

Changes in Personal Protective Equipment Practices of Craniofacial Surgeons during COVID-19: A Cross-sectional Study

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Background: Surgeons who operate around nasal or oral airways are at particularly high risk for transmission of the severe acute respiratory syndrome coronavirus 2. This multipart study explores the changes in craniofacial surgeon preferences and practices for personal protective equipment (PPE) over the course of a worldwide pandemic.

Methods: Two identical electronic survey studies, one in 2020 and one in 2022, were conducted on the use of PPE before, during, and after the pandemic among active craniomaxillofacial surgeons. Statistical changes in behaviors and preferences and differences across time points and demographic groups were evaluated.

Results: The initial study included responses from 48 surgeons, and the follow-up study consisted of 36 responses. Although only 4.3% of surgeons wore N95 masks or powered air purifying respirator for craniomaxillofacial operations before the pandemic, 91.5% wore these measures during the early pandemic ($P < 0.001$). However, this fell to 74.3% 2 years later. Similarly, more than 95% of surgeons wore a mask in clinic during the pandemic at both time points compared to only 40.3% before the pandemic ($P < 0.001$). In 2020, 31.9% of surgeons planned to continue using N95 masks or powered air purifying respirator for craniofacial cases after the pandemic was over, but that fell to 11.4% in the follow-up study.

Conclusions: Craniofacial surgeon practices have shifted significantly toward more protective PPE over the course of the coronavirus disease 2019 pandemic. However, this effect was dampened over the course of a protracted pandemic. Despite this, our studies indicate a long-term shift in surgeon preference that is likely to persist after the pandemic is over. (*Plast Reconstr Surg Glob Open* 2023; 11:e4793; doi: 10.1097/GOX.0000000000004793; Published online 13 January 2023.)

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic was first identified in late 2019 as a respiratory disease caused by a novel coronavirus strain, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).¹ Over the course of the last 2 years, the SARS-CoV-2 virus has infected over 500 million people and has led to over six million deaths worldwide. This widespread global

pandemic has created a healthcare catastrophe akin to the Spanish flu pandemic in 1918. Hospital-based medicine in the United States has been particularly affected, with severe limitation in hospital staffing, hospital beds, equipment, and essential resources leading to delays in elective operations recommended by the Center for Medicaid Services for periods during the pandemic.² Additionally, the rise of a respiratory infection has raised concerns among healthcare workers about the exposure risk they face, especially as more data arise regarding neurologic sequela and prolonged pulmonary complications from COVID-19.^{1,3,4}

Those at the highest risk for respiratory pathogen exposure include surgeons working near or around the aerodigestive track. Research has demonstrated

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that regions of the pharynx and upper aerodigestive track carry the highest density of SARS-CoV-2 virus.⁵ Furthermore, transmission of virus through aerosolized droplets from these tissues is well documented in the literature.⁴⁻⁶ Thus, specialists working in the fields of craniofacial surgery, dentistry, oral surgery, and otolaryngology are particularly troubled by the potential for viral exposure in their daily work.⁷⁻⁹ In fact, many of the professional societies for these specialties recommended limiting operations to urgent and emergent cases only during the height of the pandemic.⁸⁻¹³ A survey study conducted by our research group from June 2020 to August 2020 demonstrated a distinct shift in practices and preferences among craniofacial surgeons to more protective face masks for both surgical procedures and clinical examinations. Now as the pandemic has persisted well into 2022, we hypothesize that these practices and preferences have likely continued to evolve over time. This follow-up survey study focuses on the updated expert opinions of craniofacial surgeons and their practices as the world reflects closely on a prolonged COVID-19 pandemic.

METHODS

Two identical cross-sectional survey studies were conducted approximately 18 months apart. The first collection period was from June 4, 2020, to August 4, 2020, and the second collection period was from December 20, 2021, to February 20, 2022. The identical surveys comprised 17 required questions about the practices and preferences of surgeons before, during, and after the pandemic in various situations. (See figure, Supplemental Digital Content 1, which shows questions included in the study survey, <http://links.lww.com/PRSGO/C371>.) Multiple choice questions regarding facial PPE preference allowed surgeons to choose one answer among the following options: no mask, standard surgical mask, N95, or powered air purifying respirator (PAPR). Additionally, eight multiple choice demographic questions were collected from each respondent. Respondents included active members of the American Society of Craniofacial Surgeons (ASCFS), which is made up of practicing craniomaxillofacial surgeons meeting strict membership criteria (Table 1). The survey was distributed electronically via email. Email errors, rejections, or nonreceipt messages were excluded from the potential respondent

Takeaways

Question: How did the COVID-19 pandemic affect craniofacial surgeon mask-wearing preferences and how has that changed over time?

