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The Implications of Virtual Learning on Plastic Surgery Education: A National Survey of Plastic Surgery Residents and Fellows

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Background: Graduate medical education during the COVID-19 pandemic has seen the shift to a "virtual learning" format in many aspects of training. The purpose of this study was to describe the perceived strengths and weaknesses of virtual learning compared with a conventional, in-person format.

Methods: A 45-question survey was sent to independent and integrated plastic surgery residents and postresidency fellows nationally. The survey collected basic demographic information and evaluated three general categories of virtual learning in comparison to an in-person format: (1) time, (2) learning proficiency, and (3) collaboration.

Results: In total, 108 surveys were submitted from 48 different training programs. Participants reported that virtual learning was more efficient (mean: 3.9), conducive to more free time (mean: 3.9), and a more comfortable medium for expressing opinions (mean: 3.5) and asking questions (mean: 3.6) compared with an in-person format. When stratified between training levels, the PGY 1–3 group reported more difficulties in exam preparedness ($P = 0.05$), motivation to study ($P = 0.01$) and less time-saving benefits ($P = 0.05$) with a virtual format than the PGY 4+ group. Lastly, respondents who had higher self-reported levels of multitasking were found to have lower mean Likert scale scores on all questions related to "time," "learning proficiency," and "collaboration" ($P < 0.01$).

Conclusions: A virtual and in-person hybrid approach toward plastic surgery education may be beneficial for encouraging flexibility. Our results demonstrate impairment with collaboration and learning proficiency with a virtual format, especially with increased multitasking, but increased comfort with expressing opinions and asking questions. *(Plast Reconstr Surg Glob Open 2023; 11:e5373; doi: 10.1097/GOX.0000000000005373; Published online 3 November 2023.)*

INTRODUCTION

Graduate medical education during the coronavirus disease 2019 (COVID-19) pandemic experienced a tremendous shift toward a "virtual learning" format. Creating an educationally friendly environment for residents and fellows that is intellectually stimulating and collaborative is a difficult challenge to overcome while mitigating the risk of disease exposure. Limiting in-person gatherings per Centers for Disease Control and Prevention recommendations have forced the restructuring of a traditionally "hands-on" plastic surgery education to sustain learning, and such alterations have remained permanent despite the return to in-person activities.

As a substantial portion of plastic surgical cases are considered elective, the field of plastic surgery was disproportionately impacted by the COVID-19 pandemic. With the American Society of Plastic Surgeons and Centers for Medicare & Medicaid Services recommending a complete cessation of nonessential surgical care, plastic surgery residents experienced a significantly decreased

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caseload and an unexpected restriction to the diversity and variability of cases.[1–6] During the COVID-19 pandemic, plastic surgery residents most often reported an inability to meet case minimums for aesthetic and pediatric/craniofacial cases.[3] Plastic surgery residents found themselves facing redeployment to COVID-19-specific intensive care units, critical care, general surgery, or emergency medicine.[3,7] Subjectively, residents reported that the pandemic ultimately negatively impacted their surgical training, which has carried long-term implications related to surgical proficiency and self-confidence.[8] Supplementing operative experiences presented unique challenges, which the available strategies at the time struggled to overcome with great success. Such strategies, some of which we continue to benefit from, included live-streaming operations, the creation of surgical video libraries, or additional virtual didactic sessions, none of which were adequate substitutes for the operating room on a standalone basis.

Didactic curricula have also faced drastic changes. The successful transition of didactic curricula was limited by the availability of supplemental resources and technology. Virtual education sessions increased drastically during the COVID-19 pandemic, with residents predominantly watching live or prerecorded lectures, or engaging in visiting professor lecture series.[7] Grand rounds transitioned to a virtual format, and many programs reported participating in joint grand rounds with other institutions.[3,7,9] Residents, additionally, commonly reported having more time for self-guided learning.[3]

Although current literature has reported on the tangible ways in which plastic surgery learning curricula have "virtually" transitioned, the overall impact on the various aspects of learning including collaboration and proficiency has not been described. Understanding how well plastic surgery residents and postresidency fellows are adapting study strategies that have been reinforced over their lengthy academic careers is crucial to assess the efficacy of a virtual curriculum. The virtual changes that have come about are now persistent in different capacities at different institutions. Therefore, it is important to determine the efficacy of these practices, as they may become permanent or curricula may even benefit from making them permanent. This study aimed to describe the perceived strengths and weaknesses of virtual learning compared with the conventional, in-person format through a national survey of integrated and independent plastic surgery residents and postresidency fellows.

