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# Interventional Radiology in the Coronavirus Disease 2019 Pandemic: Impact on Practices and Wellbeing

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**Purpose:** To report the impact of the coronavirus disease 2019 (COVID-19) pandemic on interventional radiology (IR).

**Materials and Methods:** A 78-question survey was distributed to practicing interventional radiologists and IR trainees. The survey consisted of demographic and practice environment queries. Anxiety symptoms were evaluated using the Generalized Anxiety Disorder-7 (GAD-7) screener, and coping strategies were assessed using the Brief-Coping Orientation to Problems Experienced (Brief-COPE) questionnaire.

**Results:** There were 422 respondents including 333 (78.9%) attending interventional radiologists and 89 (21.1%) interventional radiologists-in-training from 15 counties. Most respondents were from academic medical centers ( $n = 218$ ; 51.7%). A large majority ( $n = 391$ ; 92.7%) performed a procedure on a patient with confirmed COVID-19 infection. An N95 mask was the most common ( $n = 366$ ; 93.6%) safety measure employed. Cancellation or limitation of elective procedures were reported by 276 (65.4%) respondents. Many respondents ( $n = 177$ ; 41.9%) had self-reported anxiety (GAD-7 score  $>5$ ) with an overall mean GAD-7 score of  $4.64 \pm 4.63$  (range: 0-21). Factors associated with reporting anxiety included female gender ( $p = 0.045$ ), increased call coverage ( $p = 0.048$ ), lack of adequate departmental adjustments ( $p < 0.0001$ ), and lack of adjustments in a timely manner ( $p < 0.0001$ ). The most utilized coping strategy was acceptance (mean of  $5.49 \pm 1.88$ ), while the most employed dysfunctional coping strategy was self-distraction (mean of  $4.16 \pm 1.67$ ). The odds of reporting anxiety increased by  $> 125\%$  with adoption of dysfunctional strategies.

**Conclusion:** The COVID-19 pandemic induced practice alterations and high rates of self-reported anxiety in IR. Female gender, increased call coverage, and lack of adequate or timely departmental adjustments were associated with increased anxiety levels.

**Key Words:** Coronavirus disease 2019 pandemic; COVID-19; Practices; Anxiety; Coping strategies; GAD-7, Brief-COPE; Wellbeing; Burn-out; Interventional radiology; IR.

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**Abbreviations:** COVID-19 Coronavirus disease 2019, IR Interventional radiology, GAD-7 Generalized anxiety disorder 7-item scale, Brief-COPE Brief-coping orientation to problems experienced, HIPAA Health Insurance Portability and Accountability Act, IRB Institutional Review Board, STROBE Strengthening the reporting of observational studies in epidemiology, SIR Society of interventional radiology, DR Diagnostic radiology, PPE Personal protective equipment

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## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has had widespread impact on society. The pressure on healthcare has been felt with increases in hospitalization rates, economic hardships to providers and hospitals, and healthcare disparities (1). At the time of this study, there were  $>100$  million reported COVID-19 cases worldwide with 25 million in the United States (2).

Within radiology, there have been workflow alterations and financial devastations (3). The accompanying decline in non-COVID-19-related healthcare delivery resulted in a 50–70% reduction in the use of medical imaging. Combining this with exacerbated inpatient healthcare resource utilization related to COVID-19 hospitalizations, the pandemic has

resulted in a challenge distinct from historical economic recessions where accompanying decreased expenditures are expected (3).

Pandemic-related stressors profoundly impact the practices and mental health of healthcare personnel. Occupational exposure to COVID-19 patients and abrupt lifestyle changes of social distancing are known to promote anxiety and even the development of post-traumatic stress disorder (4,5). The impact of the COVID-19 pandemic on various medical specialties has previously been described (6,7). Furthermore, several recent studies have evaluated the magnitude of pandemic-related case-load variation in radiology practices, including reductions of interventional radiology (IR) volumes by 29.0–42.6% (8–11).

The purpose of this study was to study the impact of the COVID-19 pandemic on IR physicians using a survey containing practice pattern-related questions, the Generalized Anxiety Disorder-7 (GAD-7) screener, and the Brief-Coping Orientation to Problems Experienced (Brief-COPE) questionnaire.