Findings: We conducted survey studies of craniofacial surgeons—one at the beginning of the pandemic and one at 2 years later. Overall, surgeon preferences shifted toward more protective masks in the operating room and clinic. These changes dampened over time but on average surgeons still preferred more protective masks than before the pandemic.

Meaning: The COVID-19 pandemic caused surgeons to prefer more protective masks, although some reverted to their original practices over time.

group. All responses were collected anonymously, with the exception of an optional opportunity to provide an email contact for gift card drawing purposes only. Data were collected in spreadsheet format and analyzed using Microsoft Excel (Microsoft Corp, Redmond, Wash.). Data from respondents identifying as not actively practicing craniofacial surgery were excluded. (See figure, Supplemental Digital Content 1, <http://links.lww.com/PRSGO/C371>.)

Statistical Analysis

Statistical analysis was performed utilizing two-tailed Fisher exact tests of categorical variables comparing initial study results versus later study data in GraphPad Prism (GraphPad Software, La Jolla, Calif.) and Microsoft Excel (Microsoft Corp). Statistical significance was set at the conventional standard of a *P* value less than 0.05. Alpha was set at $\alpha = 0.5$. Power calculation was performed with $\beta = 0.2$ (power = 0.8) and a minimal sample size of 29 was determined.

RESULTS

A total of 296 email addresses were identified from the ASCFS membership. Of those email addresses, 43 resulted in email rejection or error messages, indicating nonreceipt of those messages. This resulted in 253 survey forms that were successfully sent. From those sent messages, 48 responses were received in the initial study (19.0%) and 36 responses were received from the follow-up study (14.2%).

Table 1. ASCFS Active Membership Requirements

1. Be a legally qualified, reputable practicing surgeon who is board certified in plastic surgery, active in craniofacial surgery, and who has made worthwhile contributions in this field.
2. Has at least 12 mo training in craniofacial surgery at a program recognized by the Society.
3. Completed a plastic surgery residency.
4. Has been in active practice of craniofacial surgery for a minimum of 3 y.
5. Board certified by the American Board of Plastic Surgery or the Royal College of Physicians and Surgeons of Canada.
6. Must submit a list of operations performed in two consecutive years, which have been approved by the Society. At least 25 of these should have been of the intracranial type.
7. Submit a list of members of your clinical team.
8. Has published at least two articles on the subject of craniofacial surgery.
9. Shall live and practice craniofacial surgery in the United States.

