


## ORIGINAL ARTICLE

# Impact of COVID-19 on advanced dental education: Perspectives of dental residents in Wuhan

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## Abstract

**Purpose:** This study investigated the impact of coronavirus disease 2019 (COVID-19) from the perspectives of dental residents in Wuhan, the former COVID-19 epicenter of China.

**Methods:** A survey form was sent to 424 residents in the School of Stomatology, Wuhan University (WHUSS) in September 2020. The form included 23 questions on demographics, study situation of residents during the COVID-19 outbreak, effect of COVID-19 on graduates, and status of residents who returned to clinic training.

**Results:** A total of 361 (85%) survey forms were collected. Over 70% of respondents felt anxious during Wuhan lockdown. Most respondents continued studying (94%) mainly through free online resources (79%). The majority reported improvement in didactic knowledge (80%), but the respondents' perceptions of their clinical skills, especially those in Wuhan, did not change (41%) or worsened (40%) ( $p < 0.05$ ). Most graduates (88%) reported having found jobs or continued study. Among the 209 responders who returned to clinical training, 52% felt no concern about COVID-19 infection, 89% thought they were equipped with adequate personal protective equipment (PPE), and 57% indicated that they received sufficient knowledge for preventing COVID-19 in clinic. Most respondents agreed that the way to gain the knowledge for preventing COVID-19 in clinic was training at dental school (93%).

**Conclusion:** Although online study has been appreciated by residents, concern about clinical skill learning in the COVID-19 hardest-hit area has arisen. Most graduates felt that the impact of COVID-19 on their immediate postgraduation career was limited. Teaching about infection control in dental schools seemed effective to develop a positive attitude for residents after they returned to clinical training.

## KEYWORDS

advanced dental education, COVID-19, dental residents

## 1 | INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 was first identified in Wuhan, Hubei Province, China at the end of December 2019.<sup>1</sup> As of December 30, 2020, the COVID-19 outbreak has resulted in 68,149 cumulative cases including 4,512 deaths in Hubei province,<sup>2</sup> and 80,773,033 cumulative cases including 1,783,619 deaths globally.<sup>3</sup> The World Health Organization officially declared COVID-19 as a pandemic on March 11, 2020 due to its wide spread and high contagiousness. During the COVID-19 outbreak, the majority of dental schools worldwide suspended activities to minimize the transmission of the virus.<sup>4–6</sup>

The School of Stomatology, Wuhan University (WHUSS) is located in Wuhan, the former COVID-19 epicenter of China. It is the largest dental school in Hubei Province and ranks as one of the top five dental schools in China in terms of school-running scale and educational quality.<sup>7</sup> To block the rapid spread of COVID-19, the government has conducted strict measures including locking down Wuhan from January 23, 2020. Since then, no students including residents had been allowed to return to WHUSS.<sup>8</sup>

Few new daily COVID-19 cases are reported in China currently due to strict measures.<sup>9</sup> The Wuhan lockdown was lifted on April 8, 2020, and residents of WHUSS were then allowed to return to continue their studies, clinical training, and attend an in person graduation ceremony in batches. Clinical training is one of the most important parts of advanced dental education and was halted during the COVID-19 outbreak. Limited literature is available on the impact of COVID-19 on advanced dental education. Thus, the purpose of this survey was to investigate the impact of COVID-19 on advanced dental education from the perspectives of dental residents.

## 2 | METHODS

### 2.1 | Questionnaire design

The cross-sectional research design was approved by the Ethics Committee of WHUSS (project number: 2020B56). A 23-question survey form was constructed through WJX (<https://www.wjx.cn>).<sup>10</sup> The questionnaire contained four sections (Table 1). The first section included four questions regarding provider's demographics of gender, specialty, location, and year during Wuhan lockdown. The second section included seven questions referring to their study situation and psychological status during Wuhan lockdown. The third section included three questions that

TABLE 1 Sample questionnaire

#### 1. Are you female or male?

- A. Female
- B. Male

#### 2. Which residency training program are you in?

- A. General dentist
- B. Oral and maxillofacial surgery
- C. Prosthodontics
- D. Orthodontics
- E. Oral pathology
- F. Oral and maxillofacial radiology
- G. Endodontics
- H. Periodontics
- I. Pediatric dentistry
- J. Oral medicine

