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A cross-sectional multicenter survey on the future of dental education in the era of COVID-19: Alternatives and implications

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Abstract

Purpose: The coronavirus disease 2019 (COVID-19) pandemic has significantly challenged dental education. This study investigated the procedures outlined by dental faculty members to maintain quality dental education in a safe bioenvironment and adequately control the risk of cross-infection

Method: Dental educators from dental schools around the world were invited to join an online survey considering different demographic factors. The survey consisted of 31 questions that were classified into separate sections, including academic characteristics, college size and facilities, action taken after announcement of the COVID-19 pandemic, perception of the pandemic, opinion regarding teaching, patient flow, possible facilities to implement for short- and long-term plans, and actions suggested to deal with the COVID-19 pandemic

Results: Two hundred-twelve responses were received. Respondents commonly agreed that COVID-19 will have major negative effects on dental education, adversely affecting all clinical disciplines. Shifting to virtual curricula, simulation labs, and distant learning were the prevailing actions taken in different dental colleges during the pandemic. Special attention was raised by the majority of respondents regarding dental aerosolizing procedures, preferring to postpone their training to a postpandemic/later phase. Coinciding opinions suggested adopting a future dynamic hybrid strategy analysis that combines online distant learning, virtual simulation, and haptic labs together with traditional direct clinical training on real patients

Conclusion: The future of dental education will have far-reaching changes in strategies and tools to cope with COVID-19 pandemic and the postpandemic requirements of an effective, yet safe, dental learning environment. Dental colleges need to invest in infection precautions and in modern virtual education and training facilities.

KEYWORDS
dental, education, online distant learning, pandemics, surveys and questionnaires, virtual simulation

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was announced by the World Health Organization (WHO) as a pandemic that began in Wuhan, China, in December 2019.[1] This outbreak has challenged the entire world. The number of infections is rising every day, and because of COVID-19, millions of infections and hundreds of thousands of deaths have been recoded globally.[2] Currently, there is no proven therapy or effective vaccination for the infection.[3] The high rate of infectivity and the uncertainty in much information about SARS-CoV-2, especially with respect to the exact route of transmission and the probability of airborne infection, have forced health authorities around the world to implement a number of rules and lockdown measures, including suspending schools and universities.[4–6] One recent study isolated SARS-CoV-2 from air samples collected > 2 meters away from COVID-19 patients in clinics of a medical educational institute.[5,7] Another study performed at Wuhan hospitals found higher SARS-CoV-2 viral contamination in intensive care rooms and on floors, computer mice, and trash cans. Moreover, the virus was found in the air about 4 meters away from patients.[7]

As an alternative to direct learning strategies, most schools and universities implemented distant learning to proceed with the educational process during the COVID-19 pandemic. Virtual curriculum, online courses, lectures, virtual workshops and webinar sessions, including online formative and summative assessments, have been the alternative strategy of choice adopted by most dental schools around the world.[4]

Dentists have been listed by the Occupational Safety and Health Administration to have a very high risk of infection, owing to the unavoidable aerosolizing procedures included in their everyday clinical practice. The airborne route of infection has been widely reported, listing many aerosol-producing dental procedures as having severe risk for transmission of infection.[8] A number of recommendations and guidelines have been informed by different health authorities, as well as the American Dental Association (ADA) and the Centers for Disease Control and Prevention, to prevent COVID-19 infection among patients and dental professionals.[9] However, there is still a lack of reliable criteria for establishing a protective working environment and solid standards that ensure safety and prevent cross-infection among patients, students, and faculty and staff at dental schools, while at the same time permitting satisfactory progress of dental education.

