


## ORIGINAL ARTICLE

# Perception of COVID-19 pandemic restrictions on dental researchers

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## Abstract

**Background/objectives:** Historical evidence shows a gender-based disproportionate effect of pandemics across different populations. In 2020, the coronavirus disease 2019 (COVID-19) pandemic began spreading its devastating effects worldwide. The goal of the present study was to investigate the effect of the COVID-19 pandemic on research productivity, work-life arrangements, and mental health of dental professionals worldwide with focus on gender differences.

**Methods:** A 38-item survey, concerning demographics, career stage, employer support, family structure, mental health, and relationships, was distributed to 7692 active members of the International Association for Dental Research. Bivariate associations between independent variables and the primary outcome variable were tested using Spearman's correlation test. A logistic regression model was used to assess the simultaneous, independent associations between each variable and researcher productivity.

**Results:** A total of 722 responses were obtained, indicating a 9.4% response rate. Higher productivity was reported by male respondents ( $p = 0.021$ ), and by those in senior career stages ( $p = 0.001$ ). Institutional support was associated with higher productivity ( $p < 0.0001$ ). Lower productivity was reported by

younger researchers ( $p = 0.003$ ). Remote work negatively affected productivity ( $p < 0.0001$ ) and female respondents reported working more hours, regardless of work location ( $p = 0.004$ ). Poor mental health was associated with low productivity ( $p < 0.0001$ ).

**Conclusions:** Our results showed that the COVID-19 pandemic significantly affected dental professionals' perceived productivity and mental health around the globe. Younger individuals and women were disproportionately affected, and institutional support had a significant influence to mitigate effects of the pandemic for dental researchers.

#### KEYWORDS

gender differences, research productivity, researchers, scholarly work, workforce

## 1 | INTRODUCTION

Historical evidence shows a gender-based disproportionate effect of pandemics across different populations.<sup>1</sup> Previous evidence based on the 1918 influenza pandemic showed that the effects of environmental conditions on women may last for up to three generations, with direct consequences, including a reduced level of education, younger age at marriage, and the lower education of their marrying male partners.<sup>2</sup> These consequences collectively result in long-term social gender inequities.

Since 2020, the coronavirus disease 2019 (COVID-19) pandemic continues to cause unprecedented effects worldwide.<sup>3,4</sup> Women have been disproportionately exposed to the COVID-19 virus given that they represent most of the health, social, and caregiving workforce worldwide. Specifically, women are more likely to care for children, and ill relatives.<sup>5,6</sup> National school closures and other “shelter-in-place” measures were examples of measures taken by countries to contain the spread of the virus and rate of infections.<sup>7</sup> Given the higher risk related to severe respiratory consequences in the elderly, and requirements for social distancing, grandparent-provided childcare and formal and informal childcare delivery was limited.<sup>8</sup> Thus, female health-care workers were disproportionately tasked with caring for the children, which resulted in a shortage of female health-care professionals,<sup>8</sup> due to the combination of a sudden increase in family responsibilities with “remote work” arrangements.<sup>9</sup> Higher self-reported levels of stress, anxiety, depression, and post-traumatic stress symptoms have been described as psychological effects of the pandemic on health-care workers,<sup>3,7,10,11</sup> with a significantly higher impact on female health-care professionals than their male counterparts.<sup>11,12</sup> This effect is likely to further contribute to a model of vertical gender segregation, leaving women in serious disadvantage when competing

with their male colleagues for tenure, promotion, and leadership opportunities.<sup>13</sup>

Although the representation of women in the health-care workforce has increased over the last several decades,<sup>14</sup> financial gains and leadership opportunities for women still rate well below those available for their male counterparts.<sup>15</sup> In dentistry, women's representation worldwide has grown from 3% to ~30% in the past 40 years<sup>16</sup>, although, in 2020, 36.8% of North American dental faculties were women, and 20% of permanent US dental school deans were women. Given these preexisting disparities and the inequitable distribution of childcare and home caretaking activities between male and female faculty members,<sup>17,18</sup> it has been suggested that the impact of the pandemic may have been more acutely felt by female dental faculty. Women with school-age children may have been forced to sacrifice the number of hours dedicated to research and scholarly work in lieu of family activities.<sup>17,19</sup>

Therefore, this study aimed to investigate the impact of the early COVID-19 pandemic restrictive measures on perceived productivity, work-life arrangements, and the mental health of dental professionals engaged in research worldwide.

## 2 | METHODS

### 2.1 | Survey development, validation, and implementation

The study received exempt status from the University of Connecticut Institutional Review Board in August 2020 (IRB #21X-043-2; 08/19/2020). The survey instrument was developed by the study team based on a systematic review of the existing evidence on the effect of COVID-19 on research productivity, using survey-reporting guidelines.<sup>20</sup>

The 38-item survey focused on addressing research productivity measured by perceived productivity of scholarly work and work hours during the pandemic, and aimed to identify factors associated with research productivity, including family arrangements, mental health, and demographics. The survey instrument containing five domains (main focus, employer support, childcare and family, mental health, relationships and demographics) is provided as an online appendix (Appendix 1). The instrument was validated in a group of researchers, and after additional pilot testing, the survey was launched in October 2020.