#### 3. What is your location during Wuhan lockdown? Indicate your province and city.

#### 4. Which year were you in during Wuhan lockdown?

- A. The 1<sup>st</sup> year resident
- B. The 2<sup>nd</sup> year resident
- C. The 3<sup>rd</sup> year resident

#### 5. Did you continue your study during Wuhan lockdown?

- A. Yes
- B. No

#### 6. What was your main way of studying during Wuhan lockdown? (Multiple-answer question)

- A. Online lessons from your faculty at the dental school
- B. Free online resources, such as webinars and lessons
- C. Paid online resources, such as webinars and lessons
- D. Studying textbooks and reference books
- E. Hands-on training with dental model or material
- F. Performing research, such as reading literature or conducting statistical analysis
- G. Other ways of study
- H. Discontinue studying during Wuhan lockdown

#### 7. Will COVID-19 change your future learning style in that you will increase the portion of online study in the future even when the COVID-19 epidemic ends?

- A. Yes
- B. I don't know
- C. No

#### 8. How has your dental didactic knowledge changed after Wuhan lockdown?

- A. Improved
- B. Stayed the same
- C. Worsened

(Continues)

TABLE 1 (Continued)

**9. How have your dental clinical skills changed after Wuhan lockdown?**

- A. Improved
- B. Stayed the same
- C. Worsened

**10. I felt anxious during Wuhan lockdown.**

- A. Strongly agree/agree
- B. Neither disagree nor agree
- C. Strongly disagree/disagree

**11. What is the main reason for your anxiety?**

- A. I was worried about COVID-19 infection of myself or my family
- B. I was worried about my studies and future
- C. Financial pressure
- D. Other reason

**For the 3<sup>rd</sup> year residents****12. Which form did you use to attend your graduation ceremony?**

- A. Online graduation ceremony
- B. In person graduation ceremony in batches
- C. Did not attend graduation ceremony of any form

**13. What is your immediate postgraduation career now?**

- A. Continue studying in a domestic university
- B. Plan to study abroad but interrupted by COVID-19
- C. Work in a public hospital or clinic
- D. Work in a private hospital or clinic
- E. Unemployed and is looking for a job
- F. Others

**14. Do you think COVID-19 has a great effect on your immediate postgraduation career?**

- A. Yes. The effect is great
- B. COVID-19 affects my immediate postgraduation career, but the degree is limited.
- C. No effect

**For the 1<sup>st</sup> and 2<sup>nd</sup> year residents****15. Have you returned to clinical training at dental school?**

- A. Yes
- B. No

**For those who answered "Yes" on question 15****16. What types of COVID-19 tests have you done for yourself, especially for returning to clinical training? (Multiple-choice question)**

- A. RT-PCR for virus RNA
- B. ICG strip targeting IgM and IgG antibody
- C. Chest CT scan
- D. Others
- E. No test

(Continues)

TABLE 1 (Continued)

**17. Was the result of your test above abnormal, including positive result of RT-PCR, any positive result of ICG, abnormal chest CT images, or any other abnormal result?**

- A. Yes
- B. No

**18. How has your anxiety changed after you returned to clinical training?**

- A. Decreased
- B. Increased
- C. Stay the same
- D. I neither agree nor disagree that I felt anxious all the time
- E. I disagree/strongly disagree that I felt anxious all the time

**19. Have you received patients who have recovered from COVID-19, suspected COVID-19 patients, or close contacts of COVID-19 confirmed cases during practice after you returned to clinical training?**

- A. Yes
- B. No

**20. I am concerned about COVID-19 infection on account of returning to clinical training**

- A. Strongly agree/agree
- B. Neither disagree nor agree
- C. Strongly disagree/disagree

**21. Do you think you are equipped with adequate PPE in clinic now?**

- A. Yes
- B. No

**22. How did you gain knowledge for preventing COVID-19 in clinic? (Multiple-answer question)**

- A. From the Internet
- B. From the training at dental school
- C. From the literature
- D. From other resources
- E. I have not received any knowledge for preventing COVID-19 in clinic

**23. I have received sufficient knowledge for preventing COVID-19 in clinic**

- A. Strongly agree/agree
- B. Neither disagree nor agree
- C. Strongly disagree/disagree

assessed the effect of COVID-19 on the immediate postgraduation career of senior residents. The fourth section included nine questions pertaining to the situation of the respondents who returned to clinic training during the post-COVID-19 era.