## MATERIALS AND METHODS

### Study Population and Data Collection

This *Health Insurance Portability and Accountability Act* (HIPAA)-compliant study was exempt from *Institutional Review Board* (IRB) approval based on institutional assessment of criteria listed in 45 CFR 46.101(b). The study was assessed using *STrengthening the Reporting of OBservational studies in Epidemiology* (STROBE) guidelines (12). The survey was disseminated starting on November 28, 2020 and was closed to responses on December 23, 2020 (25 days). The survey was distributed via the *Society of Interventional Radiology's* (SIR) SIRConnect (<http://connect.sirweb.org/home>) general and resident-fellow-medical student forums. Forum membership, at time of distribution, was 6,927 and 3,002, respectively. Additionally, the survey was promoted using social media platforms such as Twitter (Twitter Inc; San Francisco, California), Facebook (Facebook Inc; Menlo Park, California), Instagram (Instagram; Menlo Park, California), and LinkedIn (LinkedIn Corp; Sunnyvale, California). Direct contact via e-mail, text messaging, and WhatsApp messenger application (WhatsApp Inc; Mountain View, California) further augmented recruitment efforts.

### Survey Design and Evaluation

An anonymous survey was created using Google Forms (Google; Mountain View, California) software and consisted of 78 questions (*Supplementary Appendix 1*). Most of the questions ( $n=76$ ; 98.7%) were multiple-choice. Of the 78 items, 59 (75.6%) questions required a response to generate a valid submission, 69 (89.6%) questions allowed only a single response, 7 (9.1%) allowed multiple responses, and one optional question asked for a free text response. Participants consented to participation in the study by selecting "I agree

to participate in this survey and have my responses pooled, analyzed, and reported for a study."

The GAD-7 is a validated seven question survey for self-reporting anxiety (13). The seven questions address symptoms of anxiety over the previous two weeks and are answered with four choices: not at all (0 points), several days (1), more than half the days (2), and nearly every day (3). A total score of  $\geq 5$  denotes a measurable level of anxiety, with  $\geq 5$  and  $< 10$  for mild anxiety,  $\geq 10$  and  $< 15$  for moderate anxiety, and  $\geq 15$  for severe anxiety.

The Brief-COPE is an abbreviated version of the COPE Inventory, a validated self-reporting questionnaire assessing coping strategies to stressors (14). The brief-COPE consists of 28 questions that are answered using a four-point Likert rating system: "I haven't been doing this at all" (1 point); "I've been doing this a little bit" (2); "I've been doing this a medium amount" (3); and "I've been doing this a lot" (4). There are 14 coping strategies each addressed with a pair of questions. Summed scores range from 2 (limited utilization) to 8 (high utilization). The coping strategies are divided into emotion-focused (acceptance, emotional social support, humor, positive reframing, and religion), problem-focused (active coping, instrumental support, and planning), and dysfunctional (behavioral disengagement, denial, self-distraction, self-blaming, substance use, and venting). Emotion-focused coping strategies aim to lessen the emotional distress of a stressor by altering feelings about the matter. Problem-focused coping strategies define the problem, seek alternative solutions, and consider relative risks and benefits. Approach coping, which includes both emotion and problem-focused, is associated with more helpful responses to adversity, including adaptive practical adjustment, more stable emotional responding and better physical health outcomes. Dysfunctional or avoidant coping is associated with poorer physical health among those with medical conditions. Compared to approach coping, avoidant coping is shown to be a less effective at managing anxiety. *Further description of each coping strategy is provided in Supplementary Appendix 2.*

### Eligibility Criteria

All respondents who completed the survey were included. There were 422 responses. Direct communication methods (email, text messaging, WhatsApp messenger, or word-of-mouth referral) reached 176 (41.7%) participants. 155 (35.7%) were recruited by social media (Twitter, LinkedIn, Facebook, or Instagram) and 81 (18.7%) were reached by professional society-based online discussion forums (SIR-Connect). There were no incomplete surveys, as responses were required for 59 of the 78 questions in order for the application to allow submission.

### Statistical Analyses

Data were collated within the Google Forms platform, and analyzed using Microsoft Excel (Microsoft; Redmond,

Washington) and R statistical software (R Core Team; Vienna, Austria) by a dedicated statistician included on this study. Tests for independence were conducted using ANOVA and F-test. Contingency tables were created using Chi-squared analysis. Univariate group comparisons were conducted using ANOVA, F-test, and Chi-squared analyses. P-values for Chi-squared analyses were estimated using Monte Carlo simulation. Multivariate proportional odds models were created using a proportional odds model fitted with stepwise variable selection using Akaike information criterion.  $P < 0.05$  was considered significant for all two-sided tests.

**RESULTS**

**Demographics**

Demographic data are shown in Figure 1. A total of 422 respondents completed the survey including 333 (78.9%) practicing interventional radiologists and 89 (21.0%) interventional radiologists-in-training. Of the participants, 354 (83.9%) identified as male, and 67 (15.9%) as female; 216 (51.2%) reported their race as “white,” followed by 129 (30.6%) as “Asian.”