The survey was distributed to 7692 International Association for Dental Research (IADR) active members worldwide via an email sent by the IADR and linked to a secure web-based software supporting clinical research data capture (REDCap—Research Electronic Data Capture). Two reminders were sent 2 weeks apart, allowing participants a total of 6 weeks to respond.

## 2.2 | Data analysis

The primary outcome variable for this study was treated as a categorical binary variable measured by the response to the statement “*I feel (more/less)\_\_\_\_\_productive*” reflecting the period between March and October 2020. The response was categorized into “less productive” or “more/equal productive.”

For descriptive statistics, secondary categorical variables were summarized with counts and percentages and stratified by gender. Chi-square test was used to assess differences in categorical variables by gender. Bivariate associations were tested using Spearman's correlation test between independent variables and the primary outcome variable. A logistic regression model was used to assess the simultaneous associations between each variable and researcher productivity. Variables were included in this model only if they achieved a significance level of  $p \leq 0.20$  in the bivariable analysis. Independent variables were assessed for multicollinearity. Two independent variables (*researchers' mental health experiences during COVID* and *reasons for mental health issues*) exhibited collinearity. Thus, in the final model, *the researchers' mental health experiences during COVID* were selected based on the levels of correlation with primary outcome in the bivariate model. Data was analyzed in SPSS.  $p$ -Value  $< 0.05$  was considered for all analyses.

## 3 | RESULTS

Out of the 7692 surveys distributed, 722 responses were obtained (9.4% response rate). For demographics, data

was collected based on the IADR's membership distribution considering countries in five regions: 41% of the respondents were from North America, 13% from the Pan-European region, 16.2% from Asia-Pacific region, 13.1% from Latin America, and 6.8% from African and Middle East region. About 4.3% of the respondents did not respond about their membership region.

Table 1 presents an overview of respondents' demographics and variables analyzed. From the 722 respondents, 47% were female and 53% were male. Male respondents were the majority in the age group 60 years of age and older (71.4%), and female respondents were the majority between 20 and 29 years of age (72.2%). Over 80% of male respondents reported having children under 18 living with another parent. Female respondents were mostly graduate students and post-doctoral fellows, whereas male respondents were the majority within tenured professor and retired categories ( $p < 0.001$ ).

Female respondents tended to be highly or moderately concerned about their upcoming tenure and promotion applications compared to males (highly: 56% vs. 44%; moderately: 67% vs. 43%) ( $p < 0.0001$ ). Female respondents were also the majority in selecting *not comfortable at all* when asked about using performance indicators for salary increase in the near future (54% vs. 46%) ( $p < 0.0001$ ).

Figure 1 provides an overview of how gender affected the perception of professional productivity. Overall, female researchers reported worse *writing of manuscripts and grants*, *review of manuscripts* and *data collection*, and better *conference participation*, *research collaborations*, and *access to scientific information/data* during these restrictions. Figure 2 shows the gender distribution by career stage of survey respondents. Women were more often highly concerned or moderately concerned with tenure after the pandemic, and men indicated to be very comfortable with institutions using performance indicators for salary increase.

Survey respondents' age was positively correlated with perceived productivity ( $r = 0.11$ ;  $p = 0.003$ ), whereas males reported being more productive than females ( $r = 0.86$ ,  $p = 0.021$ ) (Table 2). Career stage was positively correlated with productivity; respondents at higher academic ranks reported being more productive ( $r = 0.120$ ,  $p = 0.001$ ). Considering effort, primary researchers were more/equally productive during the pandemic compared to faculty with primary effort dedicated to teaching and administrative duties, or who were retired ( $r = 0.89$ ,  $p = 0.017$ ) (Table 2).

Scholarly activity during the pandemic was assessed for the entire sample and through several variables (Table 2). Survey respondents perceived that productivity during the pandemic was positively correlated to writing of manuscripts ( $r = 0.316$ ,  $p < 0.0001$ ), review of manuscripts ( $r = 0.205$ ,  $p < 0.0001$ ), writing of grants ( $r = 0.196$ ,

TABLE 1 Description of the study population ( $N = 715$ )