Takeaways

Question: Plastic surgery educational curricula have "virtually" transitioned due to COVID-19, but their efficacy and shortcomings have not been described.

Findings: In total, 108 responses were collected from a national survey sent to plastic surgery residents and fellows. Virtual learning was more time efficient and conducive to expressing opinions compared with an in-person format. Participants who self-reported higher levels of multitasking during virtual sessions scored lower on questions related to the time efficiency, learning proficiency, and collaborative capability of virtual learning.

Meaning: A virtual and in-person hybrid approach may be beneficial for time efficiency while minimizing the negative effects of multitasking on collaboration and learning proficiency.

METHODS

A 45-question survey was sent nationally to integrated and independent plastic surgery residents and postresidency fellows to examine the strengths and weaknesses of a virtual learning curriculum. Accreditation Council for Graduate Medical Education (ACGME)–approved residency programs were identified through the ACGME website, and contact information for residents and residency coordinators was collected via publicly accessible data. Residents were contacted directly, and coordinators were asked to forward the survey to their program's respective residents.

Question types included a five-point Likert scale, sliding scale, multiselect checkboxes, and dichotomous questions. Likert scale responses were rated on a five-option scale (1= strongly disagree, 2 = disagree, 3 = neutral, 4 =agree, 5= strongly agree). The survey collected basic demographic information and learning style preferences. It also evaluated three general categories of virtual learning in comparison with an in-person format: (1) time (ie, time efficiency of a virtual format), (2) learning proficiency, and (3) collaboration. Questionnaire data were distributed and collected using the REDCap Database Collection software. (**See figure, Supplemental Digital Content 1**, which displays the anonymous survey. **http://links.lww.com/PRSGO/C843**.)

Univariate analysis was performed between categorical variables using the Pearson chi-square test. Haldane-Anscombe correction was applied to select analysis due to the intrinsic nature of the dataset. The variance and normality of the data were determined by the Levene test and the Shapiro-Wilk test, respectively. These inferential tests determined that a two-tailed Mann-Whitney U would be most appropriate to compare the means between continuous variables in our dataset. The effect size was calculated using rank-biserial correlation to determine the strength of our Mann-Whitney U analysis, where effect size less than 0.3 is considered a small effect, 0.3–0.5 is considered a medium effect, and more than 0.5 is considered a large effect. The significance for all variables was a P value of 0.05 or less. Statistical analysis was performed using SPSS (IBM Corp. Released 2020. IBM SPSS Statistics, version 27.0., Armonk, N.Y.).

RESULTS

A total of 108 individuals (response rate = 20.9%) from 48 different institutions responded to the survey. Twenty-four participants attended institutions in the West, 38 participants attended institutions in the Midwest, 19 participants attended institutions in the Northeast, three participants attended institutions in the Southwest, 19 participants attended institutions in the Southeast,