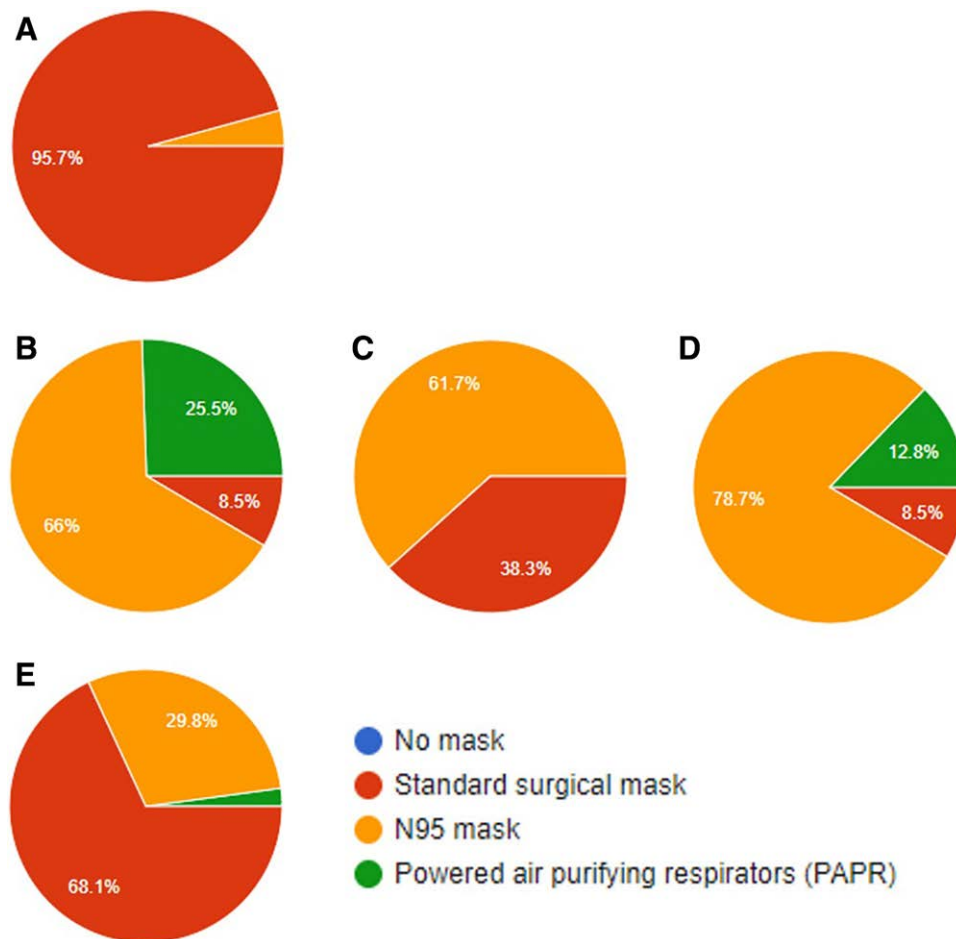


Fig. 1. Preference of PPE use in craniomaxillofacial procedures with airway exposure in 2020. Surgeon preference of PPE use for craniomaxillofacial procedures involving exposure of the airways (A) before the pandemic, (B) during the pandemic with COVID-19 positive patients, (C) during the pandemic with COVID-19 negative patients, (D) during the pandemic with untested patients, and (E) after the pandemic as reported in 2020.

The survey was successful in identifying active craniofacial surgeons, as all but one respondent from each group reported practicing craniomaxillofacial surgery. Responses from those not practicing were excluded. In the initial study, 72% of the respondents were men and 27.7% were women. In the follow-up study, 62.9% were men and 37.1% identified as women. The majority of those surgeons (55.3% and 57.1%, respectively) were between 35 and 44 years of age, whereas 25.5% (17.1% in the follow-up study) were between 45 and 54 years old, 17% (14.3% in the follow-up study) were between 55 and 64 years old, and 2.1% (2.9% in the follow-up study) were over 65 years old. This corresponded to 68.1% (57.1% in the follow-up study) of respondents between 0 and 9 years in practice, 8.5% (20% in the follow-up study) between 10 and 19 years in practice, and 21.3% (17.1% in the follow-up study) over 20 years in practice. The respondents were from various practice settings across the United States. These included academic practice (61.7% and 62.9%, respectively), employed hospital practice (17% and 20%, respectively), multispecialty group practice (10.6% and 11.4%, respectively), solo private practice

(8.5% and 2.9%, respectively), and group private practice (2.1% and 2.9%, respectively). They represented a variety of different locations, including 61.7% (62.9% in the follow-up study) in large metropolitan areas (population 1.5 million or more), 25.5% (28.6% in the follow-up study) from metropolitan areas (population 500,000 to 1.5 million), 10.6% (5.7% in the follow-up study) from medium-sized urban areas (population 200,000 to 500,000), 2.1% (2.9% in the follow-up study) in small urban areas (population 50,000 to 200,000), and none from rural areas (2.9% in the follow-up study) (Fig. 1). There were no significant differences between the two respondent groups.

Almost all craniofacial surgeons (95.7%) wore standard surgical masks for craniomaxillofacial cases involving exposure of the airways before the pandemic. However, during the COVID-19 pandemic, 91.5% of patients opted for N95 masks (78.7%) or PAPR (12.8%) instead of standard surgical masks (8.5%) for untested patients ($P < 0.001$) (Fig. 1). This effect waned slightly over time, with 25.7% of surgeons returning to standard surgical masks in 2022 (Fig. 2). The remaining chose to wear either