	Male ( $N = 373$ ) (%)	Female ( $N = 342$ ) (%)	<i>p</i> -Value*
<b>Age (categorical variable)</b>			
20–29 years old	15 (27.8)	39 (72.2)	0.0001
30–39 years old	62 (45.9)	73 (54.1)	
40–49 years old	74 (43.0)	98 (57.0)	
50–59 years old	80 (51.9)	(48.1)	
≥60 years old	140 (71.4)	56 (28.6)	
Prefer not to answer	1 (33.3)	2 (66.7)	
<b>Marital status</b>			
Single	20 (27.8)	52 (72.2)	0.0001
Partnered/Unmarried	46 (43.4)	60 (56.6)	
Married	289 (59.2)	199 (40.8)	
Divorced/Separated	10 (32.3)	21 (67.7)	
Widowed	8 (44.4)	10 (55.6)	
<b>Parent status</b>			
Child under 18	114 (49.4)	117 (50.6)	0.0001
Children under 18 living with other parent	5 (83.3)	1 (16.7)	
Children under 18 in shared custody	2 (40.0)	3 (60.0)	
Children over 18 on their own	102 (75.6)	33 (24.4)	
Children over 18 in the house	39 (59.1)	27 (40.9)	
No children	111 (40.8)	161 (59.2)	
<b>Education</b>			
Post-Doc	112 (52.1)	103 (47.9)	0.026
PhD	151 (56.8)	115 (43.2)	
Masters	40 (37.0)	68 (63.0)	
Professional degree	64 (54.2)	54 (45.8)	
Other	3 (75.0)	1 (25.0)	
DDs/PhD	2 (66.7)	1 (33.3)	
<b>Employment status</b>			
Employed—working from home, due to COVID-19	100 (41.0)	144 (59.0)	0.004
Employed—working on job site, not at home	103 (59.9)	69 (40.1)	
Employed—working from home since before COVID-19	5 (71.4)	2 (28.6)	
Employed—working from home and job site	137 (56.4)	106 (43.6)	
Not Employed—laid off or furloughed due to COVID-19	4 (57.1)	3 (42.9)	
Not employed before COVID-19	12 (63.2)	7 (36.8)	
Other	6 (60.0)	4 (40.0)	
<b>Career stage</b>			
Graduate student	27 (33.3)	54 (66.7)	0.0001
Post-doctorate fellow	18 (34.6)	34 (65.4)	
Assistant professor, non-tenure	29 (45.3)	35 (54.7)	
Associate professor, non-tenure	18 (42.9)	24 (57.1)	
Full Professor non-tenure	25 (59.5)	17 (40.5)	
Assistant professor; pre-tenure/tenure-track	24 (49.0)	25 (51.0)	
Associate professor; pre-tenure/tenure-track	12 (52.2)	11 (47.8)	
Associate Professor with tenure	49 (55.1)	40 (44.9)	
Full professor with tenure	108 (58.7)	76 (41.3)	
Retired	33 (73.3)	12 (26.7)	
Other	7 (70.0)	3 (30.0)	

(Continues)

TABLE 1 (Continued)

	Male (N = 373) (%)	Female (N = 342) (%)	p-Value*
<b>Employment</b>			
Part-time	57 (57.0)	43 (43.0)	
Full-time	298 (50.4)	289 (49.6)	
Retired	20 (74.1)	7 (25.9)	
Other	2 (66.7)	1 (33.3)	
<b>Effort</b>			
Primary researcher	104 (49.5)	106 (50.5)	0.0001
Dental, PhD, or Post-Doc student	21 (33.3)	42 (66.7)	
Professional engaging in scientific research	92 (55.8)	73 (44.2)	
Science management, policy advice, and implementation management	34 (72.3)	13 (27.7)	
Administration	18 (75.0)	6 (25.0)	
Teaching and research	16 (57.1)	12 (42.9)	
Retired	4 (100.0)	(0.0)	
Other	5 (55.6)	4 (44.4)	
Two or more roles	79 (49.4)	81 (50.6)	
Not reported	0 (0.0)	5 (100.0)	

Abbreviation: COVID-19, coronavirus disease 2019.

\*Chi square test,  $p < 0.05$  indicates statistical differences.

$p < 0.0001$ ), research collaborations ( $r = 0.173$ ,  $p < 0.0001$ ), and better access to scientific information ( $r = 0.158$ ,  $p < 0.0001$ ). Study respondents also perceived productivity during the pandemic as negatively correlated to collection of data (less/worse = 64.6%,  $r = -0.163$ ,  $p < 0.0001$ ), and supervision of students (less/worse = 47.1%,  $r = -0.113$ ,  $p = 0.002$ ). Survey respondents perceived that their productivity would be negatively affected by COVID-19 restrictions within the upcoming 6 months ( $r = -0.186$ ,  $p < 0.0001$ ).

Interestingly, adequate institutional support during the pandemic was associated with higher scholarly productivity ( $r = 0.151$ ,  $p < 0.0001$ ) and online teaching ( $r = 0.091$ ,  $p = 0.015$ ) (Table 2). Lower perceived productivity was correlated with poor mental health, with 60.1% of the respondents reporting higher than usual stress levels during the pandemic ( $r = 0.270$ ,  $p < 0.0001$ ) (Table 2).