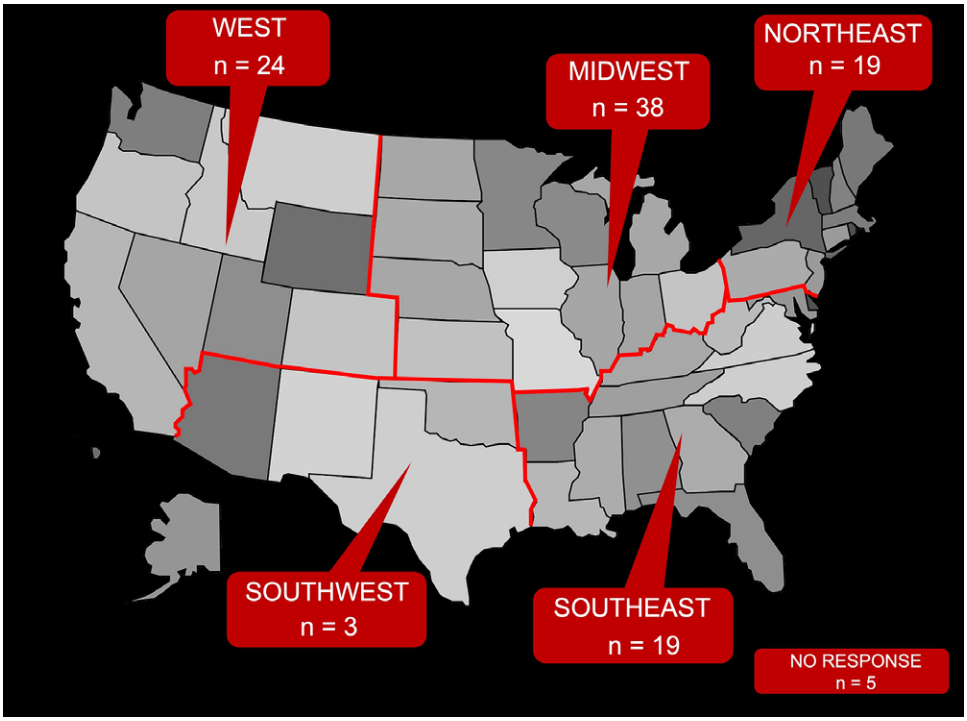


Fig. 1. Geographic distribution of respondents.

and five participants did not specify which institution they attended (Fig. 1). Responses were collected from October 2021 to May 2022. Respondents were more likely women (n = 57, 52.8%) than men (n = 51, 47.2%). The mean age was 30.4 ± 5.0 years with no significant differences between male and female participants (P = 0.68). Twenty-five participants had another degree in addition to an MD: PhD (n = 2), master of public health (n = 6), master of business administration (n = 5), master of science (n = 12). There were no other significant differences between training level (P = 0.64), training type (P = 0.8), and learning styles between female and male participants (Table 1). During the COVID-19 pandemic, nonclinical resident/fellowship curricula were more likely to be conducted in a virtual setting (mean % in person: 25.0%) compared with before the COVID-19 pandemic (mean % in person: 93.2%, P < 0.01; Fig. 2A). Participants were asked about what specific parts of their curriculum were conducted virtually versus in person. Didactic lectures, guest lectures, grand rounds, and events/ceremonies were more likely to be conducted virtually compared with in person (P < 0.001). Cadaver labs were more likely to be held virtually before the COVID-19 pandemic than during the COVID-19 pandemic (P < 0.01) (Fig. 2B).

An inquiry was made about characterizing specific aspects of learning in a virtual format directly compared with an in-person format. The specific aspects of learning included "time," "learning proficiency," and "collaboration." Participants were more likely to answer "agree'' that they would have more free time with a virtual format compared with an in-person format (mean: 3.9) and that a virtual format was a more efficient use of their time (mean: 3.6). The average response was below "neutral" on the Likert scale when participants were asked about their ability to understand concepts better (mean: 2.6), retain and recall information better (mean: 2.5), feel more prepared for exams (mean: 2.5), feel more motivated to learn and study (mean: 2.5), and feel more engaged (mean: 2.3) in a virtual format compared with an in-person format. In support of virtual learning, participants were more likely to "agree" that they felt comfortable expressing opinions (mean: 3.5) and asking questions (mean: 3.6) during virtual learning. However, results indicated that the virtual format was not better suited for collaboration (mean: 2.5), and participants, on average, "disagreed" they would have better connections with the group in a virtual learning environment (mean: 2.0; Table 2).

Results were also stratified between postgraduate year (PGY) 1–3 (n = 48) and PGY4 + (n = 60), as those in the former group did complete a full academic year in a traditional, in-person format. The PGY 1–3 group felt they had less free time with a virtual learning format (P = 0.05) compared with the PGY4+ cohort. Additionally, the PGY 1–3 group reported less comfort compared with the PGY4+ cohort when asking questions (P = 0.02), collaborating (P = 0.001), and creating connections with their team (P = 0.03) in a virtual learning format. Furthermore, the PGY 1–3 group felt less prepared for exams (P = 0.05) and less motivated to learn (P = 0.01) with a virtual format in comparison to the PGY 4+ group (Table 2).