Geographic Location data are shown in Figure 2. The United States had the greatest representation with 327 (77.5%) respondents, followed by 41 (9.7%) respondents from India, and 25 (5.9%) respondents from the United Kingdom. Within the United States, the states with the greatest representation were California ( $n = 41$ ; 9.7%), New York

( $n = 31$ ; 7.4%), Pennsylvania ( $n = 28$ ; 6.7%), and Washington ( $n = 27$ ; 6.4%).

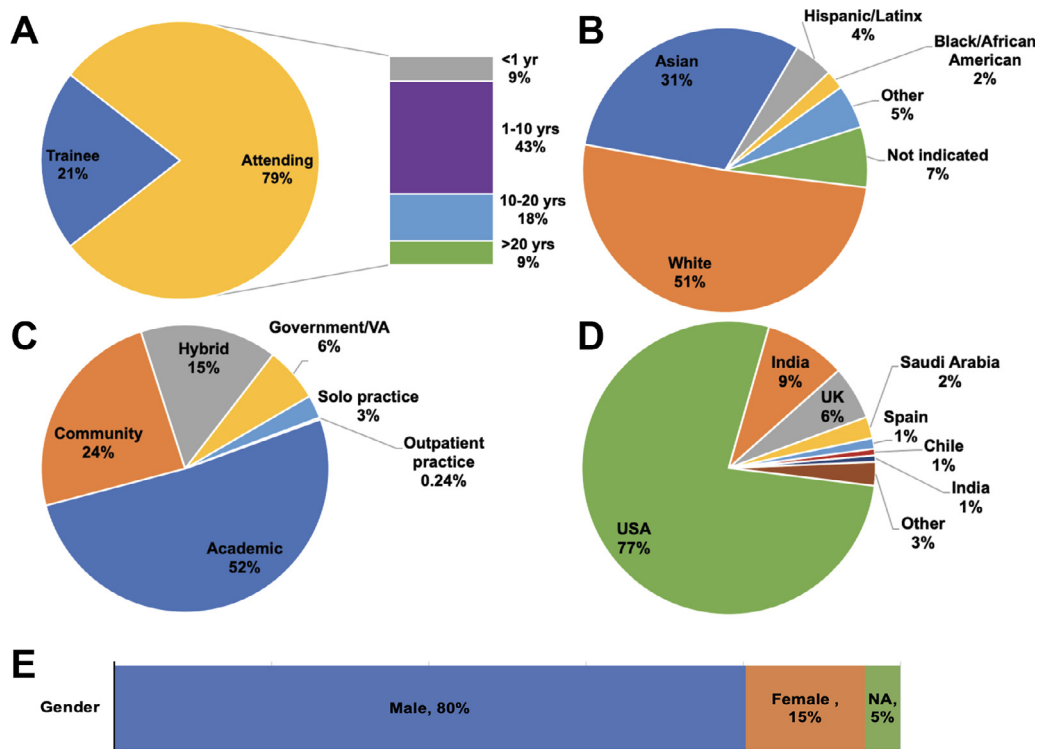
**Practice Environments**

A majority of workplaces were academic medical centers ( $n = 218$ ; 51.7%); community hospitals represented 24.2% ( $n = 102$ ); and a hybrid practice model accounted for 15.4% ( $n = 65$ ). The location of the hospital was described as “urban” by 356 (84.3%) participants, with 301 (71.3%) reporting they practiced at more than one hospital. Furthermore, 315 (74.5%) respondents described their primary hospital as a “teaching” hospital.

Of all participants, 181 (42.9%) reported that they held an institutional leadership position (such as department chair, section chief, program director, etc.). When asked about IR and diagnostic radiology (DR) responsibilities, 166 (48.4%) reported practicing 100% IR and 157 (45.8%) reported both IR and DR responsibilities with <50% DR. A small amount of administrative time (1-24%) was reported in 69.8% (238/341) of participants, followed by no administrative responsibilities in 20.2% (69/341) of participants.

**Individual Experiences with COVID-19**

A large majority ( $n = 391$ ; 92.7%) of the participants reported performing a procedure on a patient with confirmed



**Figure 1.** Survey Respondent Demographic Data. (A) Pie chart demonstrating percentage of attending and practitioner versus trainee responses. Within the attending proportion is further description of time in practice. (B) Reported race and ethnicity of the survey respondents. (C) Reported types of practice amongst respondents. (D) Representative countries for survey respondents. (E) Reported gender of the survey respondents. (Color version of figure is available online.)