While implementing distant learning, preclinical simulation labs, virtual reality systems and social distancing might be effective for developing certain levels of skills, but direct patient management in real clinical sessions remains essential in developing, instructing, assessing and achieving the expected satisfactory skills and competencies of a general dental practitioner.[4,10]

In the early phase of the COVID-19 pandemic, most dental schools around the world have suspended all clinical activities, except for the control of emergencies. Nevertheless, at the time of writing this article, different countries are facing different realities of the COVID-19 pandemic. Today, some countries are still in the peak of the curve of infection. Others have reduced or flattened the curve, while some countries are facing a second wave of the pandemic. Consequently, some dental schools around the world have started to resume safe patient care with dental students direct training on patients using personal protective equipment (PPE) together with social distancing.[11] Currently, there is a lack of reliable curative therapies or an effective vaccination; thus, a number of polices should be adopted by dental schools to validate alternatives that can be followed to ascertain adequate precautions to halt cross-infection. Moreover, maintaining constructive dental educational programs that do not undermine the quality of the dental educational process is needed that balances between safety and developing adequate levels of competency of dental graduates.[12,13]

Therefore, this multicenter cross-sectional survey was performed to investigate the adverse effects of the COVID-19 pandemic on dental education and the possible implications and best management strategy from the perspective of the dental educator.

2 | METHODS

An exemption of the Institutional Review Board (IRB) was obtained from the IRB committee of Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia. This was a cross-sectional multicenter survey on the future of dental education in the era of the COVID-19 pandemic. Dental faculty members at dental schools from Saudi Arabia, Egypt, Germany, USA, India, Hong Kong, Kuwait, Australia, Pakistan, and Canada were invited to join the online survey. The 10 selected countries are differently geographically located with variation in power of economy and quality of education. Only dental colleges that belong to governmental, public, or national universities and listing > 40 dental educators each with their email addresses in their respective webpages were included in the study. Dental colleges belonging to private universities or with concealed email addresses of their educating staff members were excluded from the study. The targeted population size was 400, which resulted in a calculated sample size of 197 faculty members. Calculations were performed

at the 95% confidence level using a free online sample size calculator (https://www.calculator.net/sample-size-calculator.html?type=1&cl=95&ci=5&pp=50&ps=500&x=76&y=28). Email addresses of 40 faculty per each of the 10 participating dental colleges were randomly selected using computer software after transferring and coding of all faculty email addresses. Email invitations were sent to them to voluntarily and anonymously join the online survey.

To test the validity and reliability of our questions, content validation was performed by inviting 10 experts to validate each question of the survey over a scale of 4 ranks: the question is not relevant, the question is somewhat relevant, the question is quite relevant, or the question is highly relevant. All of them ranked all questions as relevant or highly relevant. Demographic data, including the area and facilities, were among the items analyzed.

The survey consisted of 30 questions classified into the following sections: academic characteristics of respondents, respective college size and facilities, action taken after announcing the COVID-19 pandemic, respondents' perception regarding the COVID-19 pandemic, respondents' opinion regarding method of teaching during the COVID-19 pandemic, patient flow during the COVID-19 pandemic, and thereafter, possible facilities to implement for short term plans, and actions suggested by respondents after the COVID-19 pandemic (Table 1). For most questions, only 1 possible answer could be chosen, except for 3 questions where multiple answers were possible. Descriptive statistics were implemented to analyze the results.

3 | RESULTS

Out of the 400 invitations, 212 responses were received over a period from May 15, 2020, to July 20, 2020. The 30 questions, their answers and the corresponding results in the form of frequency and percentage are presented in Table 1. The demographic data of respondents relative to the location of their respective dental colleges was as follows: Saudi Arabia (16.5%), Egypt (14.4%), India (13.6%), Pakistan (13.2%), Germany (10.4%), USA (9.4%), Hong Kong (9%), Australia (5.6%), Kuwait (4.2%), and Canada (3.7%).

Respondents commonly agreed that COVID-19 will have major negative repercussions on dental education, adversely affecting all clinical disciplines. Shifting to virtual curricula, simulation labs, and distant learning were the prevailing actions taken in different dental colleges during the pandemic. Special attention was raised by the majority of respondents regarding dental aerosolizing procedures, preferring to postpone their training to a post-pandemic or later phase. A coinciding opinion suggested adopting a future dynamic hybrid strategy that combines online distant learning, virtual simulation and haptic labs, together with the traditional direct clinical training on real patients.