Respondents were asked about their preferences on camera policy during virtual sessions, their institution's camera policy during virtual sessions, and how often they were multitasking during virtual sessions (ie, doing other tasks not related to the virtual session) on a scale from 1-10. Of the 108 participants, 99 (91.7%) preferred

Table 1. Demographics and General Characteristics

Variable	Total	Women	Men	*P*
No. individuals	n = 108	n = 57	n = 51	
Age (SD)	30.4 (5.0)	30.2 (4.79)	30.6 (5.3)	0.68
Training level				0.64
PGY1	10	5 (50%)	5 (50%)	
PGY2	19	8 (42.1%)	11 (57.9%)	
PGY3	19	9 (47.4%)	10 (52.6%)	
PGY4	19	10 (52.6%)	9 (47.4%)	
PGY5	17	11 (64.7%)	6 (35.3%)	
PGY6	12	8 (66.7%)	4 (33.3%)	
PGY7	1	1 (100%)	0 (0%)	
PGY8 or higher	4	3 (75%)	1 (25%)	
Postresidency fellow	7	2 (28.6%)	5 (71.4%)	
Residency training type				0.8
Independent	5	3 (60%)	2 (40%)	
Integrated	96	52 (54.2%)	44 (45.8%)	
Learning style				
Visual	70	37 (52.9%)	33 (47.1%)	0.98
Auditory	12	7 (58.3%)	5 (41.7%)	0.68
Hands-on/interactive	79	39 (49.4%)	40 (50.6%)	0.24
Reading/writing	27	11 (40.7%)	16 (59.3%)	0.15

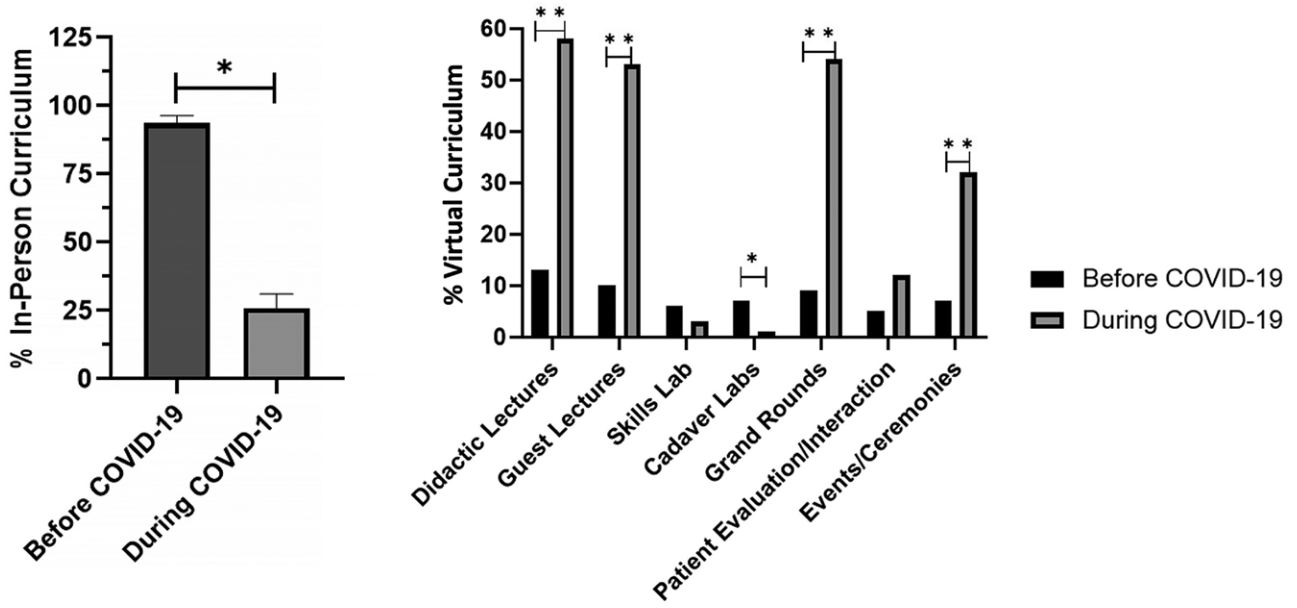


Fig. 2. Distribution of in-person and virtual curriculum before and during the COVID-19 pandemic.