TABLE 1. Intra-Procedural Safety Measures Utilized while Performing a Procedure on COVID-19 Positive Patients.

| N   | %     | N95 mask | Air purifier/respirator device | Suite isolated during intubation | Suite/control room isolated during procedure |
|-----|-------|----------|--------------------------------|----------------------------------|--|
| 137 | 34.3% | x        |                                | x                                | x  |
| 76  | 19.0% | x        |                                |                                  |  |
| 67  | 16.8% | x        |                                |                                  | x  |
| 36  | 9.0%  | x        | x                              | x                                | x  |
| 26  | 6.5%  | x        |                                | x                                |  |
| 13  | 3.3%  | x        | x                              |                                  | x  |
| 12  | 3.0%  |          | x                              |                                  |  |
| 7   | 1.8%  |          | x                              | x                                | x  |
| 7   | 1.8%  | x        | x                              |                                  |  |
| 7   | 1.8%  |          | x                              |                                  | x  |
| 3   | 0.8%  | x        | x                              | x                                |  |
| 3   | 0.8%  |          |                                |                                  | x  |
| 2   | 0.5%  |          | x                              | x                                |  |
| 2   | 0.5%  |          |                                | x                                |  |
| 1   | 0.3%  |          |                                | x                                | x  |

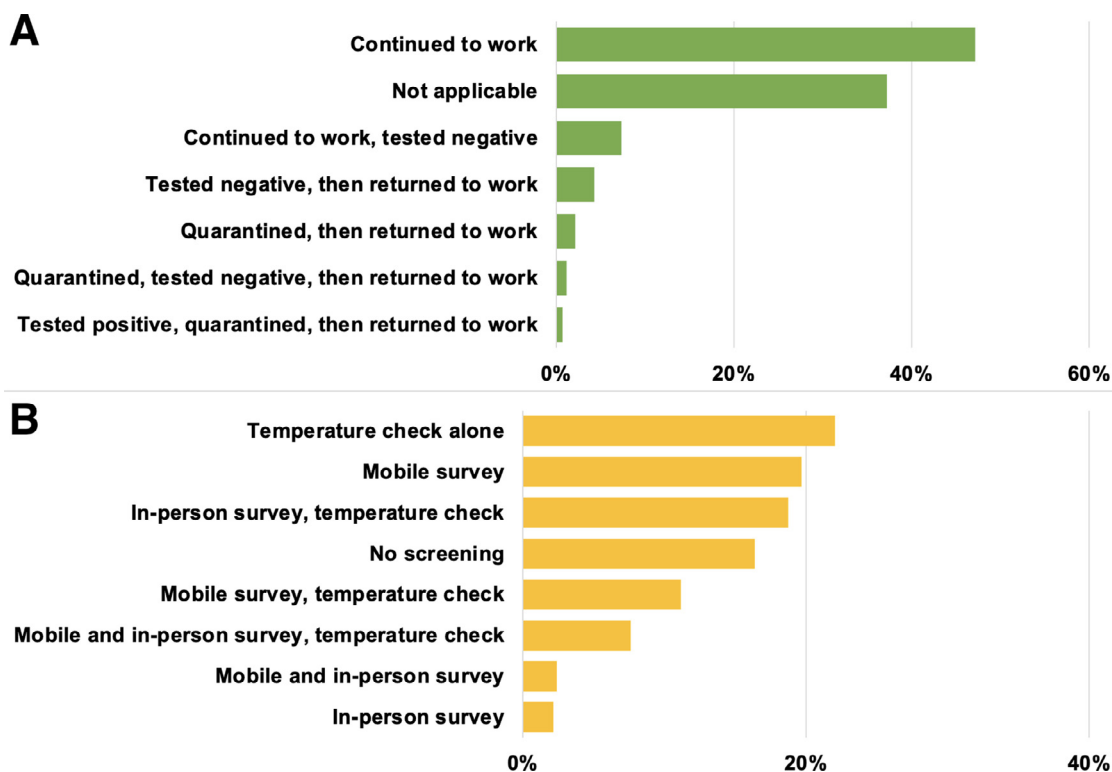


Figure 3. Patterns of COVID-19 Exposure Control and Preventative Screening. (A) Frequencies of various management strategies regarding post-COVID-19 exposure. (B) Frequencies of employed screening practices for individuals entering their clinical sites. (Color version of figure is available online.)

(42.9%) stating that all elective procedures were canceled at some point during the pandemic.

Clinical workforce was divided into two or more working teams for 89 (21.1%) respondents. There was change in location where procedures were performed for 174 (41.2%) respondents, with 126 (29.9%) reporting an increased frequency of performing procedures outside their dedicated procedural suite (e.g., at patient's bedside, or surgical operating room). A change in the amount of on-call time occurred for 82 (9.4%) participants with 58 (13.7%) reporting an increased number of on-call hours.