## 2.2 | Survey distribution

The questionnaire about the impact of COVID-19 on the residents' education in WHUSS was distributed in September 2020 via the online platform WeChat to a total of 424 residents of WHUSS. The survey introduction and invitation were sent to the residents four to five times daily for 3 days. All participants were informed that the survey was completely anonymous to facilitate collecting unbiased data.

## 2.3 | Data analysis

All raw data were exported into Excel (Microsoft Corp, Redmond, WA) and formatted for analysis using SPSS Version 23.0 (SPSS Inc., Chicago, IL). Chi-square and Fisher's exact tests were used to explore the relation between the demographic information of the participants and their anxiety during Wuhan lockdown as well as their recognitions on the change in dental didactic knowledge and clinical skills after Wuhan lockdown. Differences at  $p < 0.05$  were considered significant.

## 3 | RESULTS

From all 424 residents, 361 responded, which accounted to a response rate of 85% and included 123 participants of the first year residents (78%), 93 participants of the second year residents (86%), and 145 participants of the third year residents (91%). The demographics of the respondents are shown in Table 2. The majority of the respondents were female (69%), and most of them were enrolled in the residency training program of advanced general dentistry (27%). Thirty-eight responders were located in Wuhan during lockdown.

Most respondents (94%) had continued studying during Wuhan lockdown. The most common study mode was via free online resources (79%), followed by online lessons from teachers of dental schools (75%). Among the respondents, 35% attended paid online resources, 45% continued their research, and only 10% continued hands-on training using dental models or materials (Figure 1A).

Most respondents (74%) reported that COVID-19 would change their learning style such that they would increase the portion of online study in the future even when the epidemic ends (Figure 1B). The majority (80%) reported improvement in their dental didactic knowledge after Wuhan lockdown, 41% reported no change in their dental clinical skills, and 40% reported worsened clinical skills (Figure 1C,D). Participants located in Wuhan during the

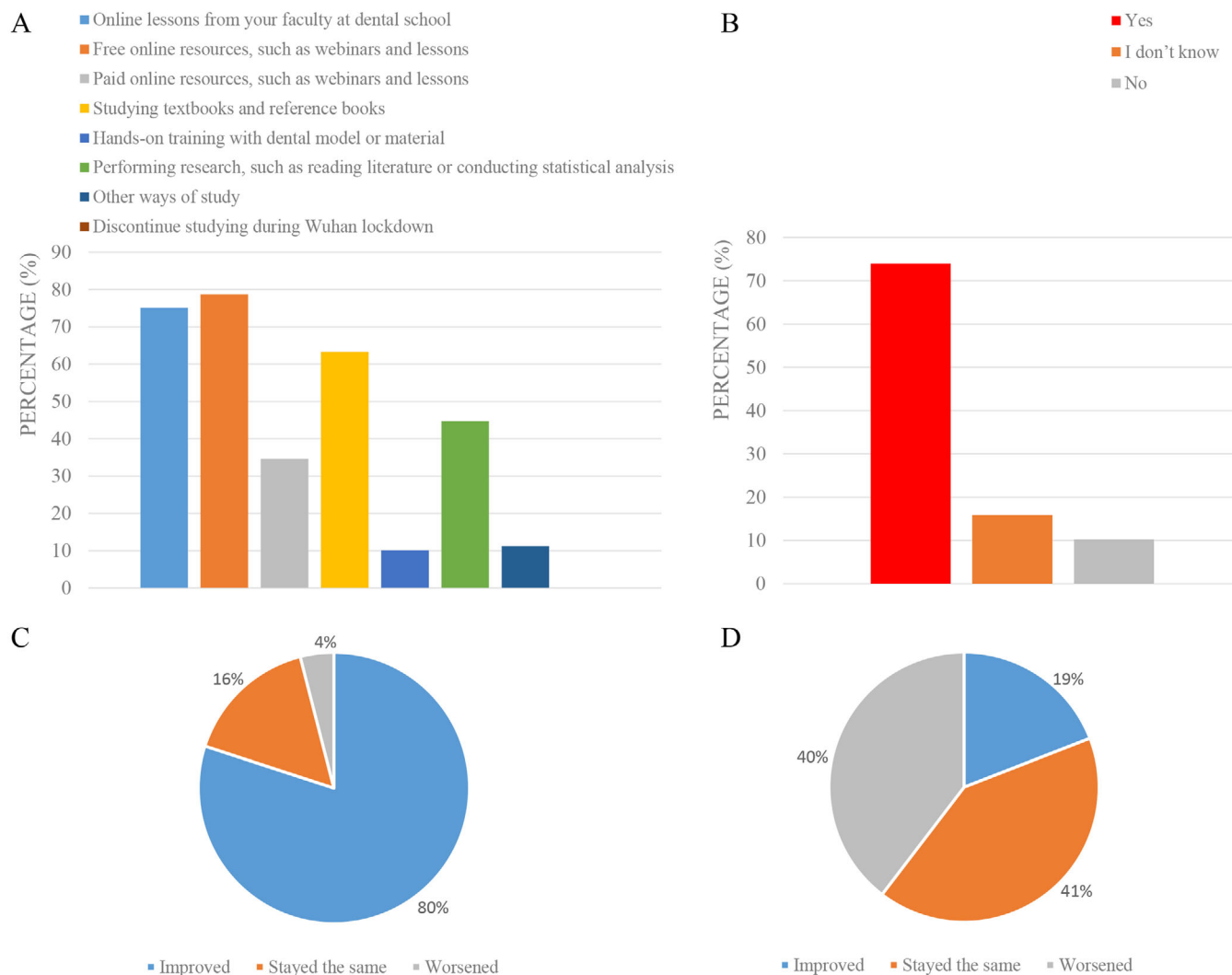
TABLE 2 Demographic information of participants