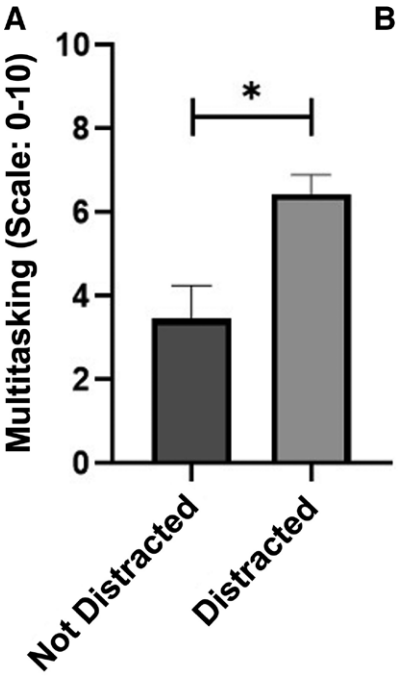
to have their cameras off, and nine (8.3%) preferred to have their cameras on. Institutions that required cameras to be "always on" or "mostly on" had participants who self-reported significantly lower levels of multitasking (mean: 5.1 ± 2.8) during virtual sessions compared with institutions that allowed cameras to be "always off" or "mostly off" (mean: 6.4 ± 2.1; $P = 0.035$). Participants who answered "True" that they were distracted during virtual sessions and had higher self-reported levels of multitasking (Fig. 3A and Table 2) compared with those who answered "false" (true, mean: 6.4 ± 2.1; false, mean: 3.5 ± 2.0) ($P < 0.0001$). Respondents reported multitasking on work-related tasks (n = 91, 18.9%), eating (n = 80, 16.6%), and reviewing patient information (n = 78, 16.2%; Fig. 3B). No significant difference was found between participants who answered "true" or "false" if they spent more time learning and understanding the information taught during virtual learning (true, mean: 5.3 ± 2.7; false, mean: 5.9 ± 2.2; $P = 0.21$; Table 2).

Lastly, respondents who had higher self-reported levels of multitasking were found to have significantly lower Likert scale scores on the average of all questions related to "time" ($r = -0.26$, $P < 0.01$), "learning proficiency" ($r = -0.48$, $P < 0.01$), and "collaboration" ($r = -0.28$, $P < 0.01$). (**See figure, Supplemental Digital Content 2,** which displays the correlation between self-reported levels

Table 2. Attitudes and Perceptions toward a Virtual Learning Format Compared with an In-person Learning Format

Attitudes Compared with an In-person Learning Format	Total	PGY 1–3	PGY 4+	Effect Size	*P*
No. individuals	n = 108	n = 48	n = 60		
Time					
1. I have more free time with a virtual learning format	3.9	3.6 (1.0)	4 (1.0)	0.21	0.05*
2. A virtual learning format is a more efficient use of my time	3.6	3.4 (1.1)	3.7 (1.1)	0.19	0.8
Learning Proficiency					
3. I understand concepts better with a virtual learning format	2.6	2.5 (1.0)	2.8 (0.9)	0.19	0.08
4. I retain and recall information better with a virtual learning format	2.5	2.4 (1.0)	2.7 (1.0)	0.16	0.14
5. I feel more prepared for exams with a virtual learning format	2.5	2.3 (0.9)	2.7 (0.9)	0.21	0.05*
6. I am more motivated to learn and study with a virtual learning format	2.5	2.3 (0.9)	2.8 (1.0)	0.28	0.01*
7. I am more engaged with a virtual learning format	2.3	2.1 (0.9)	2.4 (1.0)	0.12	0.27
Collaboration					
8. During virtual learning, I feel comfortable expressing my opinions in group discussions	3.5	3.4 (1.0)	3.6 (0.8)	0.1	0.34
9. During virtual learning, I feel comfortable asking questions	3.6	3.4 (1.0)	3.8 (0.8)	0.24	0.02*
10. A virtual learning format is better suited for collaboration	2.5	2.2 (0.9)	2.8 (1.0)	0.35	0.001*
11. In a virtual learning environment, I have better connections with the group	2	1.8 (0.8)	2.2 (0.8)	0.23	0.03*
Question			Total, n = 108		
I find myself more distracted during virtual learning		True	80 (74.1%)		
		False	28 (25.9%)		
Overall, I spend more time to learn and understand the information taught during virtual learning.		True	47 (43.5%)		
		False	61 (56.5%)		

*Significance set at $P \leq 0.05$. Values were based on a Likert scale where a value of 0 is "Strongly Disagree" and a value of 5 is "Strongly Agree." SDs are in parentheses.