4 | DISCUSSION

The United Nations (UN) development program has identified the COVID-19 pandemic as a global health crisis that constitutes the greatest challenge the world has faced since World War II. Spread of the infection has reached every continent, except for Antarctica.[14] Reports have highlighted that the COVID-19 pandemic is caused by the SARS-CoV-2 virus as a droplet and even airborne infection, indicating the complex procedures and precautions needed to control cross-infections, especially in hospitals and among healthcare providers. Due to the nature and routine of dental settings, dental practice has been listed as high risk with inherent the increased probability of cross-infection between dental practitioners and patients. Consequently, tight and essential guidelines and infection control procedures against this highly spreading virus are considered a priority in all dental clinics and hospitals around the world.[15]

Dental schools around the world have generally shifted to virtual curricula and distant learning with a lack of long-term standards and/or action plans, which are needed as the COVID-19 pandemic might continue for years.[16] While didactic aspects of the dental educational curricula can be successfully conducted through online distant learning, effective standards for developing adequate clinical training and experience for dental students are still lacking with gaps in vision between different dental colleges.[17,18]

In the current study, we designed our questions to represent the primary concerns of dental educators raised during the COVID-19 pandemic after shifting to distant learning and virtual curricula.[4,16,19,20] Nevertheless, our questionnaire was designed to be simple, concise, and precise, taking only about 10 minutes to complete. Previous surveys were referred to for general guidance.[21,22] To encourage the invited faculty members to join the survey, clear statements were used in the email invitations, and the survey link to complete the survey was anonymous and voluntary with the option to leave at any time. Phrasing and sequence of the questions were set up in consideration of the basic aspects of developing research questions listed by Kelley et al. and to ensure consistency and relevance with the study objectives.[23]

A pilot phase was performed by inviting 10 experts in the field of dental education to voluntarily and anonymously rank our 31 questions.[21,22] All of them scored all questions included in our survey as relevant or highly relevant questions. Additionally, a great deal of encouraging feedback

TABLE 1 Questions, answers, and results (frequency and percentage) of the survey (n = 212)

Question	Answer	Frequency (no. of replies)	Percentage (%)
Academics characteristics of respondents (n = 212)			
Which branch of dental sciences are you teaching?	Clinical dental sciences	155	73
	Non-clinical dental sciences	19	9
	Both	38	18
For how long (years) have you been teaching dentistry?	≤5	47	22.1
	6–10	35	16.4
	>10	130	61.5
How many courses on average do you contribute per semester?	Only 1 course	28	13.1
	Two courses	52	24.6
	More than 2 courses	132	62.3
Have you been a course director?	Yes	155	73
	No	57	27
How many clinical courses do you have at your dental school?	<5	23	10.7
	5–10	104	49.2
	>10	85	40.2
Respective college size and facilities			
What is the average number of students usually attending a lecture at your college?	<20	7	3.3
	20–50	81	38.5
	51–100	77	36.1
	>100	47	22.1
What is the number of dental units per clinic on average at your dental school?	20-50	78	36.9
	51-100	108	50.8
	>100	26	12.3
How many dental units on average in each clinical session are usually occupied by dental students involved in treating patients?	<20	21	9.8
	20-50	113	53.3
	51-100	73	34.4
	>100	5	2.5
How far apart are the dental units placed in the clinics of your dental school?	<1 meter (3 feet) apart	56	26.2
	1-2 meters (3-6 feet) apart	109	51.6
	>2 meeters (6 feet) apart	47	22.1
Are the dental units in the clinics of your dental school separated with partitions?	Yes	165	77.9
	No	47	22.1
How many dental manikin units are available at your dental school for preclinical training?	20-50	82	38.5
	50-100	105	49.2
	>100	26	12.3
Do you use portable manikin heads at your dental school that can be fixed to the dental units to replace real patients?	Yes	80	37.7
	No	132	62.3
Action taken after announcing the COVID-19 pandemic			
What has been the action taken at your dental school after announcing the pandemic?[a]	Suspension of all academic activities	3	1.64
	Suspension of all academic activities, conducting online virtual learning	49	22.95
	Conducting online virtual learning	120	56.56
	Conducting online virtual learning, using social distancing while attending	16	7.38
	Using social distancing while attending	2	0.82
	All above	22	10.66