Table 3 shows the results for the logistic regression model. Significant associations were noted for perceived productivity with age ( $\beta = -0.016$ ,  $p < 0.0001$ ) and relationship status ( $\beta = -0.113$ ,  $p < 0.0001$ ). Married respondents reported lower perceived productivity, and females reported being less productive than males ( $\beta = -0.152$ ,  $p < 0.0001$ ). Additionally, respondents who worked from home reported being less productive ( $\beta = -0.043$ ,  $p < 0.0001$ ). The career stage of the respondents was positively associated with their perceived productivity levels, where higher academic ranked respondents were more

productive ( $\beta = -0.008$ ,  $p = 0.004$ ). Of note, the lack of adequate measures from the institution to protect the health and safety of students and faculty had an impact on the perceived productivity of the respondents ( $\beta = -0.025$ ,  $p = 0.034$ ). Adequate information and technology support from institutions during COVID 19 was associated with more/equal perceived productivity ( $\beta = -0.006$ ,  $p = 0.009$ ). Mental health was also negatively associated with perceived productivity ( $\beta = -0.013$ ,  $p < 0.0001$ ), where poor mental health was associated with lower perceived productivity. Respondent's effort (measured by job category) was negatively associated with researcher productivity, where primary researchers were more/equally productive during the pandemic compared to faculty with primary effort dedicated to teaching and administrative duties or who were retired ( $\beta = -0.004$ ,  $p = 0.025$ ).

Amongst the respondents who reported poor mental health, males were the majority in selecting depression and other symptoms, whereas females selected two or more symptoms ( $p < 0.001$ ). Amongst the reasons associated with poor mental health, increased child-care for/homeschooling responsibilities ranked highest amongst female respondents, whereas male respondents ranked *financial responsibility* and *others* the highest ( $p = 0.001$ ). When asked about their ability to manage the challenges imposed by the pandemic restrictions, the majority of females ranked poorly ( $p < 0.0001$ ). Female respondents also reported their children's ability to

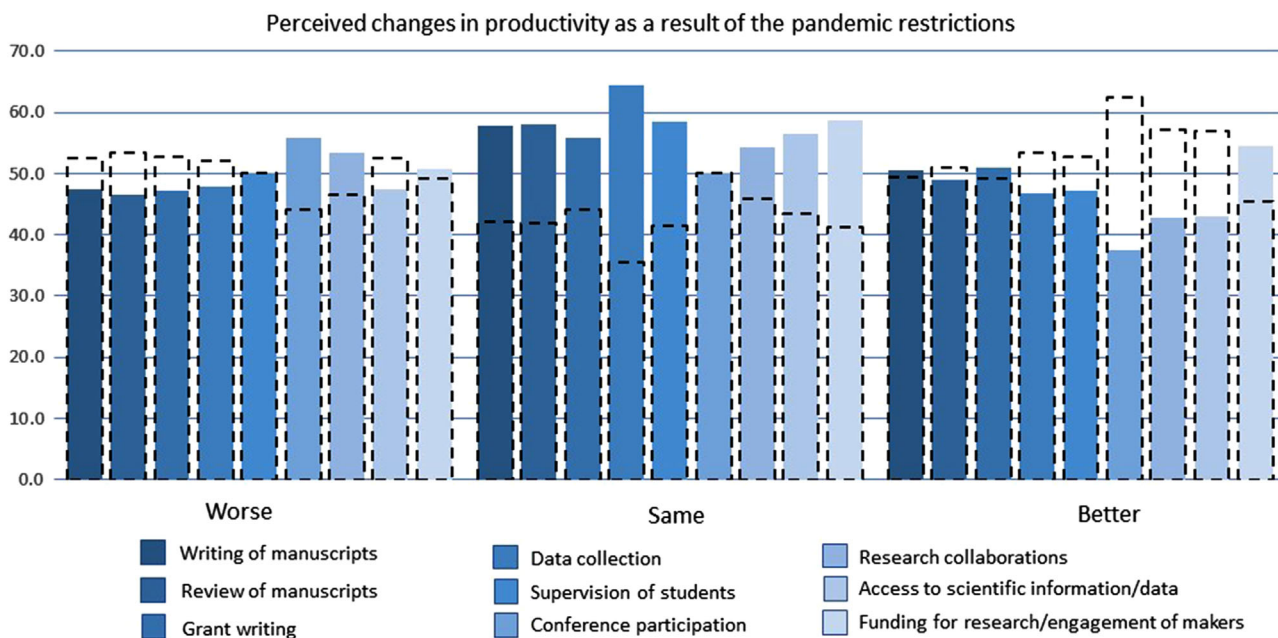


FIGURE 1 Changes were reported in scholarly productivity as a result of the coronavirus disease 2019 (COVID-19) pandemic restrictions. Blue bars represent male respondents and dashed lines represent female respondents for the same category.