|                                  | Frequency (n) | Percent (%) |
|----------------------------------|---------------|-------------|
| Gender                           |               |             |
| Male                             | 111           | 31          |
| Female                           | 250           | 69          |
| Residency training program       |               |             |
| Advanced general dentistry       | 97            | 27          |
| Oral and maxillofacial surgery   | 43            | 12          |
| Prosthodontics                   | 66            | 18          |
| Orthodontics                     | 49            | 14          |
| Oral pathology                   | 6             | 2           |
| Oral and maxillofacial radiology | 5             | 1           |
| Endodontics                      | 51            | 14          |
| Periodontics                     | 23            | 6           |
| Pediatric dentistry              | 16            | 4           |
| Oral medicine                    | 5             | 1           |
| Location                         |               |             |
| Wuhan                            | 38            | 11          |
| Other cities                     | 323           | 89          |
| Year                             |               |             |
| Third                            | 145           | 40          |
| Second                           | 93            | 26          |
| First                            | 123           | 34          |

lockdown more significantly felt worsened clinical skills compared with those in other places ( $p < 0.05$ , Table 3). No significant correlation was found between the recognition on the change in dental didactic knowledge and the demography of the respondents ( $p > 0.05$ ). Most respondents (72%) felt anxious during Wuhan lockdown, and the most common reason was concern about COVID-19 infection of their families (47%), followed by worries about studies and future (46%). No significant correlation was found between anxiety and respondents' demography ( $p > 0.05$ ).

Most third year residents (69%) attended an in person graduation ceremony in batches, and 21% chose an online graduation ceremony. The most common immediate postgraduation career for graduates was working in a public hospital or clinic (37%), followed by working in a private hospital or clinic (30%) and continuing to study in domestic universities (21%). Most third year residents (65%) indicated that COVID-19 affected their immediate postgraduation career, but the degree of effect was limited.

Most first and second year respondents (97%) returned to clinical training at dental schools. The most common test chosen by residents for returning to clinical training was



**FIGURE 1** Graphical illustrations about the distribution of answers to the questions. (A) “What was your main way of studying during Wuhan lockdown? (Multiple-answer question)”; (B) “Will COVID-19 change your future learning style in that you will increase the portion of online study in the future even when the COVID-19 epidemic ends?”; (C) “How has your dental didactic knowledge changed after Wuhan lockdown?”; (D) “How have your dental clinical skills changed after Wuhan lockdown?”

RT-PCR (98%). Among the respondents returning to clinical training, most (52%) reported a decrease in their anxiety. Almost 10% of them indicated having received patients who recovered from COVID-19, patients suspected to have COVID-19, or close contacts of confirmed cases. A total of 52% of respondents felt no concern about COVID-19 infection, whereas 41% expressed concern about COVID-19 infection on account of returning to clinical training. Most respondents (89%) thought they were equipped with adequate personal protective equipment (PPE) in clinic at this stage, 57% indicated that they received sufficient information for preventing COVID-19. The most common way chosen by respondents to gain knowledge for preventing COVID-19 in clinic was training at the dental school (93%), followed by the internet (90%) and other literature (27%).