(Continues)

TABLE 1 (Continued)

Question	Answer	Frequency (no. of replies)	Percentage (%)
Respondents perception regarding the COVID-19 pandemic			
Do you expect the COVID-19 pandemic will have major negative effects on the quality of dental education?	Yes	135	63.9
	No	16	7.4
	Maybe	61	28.7
Do you think the adverse effects of the pandemic on dental education will last for a long time and that an effective action plan should be developed?	Yes	123	58.2
	No	26	12.3
	Maybe	63	29.5
What are the branches of dentistry that will be most adversely affected by the pandemic?[a]	All clinical branches	104	49.2
	Clinical branches with procedures producing aerosols	51	23.8
	All clinical branches, clinical branches with procedures producing aerosols	44	20.5
	All clinical branches, clinical branches with procedures producing aerosols, non-clinical branches	9	4.1
	All clinical branches, non-clinical branches	4	1.6
Respondents' opinions regarding way of teaching during the COVID-19 pandemic			
What in your opinion is the best strategy to ensure a safe learning environment yet ascertaining continuity of effective dental educational process?	Complete shift to distant learning	7	3.3
	Dynamically shifting from 1 option to next according to the infection rate	104	49.2
	Precautions, such as social distancing, PPE, isolated negatively pressurized rooms	45	21.3
	Simulation labs training and distant learning	56	26.2
What specifically is the best way or ways to conduct effective clinical exams during the pandemic?	Only online cases presentation and discussion or OSCE exams	40	18.9
	Performing clinical exams on patients with the necessary precautions	36	17.2
	Performing virtual clinical exams in simulation labs	84	39.3
	Postponing all clinical exams till resolution of the pandemic	52	24.6
What specifically is the best way to continue with students' clinical training during the pandemic?	Keeping all clinical training on patients with the recommended precautions	45	21.3
	Postponing aerosolizing procedures till resolution of the pandemic	35	16.4
	Postponing all clinical training till resolution of the pandemic	47	22.1
	Shifting all clinical training to virtual training	31	14.8
	Shifting only aerosolizing procedures to virtual training	54	25.4
What is your expected faculty/student ratio during the COVID-19 pandemic?	High faculty/student ratio	66	31.1
	Low faculty/student ratio	63	29.7
	No change in faculty/student ratio	83	39.2
Patient flow during the COVID-19 pandemic and thereafter			
How do you find patient flow in your school during the pandemic?	Less than normal flow of patients	70	32.8
	Normal patient flow	14	6.6
	Patients coming only for emergency services	128	60.7

(Continues)

TABLE 1 (Continued)

Question	Answer	Frequency (no. of replies)	Percentage (%)
What is your expectation of the effect on patient flow on the quality of graduates' clinical skills during the pandemic and thereafter?	Dramatic adverse effect	68	32
	Not affected if supplemented by adequate alternatives	71	33.6
	Relatively inferior quality	73	34.4
Possible facilities to implement for short term plans			
What are the possible facilities that you expect to implement for short term plans in the clinics of your dental school to control the risk of cross-infection?[a]	Standard PPE	179	84.4
	Enhanced clinic ventilation	151	71.3
	Negative pressure systems	99	46.7
	Air purifiers	132	62.3
	Portable clinics and isolation rooms for suspected and confirmed cases	99	46.7
Actions suggested by respondents after the COVID-19 pandemic			
If direct clinical training on patients is resumed			
Do you expect that the psychological status and fear of infection would affect dental students' attitudes?	Yes	148	69.7
	No	3	1.6
	Maybe	61	28.7
Do you expect that the psychological status and fear of infection would affect faculty members' attitudes?	Yes	139	65.6
	No	9	4.1
	Maybe	64	30.3
Do you expect that the psychological status and fear of infection would affect other supporting staff's attitudes?	Yes	137	64.8
	No	5	2.5
	Maybe	70	32.8
Would this interfere with attaining adequate clinical skills?	Interfere	75	35.2
	Maybe	78	36.9
	Not interfere	59	27.9
In case of interference from complicated PPE, would a training phase in simulation labs be advisable?	Yes	137	64.8
	No	5	2.5
	Maybe	70	32.8
Would an adaptation phase for the new guidelines during the pandemic and thereafter improve dental education outcomes?	Yes	137	64.8
	No	12	5.7
	Maybe	63	29.5
In your opinion where should dental schools invest more in the near future?	PPE, isolated rooms with good ventilation, negative pressurized rooms	15	7.4
	Virtual simulation and haptic technology facilities	20	9
	Both	177	83.6