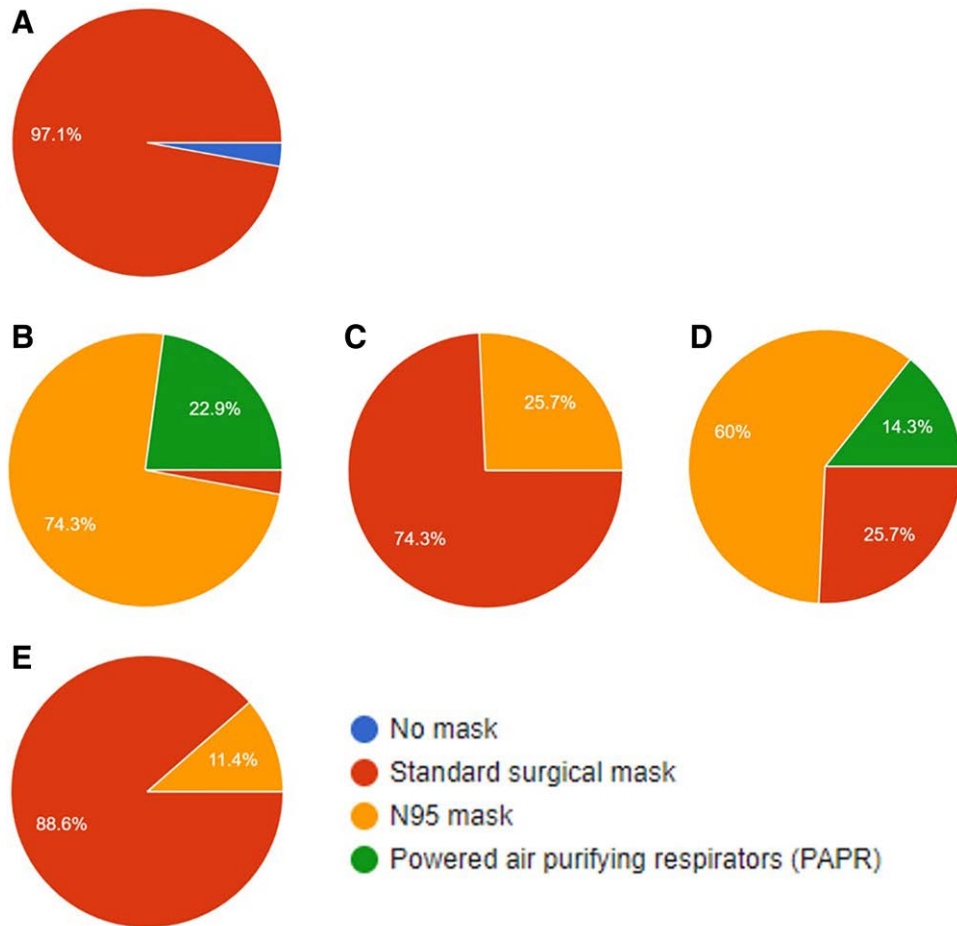


Fig. 2. Preference of PPE use in craniomaxillofacial procedures with airway exposure in 2022. Surgeon preference of PPE use for craniomaxillofacial procedures involving exposure of the airways (A) before the pandemic, (B) during the pandemic with COVID-19 positive patients, (C) during the pandemic with COVID-19 negative patients, (D) during the pandemic with untested patients, and (E) after the pandemic as reported in 2022.

N95 masks (60%) or PAPR (14.3%). For patients testing positive for COVID-19, surgeons were more likely to wear PAPR (25.5% in 2020 and 22.9% in 2022) and N95 masks (66% in 2020 and 74.3% in 2022) in both studies. For those testing negative for COVID-19, 61.7% of surgeons opted to wear N95 masks, whereas 38.3% wore standard surgical masks in the initial study. This shifted more in favor of standard surgical masks (74.3%) rather than N95 masks (25.7%) in the follow-up study.

