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The Role of Social Media on the Research Productivity of Neurosurgeons During the COVID-19 Pandemic

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■ **BACKGROUND:** The COVID-19 pandemic committees of all countries restricted face-to-face interactions. This study aimed to determine how the pandemic changed the research output for many neurosurgeons while highlighting how social media may have been used as a contactless platform to maintain research productivity during these times.

■ **METHODS:** A cross-sectional, descriptive, 24-item, and non-randomized online survey was applied worldwide, and shared using social media platforms and emails. The questions mainly focused on comparing the results of the pre-pandemic period to the pandemic period (after March 2020).

■ **RESULTS:** A total of 202 respondents from 60 different countries responded to the survey. Interest in neurosurgical education increased from 24% to 76%, while the topic of epidemiology gained interest from 28% to 72% when the pre-pandemic era was compared to the pandemic era. Preference for prospective studies decreased from 66% to 34%, while interest in retrospective studies increased from 39% to 61%. In evaluating publication types, the preference for reviews increased from 36% to 64%. Sixty-two percent of the respondents stated they had concerns over delays in individual contributions/lack of accountability. These concerns were followed by problems with theft of intellectual property/data and authorship disputes. Forty-one percent believed that the support of extra hands on a load-heavy project was the most powerful benefit of social media collaboration. Those who reported increased

publications during the pandemic were also more likely to collaborate using social media ($P = 0.030$).

■ **CONCLUSIONS:** During the pandemic, social media collaborations helped increase research output for neurosurgeons.

INTRODUCTION

The COVID-19 pandemic has altered the day-to-day work practices of all health professionals, including neurosurgeons. Practices everywhere started seeing fewer patients, leading to decreased surgeries and postponed elective operations due to the lockdown and surgical regulations. Numerous institutions reported decreased trauma patients, probably as an effect of the lockdown.¹⁻⁸ Aside from the profoundly lucid effect of the pandemic on patient inflow, the effect of the pandemic on research efforts remains somewhat blurred. It was noted that between April 2019 and April 2020, there was a 76% drop-off for inpatient enrollment in neurological and neurosurgical clinical trials.^{9,10} Research labs had to be closed, protocols were deviated from, and funding support was lost.^{11,12} Certain funding agencies and charities had to curtail spending by nearly 30% as a result of the financial toll of COVID-19. One funding competition in Canada was canceled, leaving 2300 investigator-applicants questioning their research methods.¹³ Neurosurgeon-scientists in residency especially felt the constraining effects of being away from their lab research.¹⁴

Contrastingly, the pandemic did not leave all researchers marooned. The Australian Government had not cut any funding for

Key words

- Collaboration
- COVID-19
- Pandemic
- Productivity
- Research
- Scholarly collaboration network
- Social media

Abbreviations and Acronyms

NC: Neurosurgery Cocktail

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biomedical research, and allocated more of its assets toward COVID-19-related research. Certain private health entities have continued their research support to investigators unperturbed by the financial burden of the pandemic.¹³ Many have advocated and participated in remote research activities to work around the inaccessibility to labs and the limitations to clinical research.^{11,14,15} Despite having visiting rotations canceled and surgical exposure lessened, medical students interested in neurosurgery were still able to shine by engaging in research projects varying from reviews to patient-centered studies. Tosi et al. attributed a level of their research productivity to be due to their commitment to online collaborations.¹¹

Social media and other messaging platforms have allowed researchers to connect with others and collaborate on research projects while being socially distanced.¹⁶ On one occasion, an international venture concluded in the fast-tracking of a project, a patent application, and the generation of 2 manuscripts.¹¹ This is one such incident of how online collaboration was utilized during the pandemic to advance the known literature. It was recently found that 77.9% of neurosurgeons used social media to communicate their medical knowledge with colleagues.¹⁷ Apart from the networking aspect, the power of social media to recruit patients,^{18,19} receive patient feedback,²⁰ fund research,¹⁹ increase citations,²¹ and disseminate correct information on neurosurgical disease²² is already known. Though it has been explored in other science fields and specialties,²³⁻²⁶ no group has yet to assess scholarly collaboration in neurosurgery. Further, the research habits among neurosurgeons during the pandemic are also unknown. The present study attempts to discover how neurosurgeons globally have been conducting research during the pandemic and how social media might have helped in scholarly collaborations.