Outpatient clinic office hours were limited for 112 (26.5%) participants, and 261 (61.8%) reported utilization of telehealth clinic visits. A majority ( $n = 229$ ; 54.3%) reported that overall clinic volume decreased, with 136 (32.2%) reporting decreased patient referrals, 92 (21.8%) reporting patient cancellations, and 65 (15.4%) reporting rescheduling of non-urgent visits. Overall, 347 (82.2%) reported that their department made sufficient alterations to their practice patterns, while 76 (17.8%) felt the adjustments were inadequate.

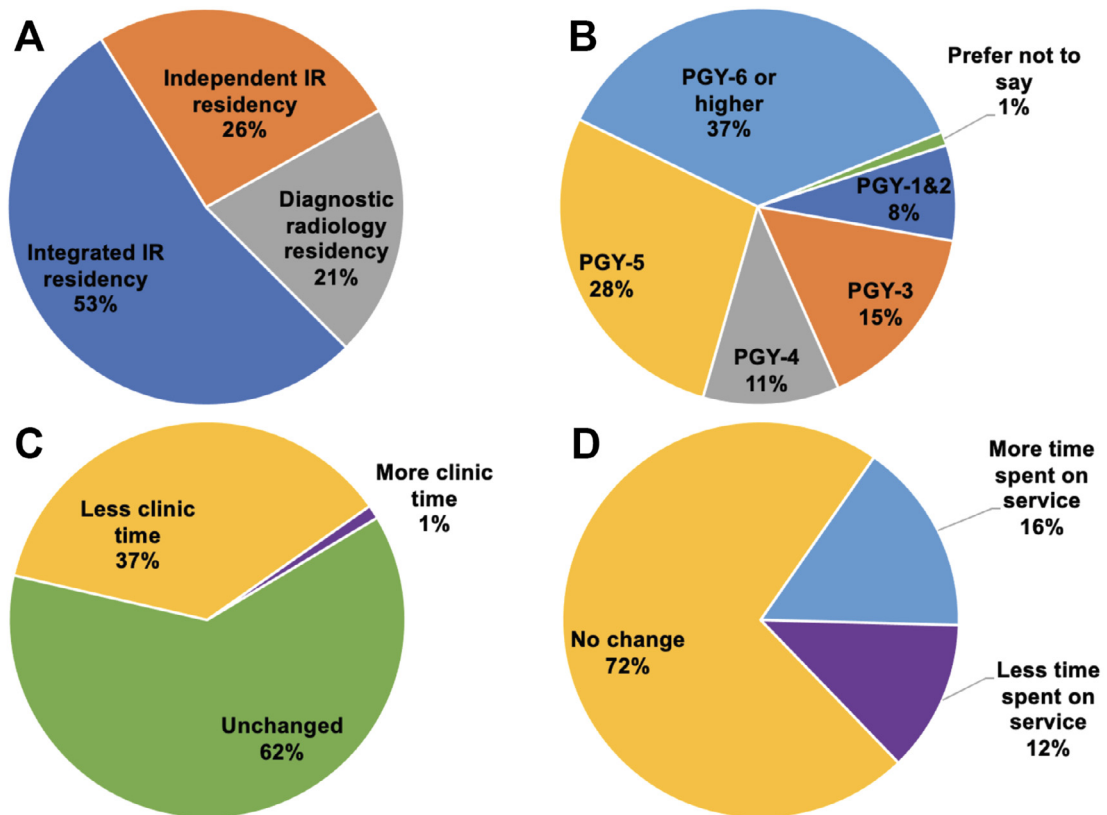
**Impact on the Interventional Radiologists-in-Training**

Trainee-specific demographic data are shown in Figure 4. Of the 89 IR trainees, 52 (58.4%) were integrated IR/DR residents, 25 (28.1%) were independent IR residents, and 21 (23.6%) were

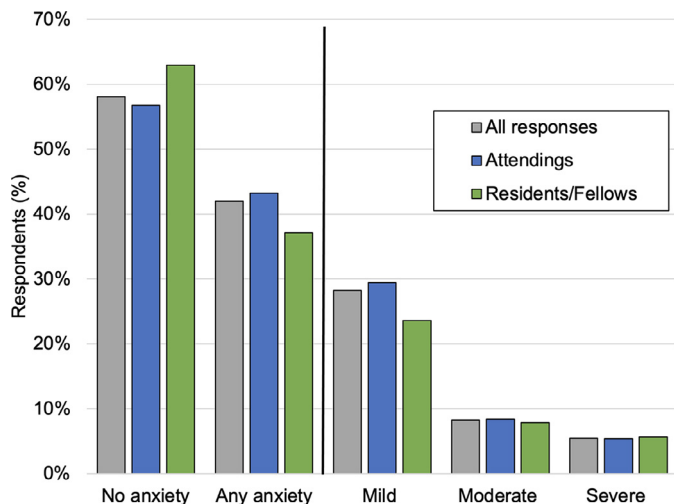
DR residents. Compared to pre-COVID, 33 (37.1%) reported decreased time spent in outpatient clinics. In terms of overall time spent working in the hospital, 14 (15.7%) reported increased work hours and 11 (12.4%) reported decreased work hours. In terms of perception on their institution's implemented changes, trainees were more likely to report that the changes made were inadequate (28.1% vs. 15.3%;  $p = 0.004$ ).