Similar results were observed for surgeons performing procedures that did not involve exposure of the aerodigestive tract (Table 2). In the initial study, most (63.8%) opted for N95 masks, whereas 21.3% wore standard surgical masks and 14.9% wore PAPR for untested patients. In the follow-up study, 40% wore surgical masks, 48.6% used N95, and 11.4% used PAPR. For patients testing positive for COVID-19, only 6.4% opted for standard surgical masks, whereas 74.5% wore N95 masks and 19.1% wore PAPR in 2020. This was consistent in the follow-up study with 71.4% opting for N95, 20% preferring PAPR, and only 8.6% selecting surgical masks. For patients

with proven negative COVID-19 tests, 46.8% opted for standard surgical masks and 53.2% wore N95 masks in 2020. There was a big shift in the follow-up study, with only 14.3% opting for N95 versus 82.9% choosing standard surgical mask. Of note, 89.4% of respondents routinely tested all patients before an operation and 93.6%

TABLE 2. Surgeon Preference of PPE Use for Craniomaxillofacial Procedures not Involving Exposure of the Airways

Patient COVID Status	PPE	Initial Study, %	Follow-up Study, %
Untested for COVID	PAPR	14.9	11.4
	N95	63.8	48.6
	Surgical mask	21.3	40
	No mask	0	0
COVID positive	PAPR	19.1	20
	N95	74.5	71.4
	Surgical mask	6.4	8.6
COVID negative	No mask	0	0
	PAPR	0	2.9
	N95	53.2	14.3
	Surgical mask	46.8	82.9
	No mask	0	0

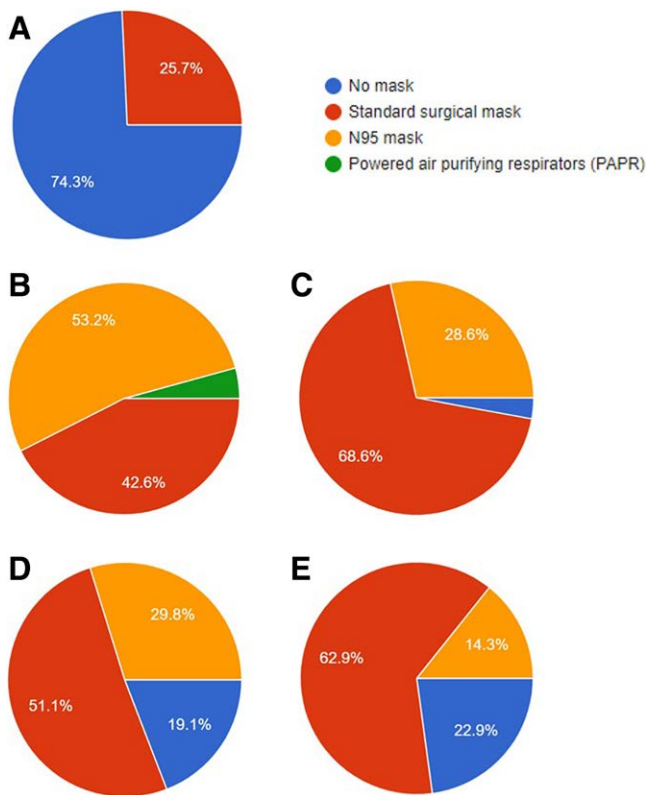


Fig. 3. Preference of PPE use in airway exams in clinic. Surgeon preference of PPE use for nasal or oral airway examinations in the clinic (A) before the pandemic, (B) during the pandemic in 2020, (C) during the pandemic in 2022, and (D) after the pandemic as reported in 2020, and (E) after the pandemic as reported in 2022.

of surgeons would only perform nonurgent operations on patients that had been tested for COVID-19 in 2020. These conditions relaxed in the follow-up study, as only 74.3% indicated a testing requirement and 77.1% would only perform nonurgent operations on tested individuals.

Large differences were also observed in surgeon behavior during nasal or oral airway examinations in the clinic (Fig. 3). Before the COVID-19 pandemic, most surgeons (57.4%) did not wear any mask in the clinic, whereas 40.4% preferred wearing standard surgical masks. During the pandemic, all surgeons reported wearing some type of mask in the clinic, with 42.6% choosing standard surgical masks, 53.2% wearing N95 masks, and 4.3% opting for PAPR in 2020. At that time, 51.1% of surgeons reported plans to continue wearing a standard surgical mask in the clinic after the pandemic was over. The rest planned to wear either an N95 mask (29.8%) or no mask (19.1%) for nasal or oral airway examinations in the clinic. These attitudes shifted toward less-protective PPE over time, with only 13.9% of respondents planning to continue wearing N95 masks, 62.9% intending to use surgical masks, and 22.9% planning to wear no mask in the clinic once the pandemic is over. This was reflected in the 2022 study of clinic practices as well, with 28.6% wearing N95 masks, 68.6% wearing surgical masks, and 2.9% opting for no

mask at that time. In both studies, these reported numbers for mask-wearing of any kind during and after the pandemic constitute a stark contrast compared to before the pandemic began ($P < 0.001$).