MATERIALS AND METHODS

A cross-sectional, descriptive, 24-item, and non-randomized online survey was created using Google Forms (<https://forms.gle/vUdhQckyMWiGiQXW6>). The CHERRIES guidelines for e-surveys were adhered to.²⁷ The link to the survey was deposited onto the largest social media page for neurosurgery, *Neurosurgery Cocktail* (NC).²⁸ NC is a private community composed primarily of neurosurgeons and those interested in the subject. Though it has amassed its predominant following on Facebook, its presence is continuing to grow across other social media as well. The authors of this manuscript also circulated the open survey using email and posted the survey link on other neurosurgical interest groups on Facebook, as well as on their ResearchGate and LinkedIn profiles. Those who frequently use ResearchGate can be described as passionate academics who like to share their recent projects and follow researchers whose work interests them. LinkedIn is a professional networking website that is not restricted to any specialty. Since both of the previously mentioned social media are non-specific to neurosurgery, we added an additional description that only requested neurosurgeons to participate. To increase the survey's reach and pique the participants' interest, we used the "hashtags" of neurosurgery, research, productivity, pandemic, COVID, and collaboration.

Due to the anonymized nature of data collection and the absence of patient involvement, the current study did not require ethics committee approval. The survey was created through several modifications of an initial 45-item survey. Keeping in mind the aspect of neurosurgery survey-fatigue,⁹ the survey was shortened to 24 items. The survey was then tested on a small group of neurosurgeons whose advice was used to strengthen the survey. Their responses were not included in the final data collection. Google Forms allows for an updated and automated data processing with each new response to the survey. Once participants opened the survey link, a 3-paragraph description provided details of who the investigators were, the purpose of the study, and the voluntary nature of participation. There were no incentives for participation.

The first 2 items of the survey, which dealt with gender and age, were the only mandatory items throughout the survey. Results were collected between January 23, 2022 (Sunday) and June 9, 2022. Since the majority of the results were going to come from NC, we released the survey and reminders for the same on Sunday at noon, during the busiest timezone of its usage, GMT +6.²⁸ Reminders for participation were sent out monthly after the initial notice. Adaptive questioning was not used. The survey consisted of 3 sections across 3 pages. The first page of the survey had 7 questions and addressed the participant demographic. The second page of the survey had 8 questions and probed the participants' research interests during the pandemic. The third page of the survey had 9 questions and asked the participants about using social media for research collaboration. Whenever the item asked the respondents to compare their habits before and during the pandemic, March 11, 2020 was used as a timestamp, since this was when the WHO director announced COVID-19 as a pandemic.²⁹ This date was generalized to March 2020 for convenience. Participants had to sign in to their Gmail accounts to fill out the survey, allowing for only one response per neurosurgeon. Before completing the survey, the participants could change their responses by going to the previous pages. All statistical analyses were performed on SPSS (SPSS Inc., Chicago, Illinois, USA).

RESULTS

A total of 202 respondents answered the survey, with a male predominance of 88% (177). The average age in years and standard deviation of the respondents were 36.6 ± 8.4 (18–67). Responses from 60 countries were received, with most of the responses being from India, Turkey, and Russia. Most of the respondents (41%) had 1–5 years of experience, while the least responses came from those with >20 years of experience (7%). Forty-two percent of the participants were consultants (85), 35% were residents (70), and 15% were faculty members (31). Most neurosurgeons worked in an academic setting (44%), while government and private practice followed with 20% and 14%, respectively. A majority of the respondents wanted more of a clinical importance over research (62%), whereas 33% stated that they would like an equal clinical and research focus, and only 5% wanted to focus more on research.