Activity	Count	%
Talking to patients	32	6.7%
Talking to colleagues	62	12.9%
Reviewing patient information	78	16.2%
Rounding on patients	19	4%
Doing other work-related items	91	18.9%
Sleeping	25	5.2%
Eating	80	16.6%
Taking care of family	15	3.1%
Getting ready/showering	42	8.7%
Exercising	29	6%
Watching TV	8	1.7%

Fig. 3. Multitasking during virtual learning. A, Association between self-reported levels of multitasking (numerical scale: 1–10) and subjective feelings of distraction. B, Commonly reported multitasking activities performed during virtual learning sessions.

of multitasking and the average score of all questions related to the three categories of virtual learning evaluated in the survey. **http://links.lww.com/PRSGO/C844**.)

DISCUSSION

The COVID-19 pandemic has significantly affected the learning experiences of integrated and independent plastic surgery residents and postresidency fellows across the United States. Many residency programs had to quickly adopt virtual learning sessions as the standard to comply with Centers for Disease Control and Prevention guidelines of in-person gathering limitations. There is an ever-increasing number of programs transitioning to a virtual curriculum, with some maintaining this change despite the loosening of COVID-19 restrictions.[10] However, before this study, no one has analyzed the relative efficacy of a virtual learning format for plastic surgery education in direct comparison with in-person learning activities. As described in the Methods section, residents and postresidency fellows were stratified into two groups: PGY1–3 and PGY 4+. Our survey questions were presented as "As compared with an in-person learning format," in an attempt to draw comparisons between the two learning formats. Therefore, our reported results between PGY 1–3 and PGY 4+ groups focused on comparing the relative deficits experienced with virtual learning as opposed to in-person learning between these two groups. This approach examines the differences in a relative context rather than measuring the absolute gap in knowledge between PGY 1–3 and PGY 4+ groups, which we would reasonably expect to be substantial. Furthermore, this reduced the risk of confounding bias by splitting the sample into those who had undergone at least one complete academic year in person (PGY 4+) versus those who only experienced a virtual format (PGY 1–3) since the start of their training. If this distinction had not been made, it would have been difficult to discern how specific attitudes toward virtual learning were affected by previous learning experiences. By conducting this national survey, we discovered that virtual learning experiences are accompanied by specific strengths and weaknesses. It is essential to understand these aspects to optimize the curriculum in the coming years and provide trainees with the best learning experience possible.

Overall, the plastic surgery residents and postresidency fellows reported that a virtual format was more efficient, thus resulting in more free time. This is consistent with the literature, which has shown that two of the main advantages of virtual learning are flexibility and time savings.[11,12] Notably, the PGY 4+ group reported a significantly higher rating of free time afforded by virtual learning than the PGY 1–3 group, likely because the PGY 4+ group had in-person sessions as a point of reference and, therefore, a more objective understanding of the time requirement differences. On the other hand, the PGY 1–3 group likely relied more heavily on inferring how much less free time they would have had if their sessions had been in person. Various factors can contribute to an increase in time efficiency with virtual sessions, such as eliminating the need to commute or walk from one location to another.

Additionally, most trainees reported overall higher comfort levels when expressing opinions or asking questions in a virtual setting. The PGY 4+ group, specifically, had significantly higher comfort levels with asking questions than the PGY 1–3 group. Comfort levels were likely higher due to the ability to ask questions and make comments through the "chat" function or while having the webcam turned off. For some, this creates the perception of a lower-stress, safer environment compared with participating in a room surrounded by others.[13] Moreover, the PGY 4+ group had significantly higher comfort levels, likely because they were more familiar with one another and the faculty, further lowering interpersonal anxiety. Despite these strengths, some may reasonably ask if the improvements in time efficiency and comfort levels are counteracted by a longer duration required to teach the same topics due to lower concentration and engagement. However, the trainees in this analysis reported no significant changes in the time required to learn topics virtually versus in person. This implies that virtual didactics and other lectures can continue to be the same length as in-person sessions without affecting overall levels of learning. Therefore, virtual learning sessions can not only inspire more discussion, but they can also decrease the burden of hectic residency and fellowship schedules.