Surgeon outlook on life after the pandemic has similarly shifted from the early to late pandemic period. In 2020, only 68.1% of surgeons planned on returning to a standard surgical mask for cases involving the airways after the COVID-19 pandemic is over. This has now increased to 88.6% of surgeons as they are increasingly leaving N95 masks behind. Comparatively, only 11.4% of respondents intend to use N95 masks in the operating room after the pandemic is over ($P = 0.001$); far less than the 29.8% from the 2020 survey but still higher than the 4.3% of surgeons before the pandemic. In fact, during the height of the pandemic, 51.1% of craniofacial surgeons reported that the COVID-19 pandemic has changed their opinion on what PPE should be routinely used for craniomaxillofacial procedures involving exposure of the nasal or oral airways in favor of more protective coverage (Fig. 4). This included 46.8% of craniofacial surgeons who believed N95 masks should be standard for all craniomaxillofacial procedures involving exposure of the aerodigestive tract (Fig. 5). These attitudes have waned in the intervening years, with only 42.9% convinced their opinions on PPE have changed and only 20% believing N95 masks should be standard for all craniomaxillofacial cases. A similar change was observed in cases not involving exposure of the oral or nasal airways, with 8.6% of respondents reporting in 2022 they would continue using N95 masks after the pandemic is over, compared to 19.1% earlier in the pandemic.

DISCUSSION

It is no surprise that the COVID-19 pandemic has influenced surgeons' perceptions of their susceptibility to airborne diseases and their preference for PPE during high-risk operations. The results of this study reflect a clear shift in surgeon preference over the course of this pandemic from less restrictive oral and nasal protection to more protective masks such as N95 or PAPR. Although these effects were dampened over the course of a protracted pandemic, our findings are suggested to last beyond the end of this current pandemic according to our respondents, as COVID-19 has served as a strong reminder of the inherent risks of operating around the aerodigestive tract.

There are several potential reasons for the change in surgeon perspective and practices over the course of the pandemic. Certainly, greater knowledge of the SARS-CoV-2 virus and development of multiple successful vaccines likely played a role in that shift. However, it is important to note that promising phase 2 and phase 3 trials were already underway for Moderna and Pfizer-BioNTech mRNA-based vaccines at the time of our initial survey study.¹⁴ The availability of a viable COVID-19 vaccine was thus an anticipated outcome during the initial study period. Regardless, the ambiguity effect likely played a role in the early stages of the pandemic.^{15,16} Uncertainty