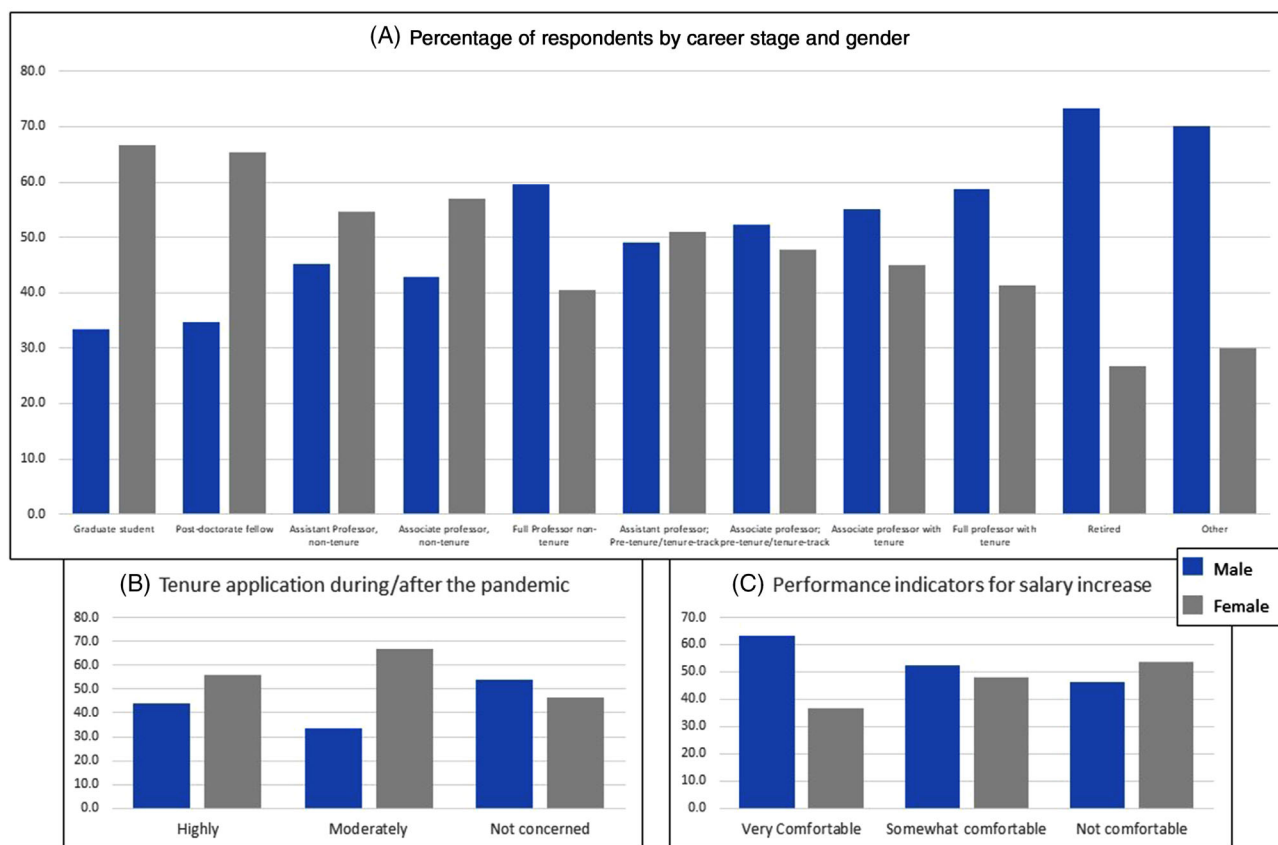


FIGURE 2 Career stage, tenure, and promotion: (A) gender percentage of respondents per career stage; (B) gender percentage and level of concern of pre-tenure respondents regarding the effects of the pandemic on tenure and promotion; (C) gender percentage and level of comfort with institutions using performance indicators (e.g., publications and grants) to determine salary increase in the years following the coronavirus disease 2019 (COVID-19) pandemic

**TABLE 2** Association between productivity and independent variables ( $n = 722$ )

Variables	Correlation coefficient	<i>p</i> -Value*
Age	0.110	0.003
Gender	0.86	0.021
Relationship status	0.039	
Parent status	-0.034	
Education	0.003	
Work	0.015	
Career stage	0.120	0.001
Effort	0.89	0.017
Scholarly work		
Writing of manuscripts	0.316	
Review of manuscripts	0.205	<0.0001
Grant writing	0.196	<0.0001
Data collection	-0.163	<0.0001
Supervision of students	-0.113	0.002
Conference participation	0.068	
Research collaborations	0.173	<0.0001
Access to scientific information/data	0.158	<0.0001
Funding for research engagement of policy makers	0.023	
Future impact of COVID-19 on research	-0.186	<0.0001
Institutional measures to protect the community	0.011	
Institutional support for faculty during the COVID-19 crisis	0.151	<0.0001
Institutional IT support for the shift to online teaching	0.091	0.015
Changes in tenure clock	-0.13	
Mental health experience	0.270	<0.0001
Reasons related with mental health issues	0.127	0.001

Abbreviations: COVID-19, coronavirus disease 2019; IT, information and technology.

\*Spearman correlation test;  $p < 0.05$  indicates statistical differences; only significant differences reported in the table.

