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Risk of Exposure of Dental Personnel to COVID-19 and their Compliance with COVID-19 Safety Guidance for the Dental Practice

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Abstract

Background: To curb the spread of the coronavirus disease 2019 (COVID-19), several guidelines for dental practice were proposed by dental practice regulating bodies. Assessing the level of compliance to these guidelines by dental personnel will provide an evidence-based report of their adherence to COVID-19 guidance and if improvement on this is required. **Aim:** To assess the risk of exposure of dental personnel to COVID-19 in the dental facility and their level of compliance with COVID-19 guidance for the dental practice. **Methodology:** This was a descriptive cross-sectional study conducted at the Dental Centre of the Lagos University Teaching Hospital, (LUTH) Lagos, Nigeria. Participants were dental personnel (resident doctors/house officers, dental nurses, dental hygienists and dental technologists) at the Dental Centre, LUTH. COVID-19 risk assessment and compliance with COVID-19 dental practice guidance were assessed using a self-administered questionnaire. **Results:** A total of 131 dental personnel aged 29.4 ± 5.16 years participated in this study. High risk of COVID-19 exposure was noted in trainees in conservative dentistry, paediatric dentistry, oral and maxillofacial surgery, and in dental hygienists. Eight dental personnel (6.1%) reported a confirmed diagnosis of COVID-19. Majority of included specialties reported a low (<50%) to moderate (>50%–<80%) level of compliance with the pre-treatment, during treatment and post-treatment guidance. **Conclusion:** Although dental personnel at the Dental Centre, LUTH had a high risk of exposure to COVID-19, they showed low-to-moderate compliance with pre-treatment, during treatment and post-treatment guidance which led to a relatively high incidence of COVID-19 transmission in the dental clinic.

Keywords: Compliance, corona virus disease-2019 guidance, risk of exposure

INTRODUCTION

The coronavirus disease-2019 (COVID-19), caused by the severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) is viral pneumonia which was declared a pandemic by the WHO on 11th March 2020, due to its high infectivity and spread.^[1] The SARS-CoV-2 is transmitted either as droplets of $>5 \mu\text{m}$ or aerosols $<5 \mu\text{m}$ in diameter.^[2] Droplet transmission is either by direct contact which involves exposure of mucosae of the susceptible individual to potentially infective respiratory droplets containing SARS-CoV-2 or by indirect contact which involves contact with fomites in the immediate environment around an infected person.^[2]

Aerosol transmission of the SARS-CoV-2, like other airborne infections, occurs when respiratory particles containing viral nuclei are inhaled and deposited in the lungs.^[3] According to the WHO, airborne transmission can only occur when aerosol-generating procedures (AGP) are performed.^[4] AGPs identified by the WHO include tracheal intubation, positive pressure ventilation, airway suctioning, nebulizer treatment, bronchoscopy, and dental procedures performed with fast speed handpieces, ultrasonic scalers and air/water jets.^[4]

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Dental personnel such as dentists, dental nurses and dental hygienists have always been at a high risk of contracting respiratory pathogens due to their exposure to both the oral flora and other pathogenic microorganisms present in their patient's mouth.^[5] Their face-to-face communication with patients, close contact with patients' oral cavity, frequent exposure to saliva, and the generation of aerosols from dental procedures expose them to dangerously high levels of microbes placing them at high risk for transmission and contraction of the coronavirus especially when the patient has a symptomatic respiratory infection.^[5] Guidance for dental practice during the COVID-19 pandemic has been proposed by the Center for Disease Control and Prevention (CDC) and the World Dental Federation (FDI).^[6-8] This guidance recommended infection prevention and control practices for routine dental healthcare delivery including the postponement of treatment for patients with respiratory symptoms, implementation of Teledentistry and triage protocols, screening and triage of every patient entering the dental healthcare facility ensuring proper use of facemask by patients, monitoring and managing all dental healthcare personnel, encouraging physical distancing of 6 feet, especially in waiting area, implementation of universal use of personal protective equipment (PPE) by all dental personnel, ensuring proper hand hygiene practices by all dental personnel and ensuring adequate dental environment sanitation and waste management.^[6,9]

This guidance is important in preventing the spread of COVID-19 in the dental setting particularly because of the high risk of exposure of dental personnel. In Nigeria, the prevalence of COVID-19 has not been as high as it has been in American and European countries.^[10] As a result, it can be expected that the level of compliance to these guidance proposed may be low. However, the fact that COVID-19 has not had as high an impact on the health of the Nigerian population is not a good enough reason to neglect said guidance especially with the advent of a second wave of the coronavirus pandemic. It is therefore important to assess the level of risk of all dental personnel in a Nigerian dental setting and also determine the level of compliance to the laid out practice guidance. This information will provide an insight on the risk of exposure of dental personnel to COVID-19 specific to our environment as well as provide an evidence-based report of our adherence to COVID-19 guidance and if improvement on this is required.