When areas of neurosurgical interest were compared before and during the COVID-19 pandemic, only 24% stated an interest in the

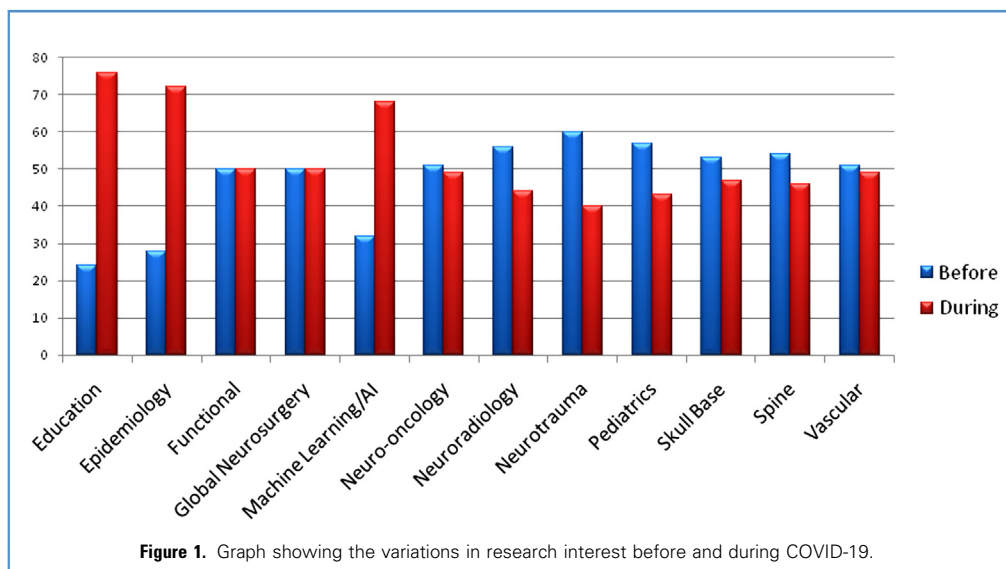
area of education before the pandemic. This value increased to 76% during the pandemic. Similar rates were observed in epidemiology with an increase from 28% before the pandemic to 72% during the pandemic. Interest in machine learning/AI (artificial intelligence) increased from 32% to 68%, whereas interest in neurotrauma decreased from 60% to 40% during the pandemic. Other areas of research did not have a major change in interest. **Figure 1** shows the fluctuations in research interest before and during the pandemic.

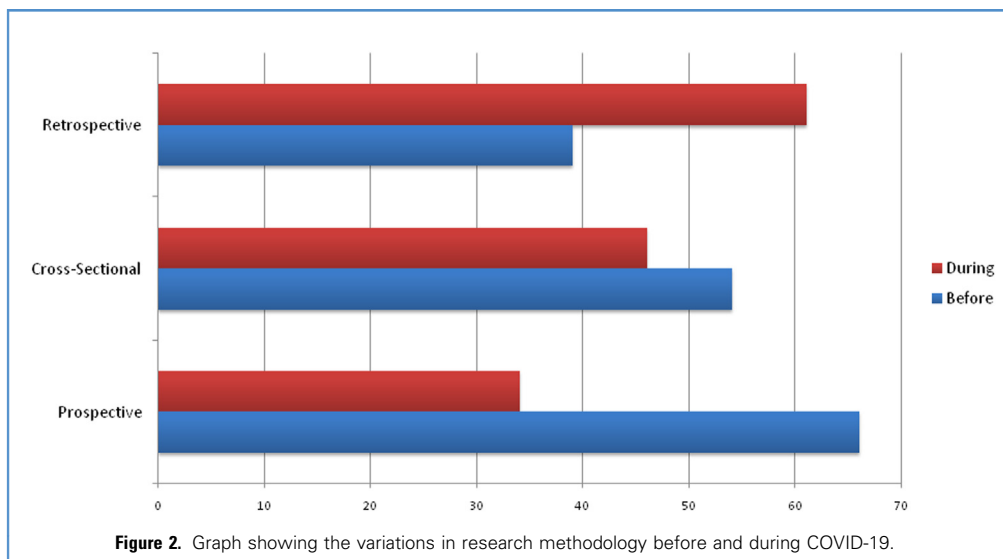
During the analysis of variations in preferences for research methodology, it was found that preference for prospective studies decreased from 66% to 34%. While preference for cross-sectional studies did not change greatly, interest in retrospective studies increased from 39% to 61% (**Figure 2**). No major change was observed regarding publication types such as case reports, editorials, letters, image/video reports, and original research, in accordance with the pandemic. However, the preference for review articles increased from 36% to 64%.