[a]More than 1 answer is allowed.

Abbreviation: OSCE, Objective, Structured Clinical Examination.

was received by peers included in discussing the validity of the research at the time when discussing the proposal at the departmental level and at the institutional level when applying for an exempt IRB.

Due to the nature of our questionnaire and as 3 questions in our survey could be answered by choosing > 1 answer, while others had answers ranging between yes, no, and maybe, only a qualitative descriptive statistical analysis was possible and was subsequently implemented.[24] Invited faculty members from different dental colleges in different countries around the world who joined our survey provided wider perspectives and exchange of expert opinions regarding current challenges of the COVID-19 pandemic and possible solutions. These data will support implementation of effective policies and standards during the current pandemic and in the future suitable to ensure students

attain adequate skills and competencies as dental graduates and satisfactorily serve the community.

Our results agreed with previous reports that the COVID-19 pandemic is a major challenge to dental practices and the dental education process.[4,16] The universal judgment of the survey respondents was that COVID-19 will or may have major negative effects on dental education. This answer was stated regardless of the location of their dental school, their specialty, length of experience, role in teaching dentistry, size of their college or available facilities. This knowledge urgently calls for consequent appropriate updates of dental educational policies and strategies using suitable tools and long-term provisions and sustainable actions in dental education.[4,16] The common agreement between respondents that education in all clinical disciplines will be adversely affected by the challenges introduced by the pandemic urges setting effective action plans and modern teaching and assessment methodologies that ensure developing adequate clinical skills and competencies of dental students and graduates of dental schools.

Dental clinical teaching and clinical student training directly on patients under close and remote supervision of senior clinical professionals and mentors is key for developing the essential clinical skills, competencies, and clinical decision-making abilities mandatory for a dental graduate and general dental practitioner.[25,26] This includes developing and upgrading the different direct skills needed in the basic domains of knowledge, cognitive skills, psychomotor skills, interpersonal and responsibility, communication skills, and information technology, together with professionalism. In competency- and discipline-based curricula, dental students are expected and required to complete a series of clinical cases and pass a number of continuous and final assessments, including clinical exams, competencies, and interdisciplinary comprehensive patient management.[25–27]

Older studies prior to the COVID-19 pandemic have outlined the future directions of dental education based on past and future health requirements.[28,29] The current study highlights the need for special reforms in dental education to cope with the current and future challenges posed by the COVID-19 pandemic.

The outcome of the current survey confirmed that, during the COVID-19 pandemic and thereafter, reforms in dental clinical training and assessment strategies should be more extensive, using virtual reality haptic labs, simulation technologies, and reliable tools that support attaining adequate skills and objectively evaluating students' clinical abilities. On the other hand, a safe environment of traditional clinical practice on real patients should add appropriate facilities and precautions to control cross-infection during the current crisis and in the future. Our results highlighted the significance of ensuring satisfactory infection control facilities in dental schools. This supports previous reports documenting deficiencies and shortages of infection control tools during the current pandemic and calls for providing more supplies to secure the needs.[30,31] Therefore, plans should involve confirming adequate supplies of PPE, medical protective masks, as well as other physical barriers and facilities for health workers to control cross-infection among patients, students, and staff.[32,33]

Despite the variation between different dental college facilities, number and settings of dental units, and number of students in lectures and clinical sessions, the most frequent answer of respondents was that their dental schools suspended all academic activities and shifted to online virtual learning. Furthermore, the greatest number of respondents agreed to shift aerosolizing procedures to virtual learning or postponing clinical training until the end of the COVID-19 pandemic. Thus, irrespective of facilities, like portable manikin heads attached to dental units, the number of manikin units, and the number and setting of dental units, additional policies should be implemented to ensure a safe environment against COVID-19 cross-infection during the different dental clinical practices, especially for aerosolizing dental procedures.