**Self-Reported Anxiety and Coping Strategies**

Responses to the GAD-7 survey are shown in Figure 5 and Figure 6. The GAD-7 survey demonstrated that 41.9% ( $n=177$ ) of respondents had a measurable level of self-reported anxiety with an overall mean GAD-7 score of  $4.64 \pm 4.63$  (range: 0-21). Mean GAD-7 scores were similar between practitioner and trainee respondents ( $4.62 \pm 4.60$  vs.  $4.75 \pm 4.75$ ;  $p = 0.80$ ). Mean GAD-7 survey scores were significantly higher for females compared to males ( $6.07 \pm 5.20$  vs.  $4.37 \pm 4.49$ ;  $p = 0.006$ ). Additional factors associated with increased rates of self-reported anxiety included increased call coverage ( $p = 0.025$ ) reporting of inadequate adjustments by the department ( $p < 0.0001$ ), and reporting of adjustments having been made in an untimely manner ( $p < 0.0001$ ). Overall mean GAD-7 scores were higher for those who considered themselves high-risk for COVID-19



**Figure 4.** Program Data and Education Environment Changes for Interventional Radiologist Trainees. Four pie-charts demonstrating (A) respondent's training program, (B) year in training, (C) changes in time in outpatient clinics, and (D) change in time on inpatient clinical services. (Color version of figure is available online.)



**Figure 5.** GAD-7 Survey Results for All Respondents. Graph demonstrating the percentage of respondents with self-reported anxiety, including subcategorization into mild, moderate, and severe anxiety levels. (Color version of figure is available online.)

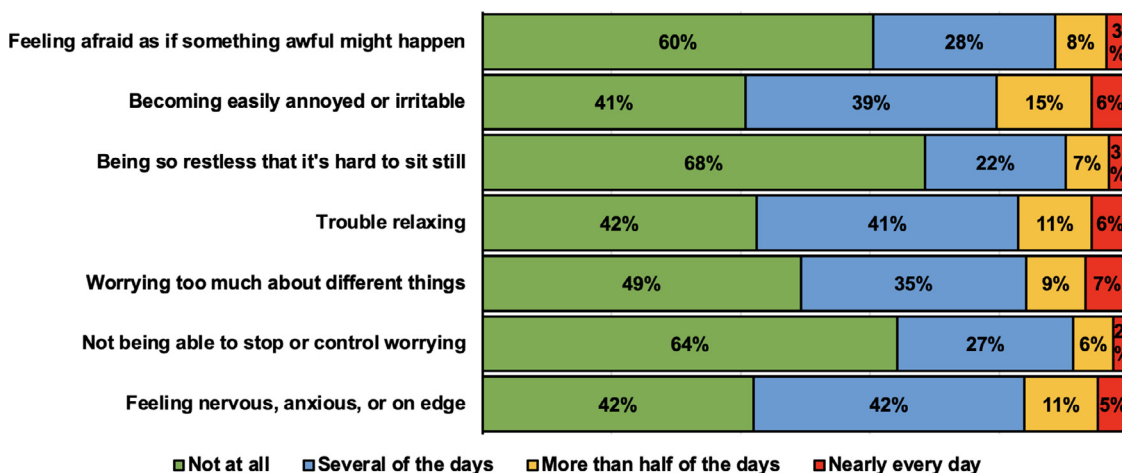
infection ( $6.10 \pm 5.58$  vs.  $4.38 \pm 4.37$ ;  $p = 0.005$ ). There was no statistical significance for other demographic data including location or training level.

The employed coping strategies are shown in Figure 7. The most utilized coping strategies were acceptance (mean of  $5.49 \pm 1.88$ ) and active coping (mean of  $4.37 \pm 1.70$ ). Dysfunctional coping strategies predominantly ranked lowest on the frequency employed by respondents, with the exception of self-distraction (mean of  $4.16 \pm 1.67$ ). Overall, usage of the five dysfunctional coping strategies was proportionally related to increasing levels of anxiety. When evaluated using a proportional odds model, the odds of reporting anxiety increased by >125% with utilization of dysfunctional strategies, with the greatest increase seen with behavioral disengagement (169%;  $p < 0.0001$ ) and self-blame (160%;  $p < 0.0001$ ). On the other hand, timely implementation of practice guidelines was associated with a 50% reduction in anxiety ( $p = 0.006$ ).