There was a lack of great variability in the number of publications when comparing the 2 periods. Thirty percent of the respondents stated that their number of publications increased. Thirty percent of the respondents also stated that their publications during this time decreased, while the remaining 40% stated it remained the same. Fifty-five percent of respondents stated that they did not author more publications of which face-to-face interactions were a prerequisite. Twenty-seven percent of the respondents have performed e-surveys during the pandemic. Only 19% of the respondents stated they had a research lab and that their collaboration with other labs did not change greatly during the pandemic. There was no significant difference in the usage of social media as a collaboration tool before the pandemic. Among those that used social media, the most preferred platforms were Facebook and ResearchGate. After March 2020, more than 50% of the respondents collaborated with researchers that they met using social media (**Figure 3**).

When participants were asked if they had ever recommended a researcher they met through social media as a peer reviewer, an overwhelming 67% responded no. Seventy-eight percent of the respondents stated that they did not have any dissatisfactory experiences while performing studies with colleagues they connected with through social media. Of the dissatisfactory experiences and concerns, 62% stated they had concerns over delays in individual contributions/lack of accountability, followed by theft of intellectual property/data and authorship disputes recorded at 28% and 13%, respectively. When evaluating the potential benefits of social media collaboration, 41% stated that it provided extra hands on a load-heavy project, and 24% stated that it would provide an opportunity to access other researchers' data. Eleven percent stated that research collaboration could allow for interaction with the experts of their research interest. Upon asking about the factors considered prior to collaborating in research with peers over social media, 32% responded by stating that the collaborators must have similar research interests, and 25% of the respondents stated that they evaluated the professional degree (i.e. M.D., Ph.D., and M.Sc.). Respondents were asked how they viewed the quality of social media collaboration to institutional collaboration. The 3 response groups reported similar results; 36% perceived social media collaboration to be of less quality, whereas 31% stated it to be the same, and 33% stated it to be of higher quality.

On performing subgroup analyses between the various questions, several interesting correlations were noted. When exploring whether demographics were implicated in amenability to social media related research, it was found that faculty were more likely to perform e-surveys than consultants or residents ($P = 0.025$). Faculty were also more likely to collaborate on social media than residents or consultants ($P = 0.008$). Consultants were more likely to use ResearchGate ($P = 0.041$) and those who self-identified as having a research predominant focus were more likely to use Twitter ($P = 0.013$) and ResearchGate ($P = 0.014$). Twitter was the





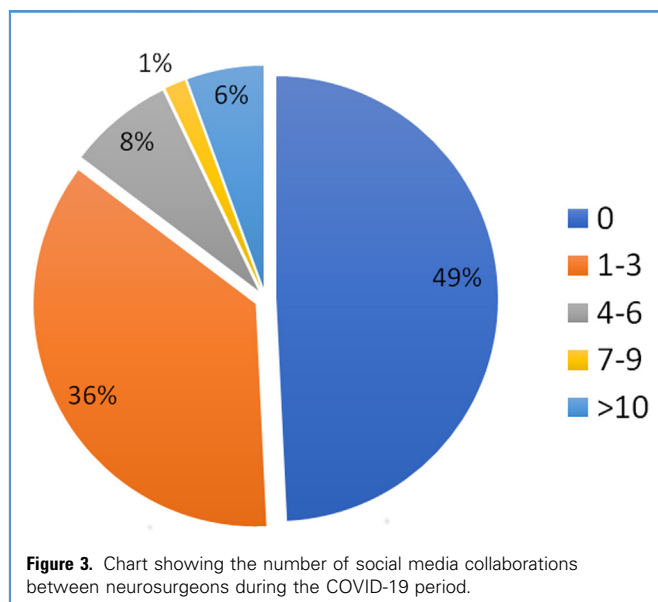
preferred social media page among those with greater experience ($P = 0.027$). Those who performed studies that did not require face-to-face interactions with patients were more likely to report increased publications ($P = 0.002$). Those who had more than 10 collaborations were more likely to have noted increased publications ($P = 0.005$). Finally, when collaborations using social media were converted into a bimodal variable (yes or no) and compared with the change in publication status during the pandemic, it was found that those who reported increased publications during the pandemic were also more likely to collaborate using social media ($P = 0.030$).