The unprecedented challenges of the COVID-19 pandemic on dental education require lively and close cooperation, excellent communication, orientation and adaptation of all faculty, nurses, assisting staff, and students to actively and periodically monitor policies and guidelines to ensure quality education in a safe and confident atmosphere. This was particularly reflected by the common answers we received that fears of students, faculty members, nurses, and assisting staff might influence the quality of dental education during the pandemic and thereafter. Furthermore, matching opinions between survey respondents to implement a dynamic shift in policies and guidelines, especially for clinical training and assessment according to the periodical reports of virus infectivity, are in line with the current policy adopted by active members of American Dental Education Association, stating that, while each dental college should follow the regulations and guidelines set by local health authorities in accordance with the periodical reports of the rate of spread and infectiousness of SARS-CoV-2 virus, leaders of the dental education community should implement alternative practices, recommendations, and guidelines specific for their institutions.[34] The need for adaptation phases and training periods that was highlighted by the majority of respondents reflects the need for assigning a training and monitoring team that calibrates and follows up on successful compliance to the adopted guidelines of infection control during the pandemic and thereafter.

A number of policies, tools, and guidelines were agreed upon between survey respondents, ranging from social distancing and direct patient management using the recommended precautions, such as isolated rooms, air purifiers and filters, together with PPE, to a combination of distant learning, virtual simulation technologies, and postponing all aerosolizing procedures until resolution of the pandemic or development of an effective vaccine against infection. Such a flexibility in timely reviewing and deciding the most appropriate policies and guidelines in response to the periodic updates provided by local health authorities might constitute an intelligent balance between values and practices of the dental education process.

The coinciding opinion among respondents that dental colleges should in the near future invest in more PPE, isolated rooms with good ventilation, negative pressurized rooms, and virtual simulation and haptic technology facilities, was evident in the current survey. This reflects that dental education in response to COVID-19 pandemic challenges will have revolutionary and likely permanent changes in both strategies and tools. A hybrid of traditional clinical training on patients using all possible precautions and physical barriers, together with distant learning, modern technologies of virtual simulation, skills labs, and using the principles of artificial intelligence in dental education, will form the skeleton of future dental education.[35–38] Such a hybrid strategy in dental education can reduce the training time needed in direct clinical practice and supports developing adequate skills and building experiences for the dental students, while ensuring optimum dental education practice safety and confidence. The majority of participants agreed that the psychological status and fear of infection among students, dental faculty members, and other supporting staff would affect their attitude leading to probable adverse effects on attaining adequate clinical skills. This highlights the need for greater reassurance, closer communication, active disclosure, and sharing of knowledge between students, faculty, and supporting staff.[20]

A greater fraction of respondents found the reduced patient flow during the pandemic to have probable adverse effects on the quality of clinical skills of the graduates. Consequently, broader communication programs and information sharing with the community should be an integral part of the action plan of dental colleges for maintaining confidence, alleviating patients' worries and keeping pace of adequate rate of patient flow.

The current study has certain limitations. As a cross-sectional study, it assessed dental educators' opinions at 1 specific point in time regardless of the probability of changing their feedback with the progress of knowledge as time passes. This is particularly true with the highly dynamic nature of COVID-19-related information leading to a time dependent broader understanding and deeper insight on how to contain it.[39] To date, there is a lack of adequate evidence regarding the rate of COVID-19 infection among patients or dental work force due to dental settings, including the potentially aerosolizing procedures.