Therefore, this study aimed to assess the risk of exposure of dental personnel to COVID-19 in the dental facility and their level of compliance with COVID-19 guidance for the dental practice. The objectives addressed were: To assess the risk of exposure of resident doctors/house officers in conservative dentistry, prosthodontics, orthodontics, paediatric dentistry, preventive dentistry, oral and maxillofacial (OMF) surgery, OMF pathology, as well as dental nurses, dental hygienists and dental technologists to COVID-19 as it relates to their specific roles in dental practice and to determine their level of compliance to COVID-19 dental practice safety guidance.

METHODOLOGY

This was a descriptive cross-sectional study conducted at the Dental Centre of the Lagos University Teaching Hospital (LUTH), Lagos, Nigeria. Ethical approval for this study was obtained from the LUTH Health Research and Ethics Committee, first-floor LUTH Administrative block, LUTH, Lagos, Nigeria on the 8th of January, 2021 and the study protocol was given the assigned protocol number ADM/DCST/HREC/APP/4061. Data were collected from the 11th to the 29th of January, 2021.

The study population included dental personnel working at the dental center, LUTH including resident doctors and house officers (trainees) in conservative dentistry, prosthodontics, orthodontics, paediatric dentistry, preventive dentistry, OMF surgery, OMF pathology, as well as dental nurses, dental hygienists and dental technologists. The multistage sampling method was used to select participants that met the inclusion criteria. Based on the proposed study population, a teaching hospital with a COVID-19 care center in Lagos, Nigeria was desirable. Only two teaching hospitals met these criteria: The LUTH and The Lagos State University Teaching Hospital. Random sampling was used to select LUTH as the study location. All dental interns and dental residents (trainees) working at the dental center, LUTH in conservative dentistry, prosthodontics, orthodontics, paediatric dentistry, preventive dentistry, OMF surgery or OMF pathology were included in the study. All dental staff nurses, dental hygienists and dental technologists working at the dental centre, LUTH were also included in the study. Participants must have been a current staff of LUTH at the time of data collection and must have worked actively for the past 6 months during the COVID-19 outbreak. A well-structured close-ended self-administered questionnaire was used. The questionnaire included information on socio-demographic characteristics (such as age, gender, religion, marital status, education attained), dental speciality, COVID-19 risk assessment and compliance with COVID-19 protocols for the dental practice.

COVID-19 risk assessment for dental personnel included questions aimed at assessing the risk of exposure to COVID-19: Do you work directly in your patients' mouth? Do you work with tissue, or blood or saliva samples from patients? Do you work on patient impressions, bite registrations and/or models? Do you use fast handpiece, surgical drills, air/water jet or ultrasonic scalers? Do you frequently use fast handpiece, surgical drills, air/water jet or ultrasonic scalers? Do you assist, observe or supervise a dental practitioner performing a procedure with fast handpiece, surgical drills, air/water jet or ultrasonic scalers? Does your work involve drilling a patient's tooth or bone? Does your work involve water/saline/mouthwash spray? Does your work involve contact with saliva? Does your work involve contact with blood? COVID-19 risk of exposure assessment score was calculated as the total number of positive responses with the lowest possible score of zero and the highest possible score of 10. Mean risk assessment score was calculated and specialties with scores

above the mean were said to be of high risk of COVID-19 exposure and specialties with scores below the mean were said to be of low risk of exposure.