## 4 | DISCUSSION

The sudden halt in the educational mission as a result of the COVID-19 pandemic has led to great impact on dental education of dental trainees, including residents.<sup>11</sup> Based on a previous study on dental students at the Harvard School of Dental Medicine, students perceived that some aspects of their educational experience were vastly different from prepandemic learning.<sup>12</sup> The present survey is the first study to demonstrate the impact of COVID-19 on advanced dental education from the perspectives of dental residents in the former epicenter of COVID-19.

Online dental education was considerably active during the COVID-19 outbreak owing to the requirement of social distancing. E-learning has been appreciated by

**TABLE 3** Chi-Square tests and Fisher's exact tests: The relation between the demographic information of the participants (Gender, Type of residency training program, Location, Year) and the recognition of dental clinical skills change after Wuhan lockdown (Question 9)

| Variables                        | Improved<br>(n = 69) | Stayed the same<br>(n = 149) | Worsened<br>(n = 143) | p     |
|----------------------------------|----------------------|------------------------------|-----------------------|-------|
| Gender                           |                      |                              |                       | 0.641 |
| Male                             | 18 (16)              | 48 (43)                      | 45 (41)               |       |
| Female                           | 51 (20)              | 101 (40)                     | 98 (40)               |       |
| Residency training program       |                      |                              |                       | 0.154 |
| Advanced general dentistry       | 17 (18)              | 46 (47)                      | 34 (35)               |       |
| Oral and maxillofacial surgery   | 10 (23)              | 16 (37)                      | 17 (40)               |       |
| Prosthodontics                   | 17 (26)              | 20 (30)                      | 29 (44)               |       |
| Orthodontics                     | 9 (18)               | 18 (37)                      | 22 (45)               |       |
| Oral pathology                   | 1 (17)               | 2 (33)                       | 3 (50)                |       |
| Oral and maxillofacial radiology | 1 (20)               | 3 (60)                       | 1 (20)                |       |
| Endodontics                      | 9 (18)               | 25 (49)                      | 17 (33)               |       |
| Periodontics                     | 3 (13)               | 15 (65)                      | 5 (22)                |       |
| Pediatric dentistry              | 1 (6)                | 3 (19)                       | 12 (75)               |       |
| Oral medicine                    | 1 (20)               | 1 (20)                       | 3 (60)                |       |
| Location                         |                      |                              |                       | 0.031 |
| Wuhan                            | 2 (5) <sup>a</sup>   | 15 (40) <sup>a</sup>         | 21 (55) <sup>a</sup>  |       |
| Others                           | 67 (21) <sup>b</sup> | 134 (42) <sup>a</sup>        | 122 (38) <sup>b</sup> |       |
| Year                             |                      |                              |                       | 0.138 |
| Third                            | 35 (24)              | 59 (41)                      | 51 (35)               |       |
| Second                           | 19 (20)              | 35 (38)                      | 39 (42)               |       |
| First                            | 15 (12)              | 55 (45)                      | 53 (43)               |       |

a, b: Groups with the same letters in the same column are not statistically different ( $p > 0.05$ ) according to post hoc tests.

students and professors in dental schools in Italy after a month of distance education,<sup>13</sup> consistent with the results of the present study. As early as February 2, 2020, WHUSS launched an integrated online educational program for residents. The program consisted of three parts: customized mobile app; online teaching and meeting using VooV Meeting, which provides functions equivalent to Zoom; and a series of cloud-based courses given by leading authorities in the discipline nationwide under the support of the Chinese Stomatological Association. The mobile app has three modules including learning packages of didactic knowledge, videos of clinical operation and evaluation system. All the app, online teaching, and cloud-based courses are one-way teaching methods used to equip residents with core frontier knowledge. Meanwhile, small-group discussion using VooV stimulated active discussion on concepts learned with PBL to encourage critical thinking<sup>14</sup> and enhance the interaction between residents and teachers.