Virtual curricula naturally had shortcomings that must also be addressed. The trainees in both groups reported impairments in learning proficiency, such as understanding concepts, retaining/recalling information, exam preparedness, and feeling motivated/engaged. Notably, this impairment was more evident in the PGY 1–3 group, particularly as it related to exam preparedness and motivation. One possible explanation for this difference is that the PGY 4+ group had the benefit of in-person collaborations and study groups early in their training, which likely established stronger study habits and accountability. Furthermore, both groups also reported a reduction in the ability to collaborate and form connections with their colleagues. This observation was more pronounced in the PGY 1–3 group likely because the transition to a virtual curriculum occurred abruptly. Unlike the PGY 4+ group, they did not have the same early opportunities to have as many in-person gatherings with their colleagues, which has been found to be the most important factor for team bonding.[14]

Virtual learning formats are notorious for facilitating the ability to multitask, with recent estimates reporting at least 40% of attendees frequently or always multitask.[15] The trainees' responses were therefore further analyzed by multitasking level. Those with the highest levels of multitasking were significantly more likely to report being distracted during virtual learning. Moreover, multitasking was negatively correlated with perceived time efficiency, learning proficiency, and collaboration, all of which are consistent with the literature.[16] These data suggest that major shortcomings of virtual learning formats, including a reduction in learning proficiencies and collaboration, could potentially be mitigated by aims at reducing distractions. Our study additionally demonstrated that levels of multitasking were generally lower in the presence

of "video on" requirements by their institution. Having "video on" requirements for some or all of the session length could diminish multitasking and distractions and, subsequently, lead to higher learning proficiency and collaboration. However, reports have found that having "video always on" requirements increase anxiety levels, and thus could lead to a decrease in comfort with asking questions and expressing opinions. Perhaps a more balanced approach would be to encourage interactivity using question polls.[13]

This study is not without limitations. Although the number of responses was acceptable and sufficient for statistical analysis, the overall response rate was only 20.9% of trainees, potentially making the study vulnerable to sampling bias. Furthermore, this analysis was reliant on self-reported attitudes and perceptions, which probably resulted in response bias. Future investigations on this topic should strive to also obtain quantifiable data, such as examination scores or learning assessment scores, to correlate with responses. Researchers might also find it valuable to explore how adjustments made to skills labs and cadaver labs—activities inherently reliant on in-person guidance and tactile engagement—further impacted plastic surgery education.

Additionally, the survey did not include questions about medical school curriculum format, which could have been a confounding variable. For example, trainees who attended medical schools heavy in virtual lectures may have become accustomed to this format and responded with higher positive attitudes. Lastly, the analysis only included plastic surgery trainees, so the results are not generalizable to trainees in other specialties. Despite these limitations, our findings are consistent with the literature reporting higher efficiency and comfort with virtual curricula.[11,12] We have also identified opportunities to improve learning proficiency and collaboration, which are especially important if programs are considering making these virtual/hybrid models a permanent change.

CONCLUSIONS

In conclusion, the COVID-19 pandemic drastically changed plastic surgery curricula across the nation and accelerated the transition to virtual-based education. Although in-person gathering restrictions have been loosening, many programs continue to operate in a virtual or hybrid setting, suggesting this may be a permanent change. Before this report; however, the efficacy and shortcomings of a plastic surgery virtual curriculum were unclear. Overall, residents and postresidency fellows found virtual formats to be more efficient and ease the burden of their hectic schedules. They also reported increased comfort with expressing opinions and asking questions during virtual sessions, likely due to features such as chat functionality. However, there were also reports of mild learning proficiency impairments with virtual formats, especially in those admitting to engagement in multitasking. Considering the distinct advantages of both virtual and in-person learning, the optimal educational environment for plastic surgery residency may well consist of a hybrid model, integrating the efficiency, flexibility, and comfort of online sessions with the tangible engagement and hands-on experience of traditional instruction. A practical approach might entail conducting all workshops and anatomy labs in person with the added option of recording them for subsequent review, while also offering the flexibility to attend didactics or grand rounds virtually when hands-on training is not required. Although this model is promising, future studies are warranted exploring ways to optimize learning proficiency and reduce multitasking without losing the perception of a safe learning environment.

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DISCLOSURES

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