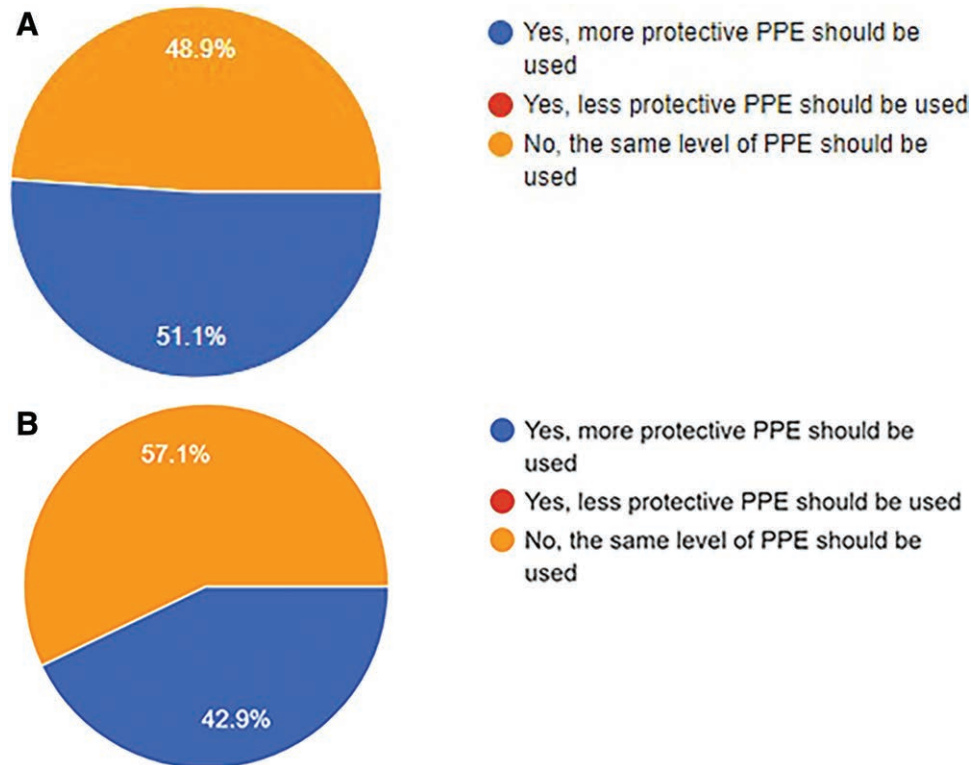


Fig. 4. Surgeon opinion on whether or not COVID-19 changed their opinions on PPE use for craniomaxillofacial procedures. Surgeon responses indicating whether or not the COVID-19 pandemic has changed their opinion on what PPE should be used for craniomaxillofacial procedures involving exposure of the nasal or oral airways in (A) the initial study and (B) the follow-up study.

regarding the long-term consequences of COVID-19 infection, risk factors, safety protocols, and mortality rates at the beginning of the pandemic likely drove risk-averse surgeons toward more conservative PPE such as N95 masks and PAPRs. Furthermore, the availability and recency of pandemic-related trauma likely served as a heuristic for many healthcare personnel.^{17,18} As news outlets highlighted the most catastrophic infection outcomes and growing number of mortalities on a daily bases, the fear of these adverse outcomes likely drove much of the physician response, regardless of the likelihood that a surgeon would face these outcomes themselves. This is likely associated with the significant mental health toll the pandemic has taken on frontline health professionals.¹⁹

As the pandemic progressed, however, surgeons likely found many of these effects waned over time. Up-to-date, detailed information about the SARS-CoV-2 virus and its variants accumulated over time.²⁰ Uncertainty was reduced and the true incidence and risk factors for long-term complications and mortality were further elucidated.²¹ Although not asked about in this survey study, vaccination further reduced these risks, giving physicians a sense of safety and protection. Similarly, past infection may also provide a sense of security, although respondents were not asked if they previously contracted the virus themselves. The “shock” of widespread COVID-19 infection likely also wore off with time as incidence, hospitalization rates, and mortality rates decreased from its peak in January 2021 to its nadir in July 2021.²² As the novelty

of COVID-19 declined, the rise of “pandemic fatigue,” burnout, and compassion fatigue likely affected surgeon perspectives.²³ Additionally, physicians may have underestimated the long-term discomfort of wearing an N95 mask versus a surgical mask. A pandemic-era study by Nwosu et al²⁴ showed that healthcare workers rated N95 masks to be significantly more uncomfortable than a standard surgical mask. Further research by Fikenzer et al²⁵ did, in fact, demonstrate that an N95 mask significantly reduced forced expiratory volume, peak expiratory flow, and ventilation in healthy individuals when compared to surgical mask and no mask. Surgeon temporal discounting of this added discomfort and ventilatory resistance may have contributed to our finding that in 2020, 31.9% of surgeons reported a plan to wear N95 masks or PAPRs for all craniomaxillofacial procedures involving the nasal or oral airways after the pandemic was over compared to only 11.4% of respondents in 2022. Similarly, the number of surgeons who felt that N95 masks should be standard for all craniomaxillofacial procedures fell from 46.8% at the beginning of the pandemic to 20% in our follow-up study.

Despite the tempering effect of the pandemic on PPE preferences among craniofacial surgeons, our results still signal a significant shift from pre-pandemic practices. The most notable areas of change include surgeon preference for N95 masks or PAPRs in craniomaxillofacial operations involving exposure of the nasal or oral airways (0% before the pandemic versus 74.3% in 2022) and mask-wearing for examinations in the clinic (25.7% before the