The COVID-19 pandemic was expected to change the training paradigms in dentistry for years,<sup>13</sup> as confirmed in the present study, where most respondents (74%) reported that they would increase the portion of online study in the future. A total of 197 registered well-organized online

lessons were available at WHUSS from April 8 to November 18, 2020, after Wuhan lockdown was lifted, although this form of online teaching has never been adopted before the COVID-19 outbreak. The two main reasons are as follows. First, some meeting rooms were occupied for the area division because the layout of the whole hospital still maintained the infection control division of "three zones and two passages" in the areas of all departments as before. Second, several advantages of online study were discovered during Wuhan lockdown. This mode of study broke the restrictions of time and zone, as residents could not only benefit from specialists all over the country but also worldwide. On October 15 and 16, 2020, WHUSS held an international online meeting for residents on which the specialists from 16 dental schools worldwide shared frontier knowledge of dental treatment and research. Moreover, this mode could be beneficial to students from local schools as well as to the large scale of population via live streaming platforms for sharing quality educational resources. For instance, the faculty of the prosthodontic department of WHUSS has shared online lectures with students and dentists in the entire country from February 17, 2020, and one of the lectures acquired 30,000 live views.<sup>8</sup> However, the disadvantages of online study were

TABLE 4 The score sheet of PPE examination

| The score sheet of wearing PPE  |  |  |   |               |
|---|--|--|---|---------------|
| Items   | The actualization point  | Score  | Scoring criteria  | Penalty point |
| Preparing procedures (scores of 20)   | 1. Personal preparation: Hand hygiene, wear overalls, took off coverall  | 5  | 2 points are deducted for wrong operation   | -             |
|   | 2. Preparation of articles: N95 mask, disposable cap, disposable isolation clothes, disposable face shield, PE gloves, surgical gloves, shoe covers, 75% ethyl alcohol | 10   | 1 point are deducted for wrong selection  | -             |
|   | 3. Evaluation before operation: Cleanliness of the environment, protection level, the quality and expiration date of protection equipment                              | 5  | 2 points are deducted for missing one item  | -             |
| Key operating points (scores of 70)   | 1. Wear N95 mask   | 15   | 2 points are deducted for wrong operation, 2 points are deducted in reverse order, 5 points are deducted for missing the step of check the adaptation of mask | -             |
|   | 1) One hand holds the mask, with the nose clip on the side facing away   |  |   |               |
|   | 2) The mask covers the nose, mouth and chin, and the nose clip part should wrap around facial contours   |  |   |               |
|   | 3) With the other hand, pull the lower lacing over your head and put it in the back of neck  |  |   |               |
|   | 4) Then pull the upper lacing to the top of the head   |  |   |               |
| 5) Place fingertips on the metal nose clip, and press the nose clip from the middle to the sides. Shape the nose clip according to nose bridge and check the adaptation of mask. Adjust the tightness of the upper and lower lacing |  |  |   |               |
| 2. Wear disposable cap  | 10   | 2 points are deducted for wrong operation, 5 points are deducted for exposing the hair or ears   | -   |               |
| 1) Pull your long hair into a bun and comb your bangs upward  |  |  |   |               |
| 2) The hat covers the head from the front to the back without exposing the hair or ears   |  |  |   |               |
| 3. Wear face shield   | 5  | 2 points are deducted for wrong operation  | -   |               |
| Wear the face shield and press the lower edge of the hat. And adjust to feel comfortable  |  |  |   |               |
| 4. Wear disposable isolation clothes  | 20   | 2 points are deducted for wrong operation, 2 points are deducted in reverse order, 5 points are deducted for the tightness of the isolation clothes was not well | -   |               |
| 1) Open the package and check if it is in good condition  |  |  |   |               |
| 2) Wear isolation clothes, look after collar, and tied it   |  |  |   |               |
| 3) Adjust the tightness of the isolation clothes and fasten the belt  |  |  |   |               |
| 5. Wear shoe covers   | 5  | 2 points are deducted for wrong operation  | -   |               |

(Continues)

TABLE 4 (Continued)