Meng et al., recorded the incidence of 9 cases of COVID-19 infections amidst 169 dental practitioners, indicating the high risk of transmission of infection in the profession.[15,40] Comparing the rate of incidence of infection among the dental workforce or dental patients to that occurring in the community needs the progressive collection of information.[41] A single case was reported for 41 healthcare providers who were exposed for at least 10 minutes at a distance < 2 meters to a COVID-19-positive patient during aerosolizing procedures of endotracheal intubation, extubation, and noninvasive ventilation, while 85% of them were using surgical masks and the rest were using N95 masks. All of the exposed healthcare providers were home isolated for 14 days and were twice tested for SARS-CoV-2 using nasopharyngeal polymerase chain reaction (PCR). None of them tested positive for the virus.[42] More evidence is needed before determining the risk of infection transmission in dental settings and the effectiveness of the current guidelines of infection control in dental clinics.

Inhalation, exposure to oral mucosa, and contaminated hands were among the reported routes of transmission of infection in dental practices.[40] Patient triage, social distancing, adequate ventilation, rinsing with mouth washes before dental procedures, filters of contaminated air, isolated rooms, PPE, hand hygiene, surface disinfection, and limiting aerosolizing procedures were some of the listed measures to contain the infection.[40,43,44] Furthermore, patient's eyes protection and limiting radiographs to extra-oral views were among the reported measures to protect patients.[45,46]

Although dental aerosolizing procedures have been listed as high risk by the U.S. CDC, the routine use of high-volume suction and rubber dam might have a potential risk reducing the effect.[41] Progressive accumulation of supporting evidence will guide decision makers of the dental education community in developing the most effective infection control policies.[47] The low response rate from certain dental colleges included in this study is another limitation that might be related to inconveniences due to the lockdown measures or because of receiving too many surveys invitations related to the COVID-19 pandemic.[48] Furthermore, our survey did not assess the psychological reaction and anxiety of participants in response to COVID-19 rate of infection and deaths in different locations.

In a survey conducted in Italy in April 2020, all respondent dentists reported reducing the number of their urgent procedures with a great number of patients canceling their routine appointments. Moreover, they admitted that the

routine PPEs should be modified during the pandemic. Concerns, fears, and anxiety were reported by the majority of participants.[49]

At this time, our affiliating dental schools vary in their implemented policies between resuming students' direct patient training and clinical exams to a more strict policy of limiting students' training to virtual simulation labs and performing non-aerosolizing clinical procedures while postponing all aerosolizing procedures. Social distancing and monitoring of body temperature of all persons upon arrival to school are common activities.

The presymptomatic or asymptomatic transmission of infection remains a challenge, indicating the need to follow procedure-linked-workflow and guidelines.[50] PPE, such as face masks, face shields, gloves, disposable surgical gowns, head caps, and shoes covers, have been recommended for the dental workforce. The California Dental Association (CDA) has listed a procedure-linked workflow with different exposure risk levels from administrative to moderate and heavy aerosolizing procedures with respective sets of corresponding PPE. In the CDA recommended list of PPE, surgical masks were limited to non-aerosolizing procedures. Medical protective masks (N95/KN95) that require respiratory seal testing were strongly recommended for aerosolizing procedures. In cases of PPE shortage, the CDA advocated the use of a surgical mask in addition to a full face shield as an acceptable alternative to N95/KN95 masks for all team members in direct contact with patients during aerosolizing procedures. Masks that do not provide respiratory seal carry potential risk of transmission of infection.[51]

Our inclusion and exclusion criteria allowed participation of dental educators from different countries around the world with variations in power of economy and quality of education providing adequate diversity of the study group and increasing the validity of the study outcomes.

5 | CONCLUSIONS

Within the limitations of the current study, the following conclusions can be drawn. The COVID-19 pandemic has introduced unprecedented challenges to dental education, demanding urgent and dynamic action plans. Consequently, the future of dental education is viewed by dental faculty members as a hybrid of distant learning, direct patient clinical training with appropriate PPE and other precautions to fight droplet and airborne transmission, and modern technologies of virtual and haptic simulation labs. For optimum quality education, dental colleges should expand communication and information sharing among students, faculty, and supporting staff, as well as with the community. In the near future, dental schools should invest in infection control precautions and effective PPE that fight droplet and airborne infection transmission in addition to modern educational technologies and simulation labs.

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