**Qualitative Analysis**

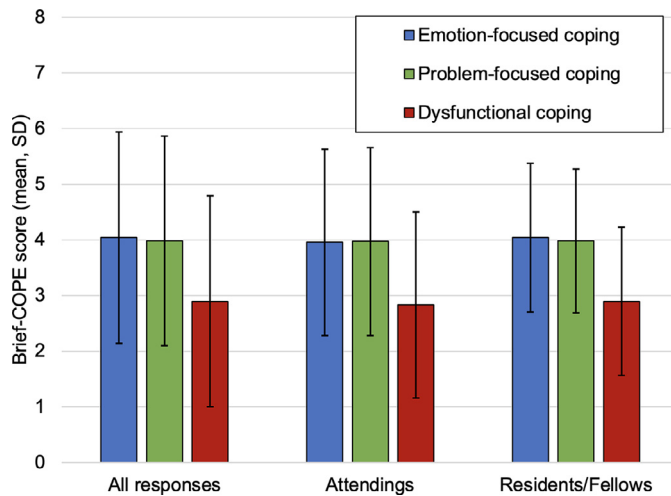
There were 34 responses from the total 422 submissions (8.1%) to the optional open-ended question asking about any additional concerns (Supplementary Appendix 3). Three general themes were identified in the provided responses, including “addressing changes to workflow,” “addressing administrative concerns,” and “addressing personal stressors.”

The most prevalent theme was “addressing changes to workflow.” Within this theme, two sub-themes emerged: “changes to the procedural coverage” and “reduction in outpatient volume.” For the former, several comments addressed concerns regarding increased coverage of minor procedures secondary to other specialties’ deferment, such as “more cases were directed to IR, as other services were either less staffed or not [wanting] to take the risk” and “IR does all the [gastrostomy] tubes on COVID-19 patients, which is new [for the department].” The potential reduction in outpatient vol-



**Figure 6.** Breakdown of Responses to the Seven Questions Included on the GAD-7 Survey. Respondents were able to provide one response to the listed statements, responses to the given prompts included “not at all,” “several of the days,” “more than half of the days,” and “nearly every day.” (Color version of figure is available online.)





**Figure 7.** Summarized Data from the Brief-COPE Survey. The 14 assessed coping strategies are grouped into emotion-focused coping, problem-focused coping, or dysfunctional coping. Brief-COPE survey scores range from 2 (minimal utilization) to 8 (maximum utilization) on the y-axis. Scores are tallied for all responses, attendings and practitioners, and trainees. (Color version of figure is available online.)

ume was described as a “massive challenge, nearly all elective intervention has been cancelled” and “the most difficult thing has been the inability to do face to face practice building.”

The next most prevalent theme was “addressing administrative concerns.” Within this theme, three sub-themes emerged entailing “PPE,” “guideline creation,” and “guideline compliance.” Multiple comments addressed concerns over PPE shortages, including “limited PPE choices... recycled PPE despite nine months passing since the start of the pandemic” and “PPE was short.” As for the establishment of guidelines, several respondents raised concerns over the consistency of policies set forth by their hospital administrations. These included comments such as “higher management was out of sync with ‘on the shop floor’ interventional radiologists” and “early preparations were overkill, and now that there was more virus transmission, increased hospitalizations, deaths, number of positives, etc. there was no change to practice.”

Finally, the third theme presented was “addressing personal stressors.” These comments ranged from those of shock (e.g., “knowing the potential consequences, caring for COVID-19 positive patients even with PPE in place still feels like a Hollywood horror movie for personal risk”) to indifference (e.g., “having to live with COVID-19”). Several respondents shared anecdotes of their own hospitalizations as well as deaths of close family members. From the trainees’ perspective, one respondent mentioned that “[graduate medical education] needs to do a better job keeping up resident morale.”

## DISCUSSION

The impact of the COVID-19 pandemic is far-reaching, and this global study describes the challenges to IR practices and mental health. A majority (65.4%) of respondents reported a significant impact to their elective procedure volume. Other unique challenges included the nearly one third of respondents reporting increased rates (29.9%) of performing procedures in alternative locations (such as at the patient’s bedside) and a smaller portion (13.7%) of respondents reporting

increased IR call coverage. The procedural location disruption is consistent with other early commentary from interventional radiologists with the goal of minimizing patient transfer and a greater utilization of COVID-19-specific isolation rooms (15).