The history of COVID-19 exposure was also assessed among dental personnel. A 3-month history was obtained for all participants because it was discovered that routine dental practice fully commenced 3 months before the administration of questionnaires in LUTH. Before this, only emergency dental services and non-AGP were performed at the dental center, LUTH. The history of COVID-19 exposure was assessed with the following questions: In the past 3 months, have you been diagnosed with COVID-19? In the past 3 months, have any of your colleagues in your present department been diagnosed with COVID-19? In the past 3 months, have you been in contact with a COVID-19 patient or colleague in your workplace? In the past 3 months, have you had to isolate due to contracting COVID-19 or potential exposure to a covid-19 patient?

Compliance with dental practice guidance was assessed using questions formulated from the Guidance for dental practice by Banakar *et al.*^[11] adopted from proposed guidance by the CDC,^[6] FDI,^[8] WHO,^[12] American Dental Association (ADA),^[13,14] and the American Dental Hygienist Association.^[15] It included questions on routine practices before, during and after dental treatment. Compliance was categorised as low, moderate or high depending on the percentage of dental personnel adopting COVID-19 dental practice guidance. Fifty percent or less was categorized as low, >50% but <80% was categorized as moderate and 80% or more was categorized as high.

Compliance before dental treatment

The following questions were included in the questionnaire: Do you delay non-urgent dental and cosmetic services? Do you prevent crowding in the clinic by setting and booking appointments? Do you postpone dental procedures in patients with a history of respiratory symptoms or COVID-19 for at least 1 month? Do you always treat high-risk patients like diabetic and immunocompromised patients at the early hours of the dental office opening? Do you use telephone triage, teleconferencing, or teledentistry options as alternatives to in-office care, (when possible)? Do you ask staff to stay home if they are sick? Do you actively screen and record the temperature of each staff at the start of the day? Do you actively screen and record the temperature of the patient at the time of check-in? Do you prevent patients from bringing accompanying individuals into the dental office while you work? Do you offer hand wash or hydro-alcoholic solutions (with 60%–75% alcohol) for hand disinfection upon entrance to the dental office? Do you provide a large room with adequate ventilation in the waiting area? Do you allow for appropriate zoning and separation in the waiting area? Do you remove magazines, reading materials, toys, and other objects that may be touched by others and which are not easily disinfected from the waiting area? Do you place signage in the dental office for instructing patients on standard recommendations for respiratory hygiene/cough etiquette and social distancing? Do you ensure the use of facemasks or cloth

face coverings by everyone entering the dental office? Do you implement PPEs (isolated wearing like N-95 masks, Health or FFP2-standard masks, gloves, face shields, goggles, gown, surgical cap, shoe cover) during dental procedures? Do you prepare dental materials and instruments in advance and cover surfaces with disposable protections? Do you treat patients in an isolated and well-ventilated room with negative pressure relative to the surrounding area?

Compliance during dental treatment: Do you practice proper hand hygiene (alcohol-based hand rub or hand washing using soap and water) before and after all patient contact, contact with potentially infectious material, and before putting on and after removing PPE? Do you use preoperative antimicrobial mouth rinses like hydrogen peroxide, povidone or chlorhexidine before treating patients? Do you use rubber dams and high-volume saliva ejectors during AGP? Do you use extraoral dental radiographs, such as panoramic radiographs or cone-beam C. T., as appropriate alternatives of intraoral radiography? Do you practice 4-handed dentistry? Do you use resorbable sutures as opposed to non-absorbable to eliminate the need for a follow-up appointment? Do you complete all your treatments in one visit (if possible) to avoid re-exposure to the oral environment?

Compliance after dental treatment: Do you ensure environmental cleaning and disinfection procedures are carried out after the completion of clinical care? Do you ensure reusable facial protective equipment is cleaned after use? Do you ensure laundry and medical waste are managed appropriately?

For dental technologists, disinfection protocol was assessed using questions formulated from the bio-safety and disinfection protocol by Sartoti *et al.*^[16] Are all impressions, bite registrations and/or models disinfected in the dental clinic before receipt in the lab? Do you check for organic material like blood or saliva before working on an impression, bite registration or model? Do you disinfect all impression materials sent to the lab? Do you wear gloves for disinfection? Which of the following disinfectants do you make use of; sodium hypochlorite, glutaraldehyde, iodoform, alcohol, phenol, chlorhexidine, ionised water, peracetic acid, tap water or normal saline?