**TABLE 3** Model of association between productivity and independent variables ( $n = 722$ )

	Estimates	Std. error	<i>p</i> -Value*	95% confidence interval
Age	-0.016	0.003	<0.0001	-0.022, -0.010
Gender	-0.152	0.013	<0.0001	-0.178, -0.126
Relationship	-0.113	0.011	<0.0001	-0.135, -0.090
Education	0.008	0.001	<0.0001	0.005, 0.011
Work	-0.043	0.006	<0.0001	-0.54, -0.032
Career stage	0.008	0.003	0.004	0.003, 0.014
Mental health experiences	0.013	0.002	<0.0001	0.009, 0.016
Institutional measures to protect the community	-0.025	0.012	0.034	-0.049, -0.002
Institutional support for faculty during the COVID-19 crisis	0.006	0.002	0.009	0.001, 0.010
Institutional IT support for the shift to online teaching	0.009	0.012	0.478	-0.015, 0.032
COVID-19 anticipated impact on research	0.005	0.001	<0.0001	0.004, 0.006
Effort	-0.004	0.002	0.025	-0.007, 0.0001

Abbreviations: COVID-19, coronavirus disease 2019; IT, information and technology.

\*Logistic regression;  $p < 0.05$  indicates statistical differences.

manage the challenges poorly ( $p < 0.0001$ ), whereas most of the male respondents reported that their children managed the challenges well (Figure 3).

#### 4 | DISCUSSION

The results presented in this study were based on a response rate of 9.4% from a sample of dental researchers distributed in five regions around the world. The COVID-19 pandemic affected professionals in dental research and education in various degrees: male respondents reported being more productive ( $p = 0.021$ ), whereas younger researchers reported being less productive ( $p = 0.003$ ). Researchers working remotely also reported being less productive ( $p < 0.0001$ ). Lower productivity was associated with poor mental health ( $p < 0.0001$ ), and amongst the reasons for poor mental health, having to care for/homeschool children was ranked the highest amongst females, whereas financial responsibility ranked highest in males. Studies have shown that caregiving without proper support and training is associated with poor mental health.<sup>21</sup> Female caregivers have previously reported higher levels of anxiety and depression, and lower levels of subjective well-being, such as life satisfaction and physical health.<sup>22</sup> Access to well-equipped childcare facilities and paid family leave are amongst the practical measures that could minimize stress for both men and women in crisis situations such as the unprecedented COVID-19 pandemic.<sup>23</sup>

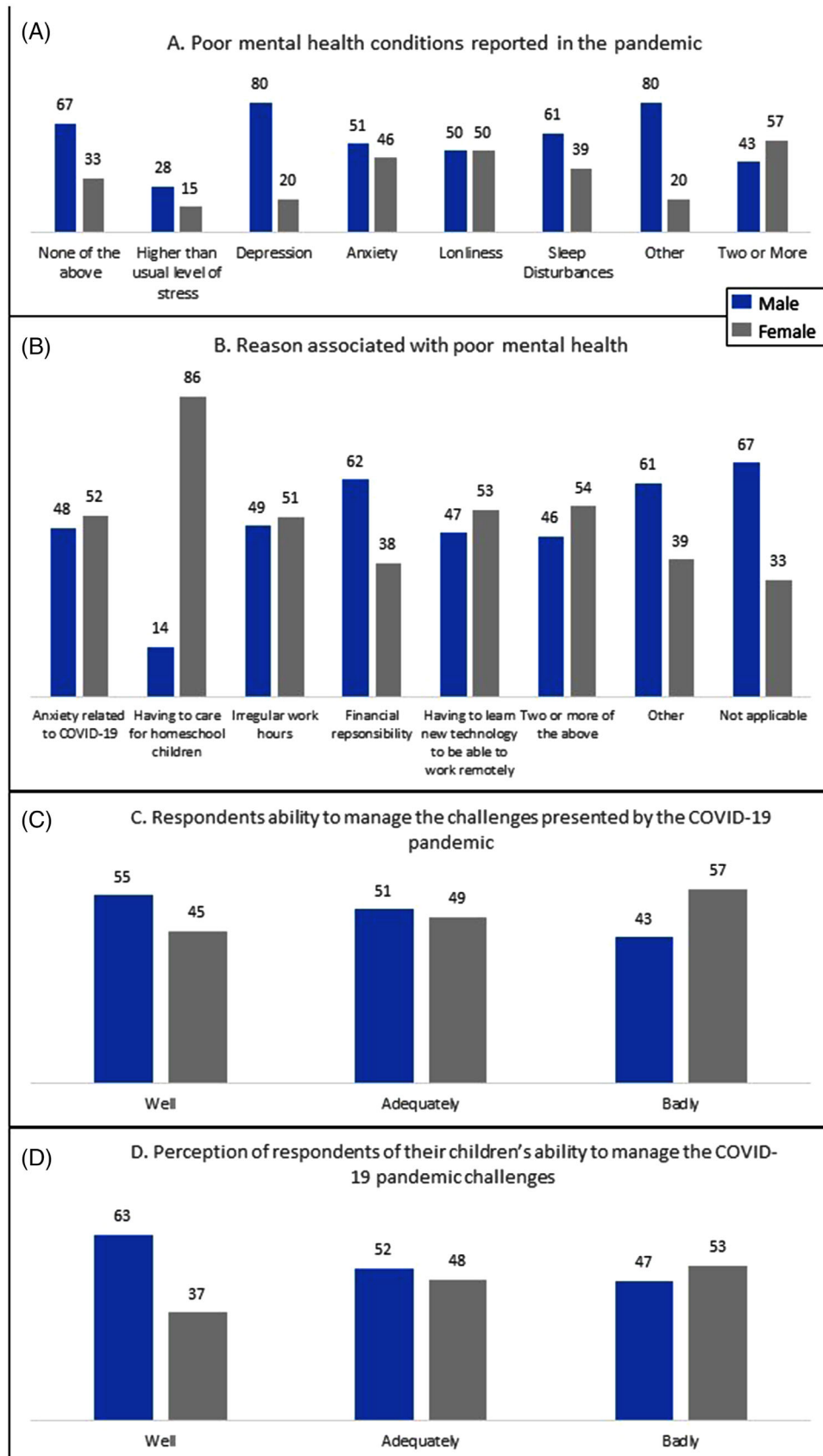
The participant demographic data shows a bimodal gender distribution with female respondents being more likely to be a graduate student or post-doctoral fellow, whereas male respondents were in mid-career or senior faculty positions. This trend for younger female and older male respondents may represent the generational trend of more women joining dental academia and is reflective of age/gender distributions identified within dental school faculty (ADEA Educational snapshot). These findings are reflective of dental faculty overall, but disparities exist with women underrepresented in senior leadership roles.<sup>24</sup> Some of the gender inequities described in this cross-sectional study may worsen the barriers for women breaking the “glass ceiling” and achieving senior faculty administrative positions in academia.<sup>25</sup>