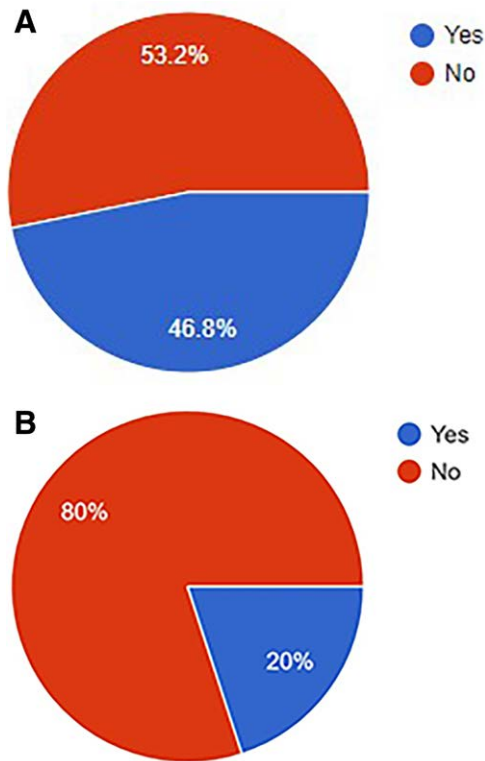


Fig. 5. Surgeon opinion on whether N95 masks should be standard for craniomaxillofacial procedures. Surgeon responses indicating whether N95 masks should be standard for all craniomaxillofacial procedures involving exposure of the nasal or oral airways in (A) the initial study and (B) the follow-up study.

pandemic versus 97.1% in 2022). Craniofacial surgeons have indicated that these preferences will persist after the pandemic is over, with 20% reportedly planning to use N95s for all craniomaxillofacial cases involving the nasal or oral airways and 77.2% planning to continue using masks in the clinic. Part of this long-term shift may be due to enhanced awareness of the airborne pathogen exposure craniofacial surgeons face on a daily basis and the role masks play in limiting those risks. In fact, the precipitous drop in influenza cases during the 2020–2021 flu season compared to the year prior perfectly illustrated the effect of mask-wearing and social distancing on the spread of other respiratory diseases.²⁶ Additionally, mask-wearing has become so ingrained in everyday healthcare practice that it has become a cultural norm. Although before the pandemic mask-wearing in a clinic setting was considered unusual in the United States, not wearing a mask in a hospital is now seen as atypical.²⁷ When physicians are faced with the difficult decision of whether to remove their mask and risk airborne illness when the pandemic is over, our data suggest a bias toward the status quo may prevail.²⁸

Survey-based data have inherent limitations, especially when addressing expert opinion or practices. Confounding factors include the influence of hospital

policies and their effect on physician behavior, such as requiring N95 masks for untested patients or necessitating COVID-19 testing for all patients before elective operations. Of course, hospitals may also serve as a limiting factor when it comes to PPE use, especially when supplies of N95 masks or PAPRs were low. The absence of supply chain issues for elevator PPE would have likely amplified this study's findings. Internet-based surveys also typically suffer from relatively low response rates, with the 19% and 14.2% observed in these two studies within the expected range of electronic survey instruments.²⁹ However, this is an important limitation to keep in mind when interpreting the data. Unfortunately, reasons for nonresponse could not be elicited in our study, but it is possible that academic interest and familiarity with online surveys may have played a part. Keeping more stringent respondent criteria (ASCFS active membership) helped reduce representativeness bias due to limitations in the response rate. Also, analysis of demographic and practice data allowed for confirmation that respondent groups were similar in the two studies and representative of the target population. Similar to the target group of ASCFS members, the respondents in both surveys favored academic surgeons (followed by hospital-employed surgeons) working in large metropolitan and metropolitan areas. Finally, it is important to note that these results reflect the practices and opinions of craniofacial surgeons in the United States and may not be representative of similar experts around the world.

CONCLUSIONS

The COVID-19 pandemic has significantly changed the expert opinion of craniofacial surgeons regarding the use of PPE in their medical practices. The magnitude of the shift toward more protective face masks for craniomaxillofacial procedures has partially diminished over time. This may be a result of increased disease familiarity, vaccine development, and behavioral adaptations; however, it is important to note that COVID-19 is likely here to stay. Despite these factors, the change in craniofacial surgeon practice is likely to endure after the pandemic is over, with many surgeons choosing to continue wearing N95 masks in the operating room and standard surgical masks in the clinic. These changes in behavior may limit surgeon exposure to other airborne diseases and help prepare the field for future epidemic outbreaks.

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