| <b>The score sheet of wearing PPE</b>    |   |              |   |                      |
|--|---|--------------|---|----------------------|
| <b>Items</b>                             | <b>The actualization point</b>  | <b>Score</b> | <b>Scoring criteria</b>   | <b>Penalty point</b> |
|  | 6. Wear surgical gloves<br>Put the gloves on, fold part of the glove back, pull the sleeve up to the palm and secure, fasten the reflexed part of the gloves to the cuffs of the isolation clothes and secure them with tape if necessary   | 15           | 2 points are deducted for wrong operation   | –                    |
| Key scoring points (scores of 10)        | 1. The whole process of wearing isolation clothes should be stable, accurate, light, fast, in line with the operating principles<br>2. After wearing, it should be neat and free from exposure  | 10           | 5 points are deducted for wrong operation. the skin is exposed after wearing. All points are deducted for the skin is exposed | –                    |
| <b>The score sheet of taking off PPE</b> |   |              |   |                      |
| Key operating points (scores of 80)      | 1. Take off shoe covers<br>Hand hygiene, remove the shoe cover from the heel  | 5            | 2 points are deducted for wrong operation   | –                    |
|  | 2. Take off surgical gloves<br>1) Hand hygiene<br>2) Hold the contaminated edge of the outer glove in one hand and remove the glove until your thumb is exposed<br>3) Insert the thumb of the inner glove into the inner side of the outer glove of the other hand, roll over each other, remove the gloves and throw them into a medical waste container   | 20           | 2 points are deducted for wrong selection   | –                    |
|  | 3. Take off isolation clothes<br>1) Hand hygiene<br>2) First take off the belt, then the tie<br>3) Put your left hand into the cuff of your right hand and take off it, hold the outside of the left sleeve in your right hand and take off the left sleeve, then switch hands and take off the sleeves slowly. Turn over the isolation clothes, roll the inner side into a package and throw it into a waste container | 20           | 2 points are deducted for wrong operation, 2 points are deducted in reverse order   | –                    |
|  | 4. Take off face shield<br>1) Hand hygiene<br>2) Hold the tie of face shield in both hands and remove it from the front and back. Place it into a container for recycling medical waste. Close your eyes when taking off face shield<br>Push the door by hand to enter buffer zone  | 10           |   | –                    |
|  | 1. Take off disposable cap<br>1) Hand hygiene<br>2) Hold the corner of the hat behind your head in each hand, remove the hat from the back and forward  | 5            | 2 points are deducted for wrong operation   | –                    |

(Continues)



TABLE 4 (Continued)

| The score sheet of taking off PPE |   |    |  |   |
|-----------------------------------|---|----|--|---|
|                                   | Place it into a container for recycling medical waste. Close your eyes when taking off face shield  |    |  |   |
|                                   | 2. Take off N95 mask  | 20 | 2 points are deducted for wrong operation, 2 points are deducted in reverse order                | - |
|                                   | 1) Hand hygiene   |    |  |   |
|                                   | 2) Take the lower lacing first and fasten it to the chest   |    |  |   |
|                                   | 3) Remove the upper lacing with the other hand. Close your eyes and hold your breath when taking off mask. Keep your hands away from the front and face of the mask |    |  |   |
|                                   | 4) Hold the tie in your hand and throw it in a dirt bag   |    |  |   |
|                                   | 5) Hand hygiene   |    |  |   |
| Key scoring points (scores of 20) | 1. Hand hygiene should be performed before and after each step  | 20 | 5 points are deducted for wrong operation. All points are deducted if secondary pollution occurs | - |
|                                   | 2. The unwinding of the isolation clothes should be done slowly. The inside of the isolation clothes faces out  |    |  |   |
|                                   | 3. The removed protective equipment should be placed in the specified container   |    |  |   |

evident: streaming integrity was restricted by the stability of the internal network, the concentration of residents may have been affected by the surrounding environment, and the emotional connection and bond between residents and faculty could have been weakened compared with traditional teaching. Thus, the faculty of the prosthodontic department of WHUSS took the lead in developing online and offline combination of lessons that they gave to residents face-to-face and through live streaming to national students and dentists via webcast regularly after Wuhan lockdown was lifted.

Most respondents, especially those located in Wuhan during Wuhan lockdown, reported no change or worsening of their dental clinical skills. The deficiency of clinical training during lockdown is an unavoidable issue. Although new and improved educational tools of virtual reality may be available in the future, no substitute could be equivalent to direct supervision and immediate feedback for improving clinical skills.<sup>15</sup> In addition to providing videos of clinical operation and evaluation system on mobile app, WHUSS actively contacted and encouraged residents to practice or observe at local dental schools or clinics out of Wuhan to reduce the impact of COVID-19 on clinical training.

Graduation ceremonies may be cancelled, delayed, or moved online depending on the local situation due to the COVID-19 crisis.<sup>14</sup> WHUSS allowed graduates to participate in graduation ceremony in batches after Wuhan lockdown. The online graduation ceremony was also offered

as an option. In the present study, most respondents of the third year residents (69%) still chose to attend an in person, the graduation ceremony that they and their families have been looking forward to.<sup>16</sup> The potential recession and its effect on the job market due to COVID-19 are the main concerns for graduates.<sup>16,17</sup> The present study demonstrated that 65% of the respondents felt that COVID-19 affected their immediate postgraduation career, but the degree of the influence was limited.