The present results also indicate that age, gender, career stage, and effort distribution had a significant effect on perceived scholarly productivity during the pandemic (Table 2). Younger female researchers in early career appointments reported being less productive due to pandemic restrictions such as “shelter-in-place” measures that forced professionals to work from home and, concomitantly, school closures that affected more than 90% of the world population at the same time.<sup>7,26</sup> These restric-

tions were at their most severe during the time frame of the deployment of the present cross-sectional survey and the responses may have reflected the significance of the impacts of these on young families and, in particular, female dental researchers who needed to care for children including managing home schooling efforts with or without digital technology. Although the bivariate analysis did not indicate a significant effect of relationship status and parental status on productivity, the study did not differentiate between elementary-aged children who likely required more overall supervision and older children who could, in general, accomplish learning tasks and social interactions more independently. It is well established that social expectations and gender disparities still in place leave the burden of managing family, house chores, and professional work to women, regardless of their professional status.<sup>7</sup> However, this issue still needs to be further investigated given the limited sample size here, and the fact that the majority of the respondents in this study did not report caring for children.

Among the reasons associated with poor mental health, *having to care for/or home school children* was the most frequently selected response by female dental professionals (Figure 2B). Further, worsening perceived mental health status was tied to decreased productivity (Table 2). In the present study, academicians with less research effort reported being less productive during the COVID-19 pandemic (Table 2). With the exception of *conference participation*, male dental professionals reported the same level of scholarly productivity before and during the pandemic, whereas female academicians reported decreased productivity in several impactful measures of work productivity, including *writing* and *reviewing of manuscripts* and *grant submission*. These differences along gender lines may be multifactorial. It has been shown that NIH-funded female professionals tend to sacrifice research time to care for children.<sup>17</sup> The role of women as caregivers for extended family members and within communities has been validated by studies that show that women worldwide constitute the majority of the informal caregivers for children, elderly, and relatives with psychiatric disorders.<sup>27</sup> A recent study has shown that differences in the distribution of housework is significant and remains unexplained, with some household chores just being labeled “feminine” work.<sup>28</sup> Although not ongoing, the effects of the “shelter-in-place” restrictions on research progress and the time and fiscal impact on dental research progress may be long term and may halt the career development of early career professionals, which comprised a higher percentage of females in this study. The majority of the respondents indeed reported expecting a negative impact of the COVID-19 pandemic on research development within 6 months after the restrictions were lifted (Table 3). Institutional





**FIGURE 3** Coronavirus disease 2019 (COVID-19) and mental health: (A) gender percentage of respondents reporting poor mental health conditions as a consequence of the COVID-19 pandemic; (B) gender percentage for different reasons associated with poor mental health; (C) self-reported ability of respondents to handle the challenges imposed by the COVID-19 pandemic; (D) reported ability of the respondents' children to handle the challenges imposed by the COVID-19 pandemic

support, viewed in this study as a mitigating factor, may be even more important moving forward to establish and promote active measures and policies to minimize possible stressors associated with the pandemic impact on females. Failure to implement such measures may have a long-lasting impact on the academic careers, especially for current female dental researchers and could shape leadership within dental academia for years to come. If pandemic-associated impacts are experienced differently for men and women, this disparity could further lengthen the time that women take to enter leadership and essentially create a “longer ladder” for women to enter senior faculty roles.<sup>29</sup> In the current study, women more frequently than men selected *high* or *moderate concern* regarding tenure and promotion after the pandemic, and they also indicated being *not comfortable* with the use of performance indicators for salary increase after the pandemic, which could indicate that the reduced productivity women reported during the pandemic may translate into delays in tenure and/or promotion that preferentially affect women. The results in this study may be certainly skewed given the higher number of females in early stage careers than males. However, considering all results taken together regarding productivity responses, mental health and ability to manage stress during the pandemic reported here by gender, the true consequences of this pandemic on female career development certainly deserves to be further investigated.