From a trainee’s perspective, there was a reduction in the time spent in outpatient clinics by 37.1% of trainee respondents, while the overall time within the hospital was similar (15.7% increased hours vs. 12.4% decreased hours). The results highlight reductions in valuable outpatient educational opportunities which may impact the quality of training. The challenge encountered by most medical specialties is balancing the risk of resident transmission with the requisite work hours needed to meet milestones. From the DR aspect of residency training, imaging volume dropped by >87.3% for junior residents (10). An additional challenge to meeting milestones was the threat of redeployment of residents to inpatient medical services, including critical care units and rapid response teams (16,17). From the perspective of specialty governing bodies, temporary modifications have been made to graduation requirements, as well as providing more structured guidance regarding redeployment of IR trainees (18).

From this study, trainees were statistically more likely than practicing interventional radiologists to report that their place of work did not make adequate changes to address the pandemic. Recent literature has recommended residency programs take aim at resident wellness and resilience with frequent and transparent communication and improved clinical efficiency (18,19).

There is increasing public and medical concern regarding the pandemic’s potential psychological impacts on healthcare providers. Within the surveyed population of 422 practicing interventional radiologists and trainees, 41.9% reported some degree of anxiety. Prevalence of anxiety among physicians in studies conducted prior to the COVID-19 pandemic were estimated to range between 24–26% (20,21), while it is estimated that the prevalence amongst the general population was 11–22% (22,23). Similar recent surveys of diagnostic radiologists addressed potential pandemic-related anxiety

symptoms. Although the standardized GAD-7 survey was not utilized, their reported anxiety rates ranged from 14.9–61% (24,25). An early survey of healthcare workers in Wuhan, China which did utilize the GAD-7 results, demonstrated similar anxiety rates of 44.6% of the 1257 surveyed (26).

Factors associated with increased anxiety included female gender and increased IR call coverage. There has been exhaustive research behind gender differences in anxiety rates, overall demonstrating greater prevalence of reported anxiety in females (27). When it comes to acute stress events, researchers theorize that the greater utilization of emotion-focused coping strategies seen in females is less effective in reducing distress (28).

Additional factors associated with anxiety were perceptions of inadequate or untimely administrative responses to the pandemic, which were described in the provided free responses. The predominant themes included addressing concerns both about PPE shortage as well as formation of consistent guidelines. Multiple respondents raised concerns that IR did not receive adequate priority for procedural guidelines and vaccinations by their hospital administrations. Overall, perceived support from administration or department may reduce anxiety levels as seen from the GAD-7 results and the multitude of concerns brought forth in free-text responses.

As is known from recent studies, physicians as a whole suffer from high levels of burnout (29,30,31,32). The results of the current study highlight several areas of concern which may overlap with external factors associated with burnout. Concerns regarding decreased clinical volume likely parallel financial concerns, an often-cited critical component of physician burnout (33). Furthermore, the magnitude of measurable anxiety in the surveyed cohort is concerning as symptoms of anxiety are linked to the development of burnout (34,35,36).

Interventional radiologists frequently use the emotion-focused coping strategy of acceptance (*Supplementary Appendix 2*). On the other hand, assessing the use of dysfunctional coping strategies is important as they are associated with higher rates of anxiety (37). Although most of the dysfunctional coping strategies were less commonly utilized, the technique of self-distraction was the third most frequently used of the 14 total coping strategies. As an avoidant coping strategy, self-distraction has historically been thought of as an additional risk factor for poorer long-term mental health outcomes. More recent studies, however, suggest that a positive-framed self-distraction technique may not be as dysfunctional as previously thought (38,39). Regardless, a greater understanding of interventional radiologists' coping processes may help highlight potential areas of support and intervention.

There are several limitations with this study, including biases inherent to self-reported survey responses from specific populations contacted via social media and direct emails. The duration during which the survey was available (November 28 to December 23, 2020) represents a small fraction of the ongoing pandemic and thus represents a cross sectional, rather than longitudinal, view of many of the parameters assessed.

Clinical experiences, preparedness, anxiety levels, and coping mechanisms have presumably oscillated and evolved with the various stages of the pandemic. Additionally, while this study intended to capture the effects on healthcare providers across the world, regions outside the United States were underrepresented in this survey. Contributing factors likely include constituency of the audiences receiving the survey, language of the survey (English only), and practice locations of the authors who solicited survey participation by personal correspondence.

This study offers important analyses on the impact of the COVID-19 pandemic on the practice of IR and on the mental health of its professionals. The highlighted risk factors for symptoms of anxiety amongst interventional radiologists underscore the importance of timely and adequate administrative support in the setting of public health crisis.

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All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This study was *Institutional Review Board*-exempt and the need for informed consent was waived.

For this type of study consent for publication was not required.

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## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.acra.2021.05.025.