DISCUSSION

In this pilot study, we aimed to identify the impact of the pandemic on research productivity among neurosurgeons. In doing so, we present the first study investigating this domain of scholarly collaboration in this specialty. As seen in the current study and with other neurosurgical surveys, the responses were more likely to come from males.^{17,30} This is probably due to the greater number of males within neurosurgery.

LitCOVID is an offshoot page of the National Library of Medicine dedicated to all COVID-19 literature published since its inception in late 2019. When accessed on June 24, 2022, nearly 263,000 articles relevant to COVID-19 had been published with a 1-week record of 4405 articles published between August 24 and August 30, 2020.³¹ This record has yet to be broken. By using the keyword 'Neurosurgery' on the LitCOVID database on the date of submission and with no filters applied, 899 results came up with the most articles (328) published in *World Neurosurgery*. It may be interesting to know that the same keyword, when explored on the date of submission with the same controls, yielded 26,361 results in a PubMed search for articles published in 2018. From this mini-experiment, we may postulate that freed-up neurosurgeons were dealing with professional or personal obstacles that delayed their contributions to the field.

Unsurprisingly, there was a 44% spike in interest for epidemiology research during the pandemic than before. Before the pandemic, virology research constituted a mere 2% of all biomedical research. Many researchers shifted their focus to adapt to the current events causing this number to skyrocket to nearly 20%.³² It was also predictable that preference for review-based studies was given over other methodologies. This can be attributable to the convenience of performing studies, wherein existing data require an analysis. E-surveys allow for rapid data collection through widespread dissemination. Researchers may prefer this style of data collection during the pandemic since it allows for social distancing. NC has hosted 30 surveys related to the



pandemic.²⁸ It is likely that more are to come. Since most of the respondents did not have their own research lab, we believe that if surveyed again, those without labs would have used social media for research collaboration before and during the pandemic, more than any other sample.

Nearly 51% of our survey participants were involved in at least one research project with new researchers through social media, during the pandemic. Impressively, 6% of participants have participated in at least 10 research projects under the same circumstances. One-third of the participants recommended someone they met over social media as a peer reviewer. These responses provide value to the fact that social media is more than just socializing with media exchange. Hunter mentions a duo collaborating on a series of mycology papers and later meeting in person after being introduced to each other over ResearchGate.¹⁶ What is encouraging about the results obtained is that those who reported increased publications during the pandemic were more likely to have a higher number of social media collaborations. This displays the fast turnover rate with the research projects conducted via social media.

Forty-nine percent of the respondents have indicated that they have not participated in any new research projects with peers they have met through social media. This response is similar to the fact that 36% of respondents have mentioned that the academic quality of the research produced through social media collaboration is less than the work produced from institutional collaboration. We surmise that this response may be due to the overwhelming notion that, neurosurgeons believe that social media is mainly meant for socializing rather than collaboration. In a recently conducted survey, Philips et al.³⁰ analyzed social media for professional usage and found that 24.14% of neurosurgical trainees believed that social media had no value to the field. The same survey found that nearly 80% of trainees and neurosurgery residents preferred collaborations and networking to occur through conferences.³⁰ The reliance on conventional means to gain contacts, despite the ubiquitous nature of social media, points to the potential pitfalls of the latter for research collaboration.

In our study, most respondents believed that delays in individual contributions/lack of accountability were the biggest concern for collaborating on research projects through social media. Research projects may take months or even years to complete. A worrying (hypothetical) scenario is one where the authors who contributed the most are later informed by the automated email from a journal that they have been named as a middle author despite their hard work and previous agreement of higher authorship. This would explain the rationale of why some respondents believed that theft of intellectual property/data and authorship disputes lead to concerns for research collaboration. Of course, there are methods to combat these fraudulent practices, such as interfacing with a journal, but having to do so may dissuade honest users of the scholarly collaboration network from trusting future research propositions. Some lesser-mentioned concerns included fears of being ostracized for collaborating with an inexperienced researcher. Though the present study focused on social media collaboration, it is possible that issues of unfair authorship and some of the other previously mentioned concerns may translate into academic collaboration as well.