Mental health was significantly associated with perceived productivity (Table 2). Although worsening mental health was reported by both men and women in this study, women were more likely to report two or more mental health challenges compared to their male counterparts (Figure 2A). Overall, female respondents reported lower ability to manage challenges presented by the pandemic than males (Figure 2C). High levels of stress, anxiety, depression, and post-traumatic stress symptoms have been reported as common effects of the pandemic on healthcare workers,<sup>7,10,11</sup> with females being disproportionately affected.<sup>11,12</sup> During the COVID-19 pandemic, the responsibility of caregiving, especially for women, may have played a special role on these psychological effects. In fact, in the present study, females reported *having to care for/homeschooling children*, whereas males reported *financial responsibility* as major triggers for poor mental health during the pandemic (Figure 2B). This was probably compounded by the fact that social support, previously reported as being associated with less anxiety and depression,<sup>30</sup> was also less accessible during the initial pandemic months.

The results of this survey provided evidence of the critical role played by institutional support on faculty well-being and professional development. Higher levels

of perceived institutional support during the pandemic, as well as for online/remote teaching, were associated with improved scholarly productivity (Table 3). Increased productivity, decreased absenteeism, or reduced financial burdens are some of the outcomes that may drive institutions to develop mental health prevention and intervention programs.<sup>31</sup> The COVID-19 pandemic itself has represented a major mental health burden not only to healthcare workers,<sup>11</sup> but across populations of all ages and genders.<sup>7,10</sup> In addition to emergent and ongoing mental health support through programs such as employee assistance programs, flexible work schedules, childcare support, and clear communication of changing expectations and regulations are essential measures to help faculty during challenging times. These measures and how they impact career development certainly warrant further investigation.

Amongst the limitations of the current survey, we can cite the composition of our female and male respondents. Forty-seven percent of survey respondents were female; however, the majority of those were in early stage academic careers. Consequently, the overall survey responses might be skewed toward more established male researchers and junior female academicians. Additionally, data collection relied on self-reported measures of *perceived* productivity, and not on objective indicators of productivity such as number of manuscripts submitted, or number of weekly hours spent on students' supervision, which could be better investigated in the post-pandemic years, given the important perception results hereby reported. In addition, the considerable amount of time required to design the survey, receive ethics approval, pilot and distribute the survey instrument resulted in the survey being distributed late in the pandemic year, October 2020. At that time, significant variability in COVID-19 restrictions were present worldwide, and ~40% of the world population was affected by “shelter-in-place” and school closures. It is possible that the return to some form of normalcy may have prevented researchers from clearly reporting the effect of the pandemic on their productivity and mental health, and thus, results should be interpreted with caution. Lastly, all the questions involving family responsibilities only considered professionals acting as primary caregivers for children. As of 2011, 65% of unpaid family caregivers in the US were women, and 80% of them cared for someone over 50 years of age.<sup>5</sup> The elderly population has been disproportionately affected by the virus, with high mortality rates being reported especially among those with comorbidities.<sup>4,32</sup> The burden of caring for elderly relatives and taking protective measures to keep them safe and in good health may have also had a major impact on female dental academicians' scholarly productivity and mental health, and this aspect of the

pandemic consequences certainly deserves further investigation. It should also be noted that the response rate for this survey was 9.4%, which is low compared to mean response rates for email surveys and may have impacted the validity and generalizability of the findings.<sup>33</sup> However, the demographics of the survey respondents mirrors the distribution of IADR members worldwide for gender (female—45%; male—55%) and geographic region (North America—40%; Pan-European region—17%; Asia-Pacific region—26%; Latin America—10%; Africa and Middle East—6%), an evidence that the survey responses are representative of the entire IADR community. Therefore, the present study provides important insights about the impact of the COVID-19 pandemic in the perceived productivity of researchers and academicians.

In conclusion, the present study showed that the COVID-19 pandemic significantly influenced researcher productivity and mental health worldwide. Younger researchers and females showed less productivity and poor mental health, which also negatively contributed to research productivity. Importantly, institutional support during the pandemic was associated with higher productivity. It is plausible to expect that the reported consequences brought up by this pandemic could result in significant governmental, academic, and societal changes, such as improved support for mental health and caregivers, policy changes regarding remote location agreements, tenure policy changes, and more equitable distribution of household duties, which could alleviate some of the gender discrepancies observed here.

#### AUTHOR CONTRIBUTIONS

Grace M. De Souza contributed to conception, design, and data interpretation, drafted, and critically revised the manuscript. Christopher H. Fox, Patricia A. Miguez, Ariadne Letra, Maria L. Geisinger, Mangala Patel, and Luciana Shaddox contributed to conception, design, and data interpretation and critically revised the manuscript. Tamanna Tiwari and Effie Ioannidou contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript.


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#### CONFLICT OF INTEREST

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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