Leppink AJ, Fossum M, *et al*. The impact of COVID-19 on research. *J Pediatr Urol* 2020; *16* : 715-6.
18. Nature Index. *The decline of women's research production during the coronavirus pandemic*. Available from: *https://www.natureindex.com/news-blog/decline-women-scientist-research-publishing-production-coronavirus-pandemic*, accessed on July 6, 2022.
19. Deora H, Sadashiva N, Tripathi M, Yagnick NS, Mohindra S, Batish A, *et al*. The aftermath of COVID-19 lockdown- Why and how should we be ready? *Neurol India* 2020; *68* : 774-91.
20. Ismail II, Abdelkarim A, Al-Hashel JY. Physicians' attitude towards webinars and online education amid COVID-19 pandemic: When less is more. *PLoS One* 2021; *16* : e0250241.
21. Schor NF, Cudkowicz ME, Banwell B. Academic neurology and the COVID-19 pandemic. *Neurology* 2023; *100* : 430-6.
22. NIH extramural nexus. *Reminder of COVID-19-related flexibilities for NIH grants*. Available from: *https://nexus.od.nih.gov/all/2021/09/24/reminder-of-covid19-related-flexibilities-for-nih-grants/*, accessed on May 27, 2023.

Corresponding author: Dr Ajay Asranna, Department of Neurology, National Institute of Mental Health and Neurosciences, Bangalore 560 029, Karnataka, India
e-mail: ajayasranna@gmail.com