The present study was the result of social media collaboration. The primary authors (RSL, IB) met through Reddit, created this topic, and later involved BC, GEU, and MMH. All the authors in the present study have participated in at least 2 research projects through social media since the pandemic. We believe that initial discussions of authorship and the criteria required to fulfill that role must be had before pursuing a project. This will ensure contributions worthy of that particular authorship.

Compared to a previous study using NC,¹⁷ the present study had a grossly lesser number of responses. The strategic tactics we employed on NC to receive greater participants may have inadvertently reduced the participation. NC receives a total of at least 1400 posts, comments, and reactions each day.²⁸ The sheer volume of new posts could have buried the survey in the page, so the view rate may have been further reduced. We also felt that responses to the survey may have been involuntary and imposed if the survey was 'pinned' on the page. Our experience may add a separate dimension to conducting surveys on social media.

To reiterate, NC has been a host of 30 surveys during the pandemic alone.²⁸ At the time of submission of this article, BC has mentioned that 95 surveys are being coordinated through him on NC (unpublished data). Though we cannot speak about the response rate of each of those surveys being conducted, we propose that researchers and social media moderators observe a 'survey-free interval' to allow the study population to recuperate from being reinterrogated across different facets of neurosurgery. Perhaps a booking system could be created to schedule surveys, while respecting this interval. At the risk of halting the expansion of the known literature, this may be a solution to the specialty's survey fatigue.⁹ Analogous to how peer reviewers and editorial boards are being inundated by the deluge of papers,³² our neurosurgery colleagues are probably experiencing the same with respect to survey participation.

This study was limited, in that the responses predominantly came from users of NC. These results cannot accurately reflect the views held by our neurosurgeon colleagues from the West, since the users of NC mainly reside in Europe and Asia.²⁸ Collaboration with large neurosurgical societies such as the *American Association of Neurological Surgeons* and the *Congress of Neurological Surgeons* may have helped garner more of a response from Western neurosurgeons. In addition, we only focused on scholarly collaboration during the pandemic. Thus, the trends we identified may inflate the actual value of research performed through social media.

Researchers often differ in their thoughts on how, when, what, and where to publish. The results obtained may have been more reflective of those neurosurgeons that publish at a high volume—the quality of those publications is unknown. Future studies may consider analyzing altmetrics such as the journal's impact factor to which the products of social media collaboration have been sent to, as well as the number of citations the work has generated. Comparisons of the previously mentioned metrics between social media collaborated research and institutional research may help illuminate the superior form of research collaboration. As a byproduct, such a study may also reveal the academic quality of collaborations.

We chose not to inquire about how much of each article type (i.e. how many case reports, how many original studies) was published during the pandemic as this may not have been easily recollected by the participants and may be perceived as intrusive. The survey was created assuming that the respondent was well versed in using technology, and therefore the survey may not have represented research practices among neurosurgeons who have not used social media to collaborate. Studies also need to be performed to analyze scholarly collaboration among neurosurgeons sans social media usage. Such research ventures may truly elucidate the steadfastness and adaptability of this community as well as reveal the publishing ethos among neurosurgeons.

CONCLUSIONS

In modern times, the World Wide Web has been used by the medical community to connect with each other, share ideas, and engage in productive dialogue. By acting as an effective venue for scholarly collaboration, social media represents the web's most current adaptation allowing for progression of neurosurgery research. This is especially true due to the ongoing obstacles that

neurosurgeons had to face during the pandemic. The present study found that social media collaborations can increase research output and productivity. Further research needs to be performed to determine the academic quality of research born out of social media collaboration.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Raj Swaroop Lavadi: Conceptualization, Methodology, Investigation, Data curation, Writing - original draft, Writing - review & editing. **Ismail Bozkurt:** Conceptualization, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Mandara Muralidhar Harikar:** Investigation, Writing - review & editing. **Giuseppe Emmanuele Umana:** Investigation, Writing - review & editing. **Bipin Chaurasia:** Investigation, Writing - review & editing.

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