Most respondents (97%) of the first and second year have returned to clinical training at dental school after Wuhan lockdown. To minimize the risk of cross infection, WHUSS laid down a strategy for the return of residents according to the rules of "in different batches; in different levels; in different time periods and off-peak." The first batch of residents who returned to WHUSS on a voluntary basis from June of 2020 was those who urgently needed clinical training to meet requirements of graduation. The second, third, and fourth batches started from July 1, 2020, August 7, 2020, and August 31, 2020, respectively. They were required to undergo COVID-19 tests and present the results.

Over 70% of respondents felt anxious during Wuhan lockdown, while more than half of the first and second year respondents reported that their anxiety decreased after they returned to clinical training. Given that COVID-19 has negative effects on the psychological well-being of the population,<sup>18</sup> dental school administration and faculty should focus on the psychological status of residents. One resident at WHUSS was observed by her instructor to



**FIGURE 2** Personal protective equipment (PPE) training after residents returned to WHUSS. (A) Standard grade 2 PPE used by residents at present; (B) PPE training for residents by the tutor who has worked on front-line of COVID-19 treating confirmed or suspected COVID-19 patients before; (C) Examination of PPE practice for residents

have abnormal silence and sudden occasional disappearance, after returning to clinical training, and was eventually diagnosed to have a mood disorder. She was able to continue her residency training because of early detection and timely treatment.

Most respondents who returned to clinical training displayed a positive attitude on their confidence to prevent COVID-19 in clinic. This finding might be attributed to the training at dental school, which was chosen as the most common method to receive knowledge about COVID-19 infection control in our study (93%). Before returning to clinical work, residents of WHUSS were required to pass strict online and offline examinations. First, residents were required to attend online courses on COVID-19

infection control and passed the online examination. Second, residents were required to attend offline PPE training lessons and passed the offline examination (the score sheet is shown in Table 4). PPE including disposable N95 masks, gloves, gowns, cap, shoe cover, and goggles or face shield was provided to residents at WHUSS since they have returned to clinical training (Figure 2).<sup>19</sup>

The current dental curriculum in the majority of dental schools mainly addresses basic infection control from blood-borne infections, such as HIV and HBV; however, droplet and airborne infections have been rarely addressed.<sup>20</sup> Knowledge level and practice of infection control measures, such as hand hygiene, were found to be poor among dental students.<sup>21,22</sup> Similar to the AIDS

pandemic in the 1980s, the COVID-19 crisis serves to heighten the awareness of dental aerosolization, pushing dentists to revisit clinical safety standards<sup>23</sup> and encouraging dental schools to regard infection control-teaching as a significant part of dental education.<sup>20</sup>

In addition to developing online and offline combined teaching method, focusing on the psychological status of residents, and establishing evaluation system of COVID-19 infection control, WHUSS has implemented measures to narrow the gap of the reduction of clinical operating opportunities of residents due to area divisions for infection control and financial pressure from PPE supplies of departments. First, the graduation examination of the second year was postponed for 3 months, and the application for complement of clinical training for the third year residents were still accepted in December 2020. Second, WHUSS has set a special budget to cover the fee of PPE for residents to relieve financial pressure and encourage the departments to provide more clinical operating opportunities. To help residents face the potential shrinking job market, WHUSS held a meeting on the demand for Stomatological graduates of 2020 and invited more than 60 recruiting units all over the country to attend.

Our study has some limitations. First, the study utilized limited number of residents from a single dental school. Second, although participants were assured of anonymity, their worries about identification may have affected the results of the survey. Third, many closed questions and no opportunities for free text comments on the questionnaire may have restricted the residents from providing further information. More efforts should be made to reduce these restrictions in future studies.

## 5 | CONCLUSION


Although online learning has been appreciated by residents in the COVID-19 hardest-hit area, most respondents, especially those located in Wuhan, reported concerns about learning dental clinical skills during the COVID-19 pandemic. The respondents located in Wuhan reported no change or worsening of their dental clinical skills. Most graduates felt that COVID-19 exerted an effect on their immediate postgraduation career, but the effect was limited. Infection control-teaching from dental school seemed effective to develop positive attitudes for residents after they returned to clinical training during the post-COVID-19 era.

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