Data entry and all statistical analyses were performed using Statistical Package for Social Sciences for Windows version 23.0 software package (IBM SPSS Version 23.0. Armonk, NY: IBM Corp.). Descriptive analysis was carried out using frequency and proportion for categorical variables; and mean, and standard deviation for numeric variables. Data were statistically analysed using Pearson's Chi-square, Fisher's exact test, and two-sided linear-by-linear association, where applicable, to test for association, and a preset probability of $P < 0.05$ was adopted.

RESULTS

A total of 131 dental personnel aged between 20 and 46 years with a mean age of 29.4 ± 5.16 participated in this study. Of

the 131 participants; 51 (38.9%) were male and 80 (61.1%) were female; 78 (59.5%) were single, 52 (39.7%) were married, and one (0.8%) was widowed. Furthermore, of the 131 dental interns and residents (trainees) that participated in this study, OMF pathology had the lowest number of participants with 6 (4.60%) participants while preventive dentistry had the highest number of participants with 22 (16.80%) participants. Figure 1 shows the distribution of participants according to speciality.

The minimum risk assessment score recorded was two and maximum was nine. The mean risk assessment score was 6.2 ± 2.42 . Mean risk assessment scores for each speciality are reported in Table 1. All specialties reported similar risk assessment scores except for dental nurses who reported scores ranging from three (low risk) to seven (high risk) which can be explained by the fact that dental nurses work with dentists of different specialties.

The history of COVID-19 exposure was assessed for all participants. Eight dental personnel (6.1%) reported a confirmed diagnosis of COVID-19 in the past 3 months before participating in this study. Of the eight, four (50.0%) were aged between 21 and 30 years, three (37.5%) between 31–40 years and one (12.5%) above 40 years; three (37.5%) were female and five (62.5%) were male; four (50.0%) were single and

four (50.0%) were married. No significant relationship was noted between socio-demographic characteristics and positive COVID-19 diagnosis ($P > 0.05$).

Seventy-seven (58.8%) participants reported that at least one of their colleagues had been diagnosed with COVID-19 in the past 3 months before participating in this study while 15 (11.5%) were uncertain. Fifty-two (39.7%) participants reported that they had contact with a COVID-19 positive patient during the study period and 35 (26.7%) were uncertain. However, only 38 (73.1%) out of the 52 participants who reported contact with a COVID-19 positive patient-reported performing mandatory isolation. Of the 38 participants, 30 (76.9%) were between 21 and 30 years, seven (17.9%) between 31 and 40 years, and one (2.5%) above 40 years. Nineteen (50.0%) were male and 19 (50.0%) were female; 27 (71.1%) were single and 11 (28.9%) were married. No significant relationship was noted between socio-demographic characteristics and performing mandatory isolation ($P > 0.05$).

Of the 52 participants who reported contact with a COVID-19-positive patient, majority were trainees in preventive dentistry (28.8%), conservative dentistry (17.3%) or were dental nurses (17.3%) compared to other dental personnel that reported less contact. This relationship was statistically significant ($P < 0.05$). Furthermore, of the 38 participants who performed mandatory isolation, majority of them were trainees in preventive dentistry (31.6%) and conservative dentistry (18.4%) compared to other dental personnel that reported less compliance. This relationship was also statistically significant ($P < 0.05$). Table 2 shows the distribution of dental personnel with positive COVID-19 diagnosis, dental personnel who had contact with COVID-19-positive patients and dental personnel who performed mandatory isolation according to their speciality.

Pre-treatment compliance was measured both relative to speciality and relative to all participants. For compliance with pre-treatment guidance relative to speciality, a high compliance rate was noted among trainees in conservative dentistry with implementing staff sick leave (81.8%), not allowing accompanying individuals into the dental office (90.9%), implementing proper hand hygiene (90.9%), placement of instructive posters on standard precautions in the dental office (81.8%), ensuring the use of facemasks by everyone entering the dental clinic (100.0%) and implementation of PPEs (100.0%).

For compliance with pre-treatment guidance relative to speciality, a high compliance rate was noted among trainees in prosthodontics only with ensuring the use of facemasks by everyone entering the dental clinic (100.0%). Trainees in orthodontists reported high compliance with the postponement of dental procedures in patients with recent history of respiratory symptoms (100.0%), implementing staff sick leave (84.6%), temperature checks for staff at check-in (84.6%), temperature checks for patients at check-in (92.3%), implementing proper hand hygiene (92.3%), placement of instructive

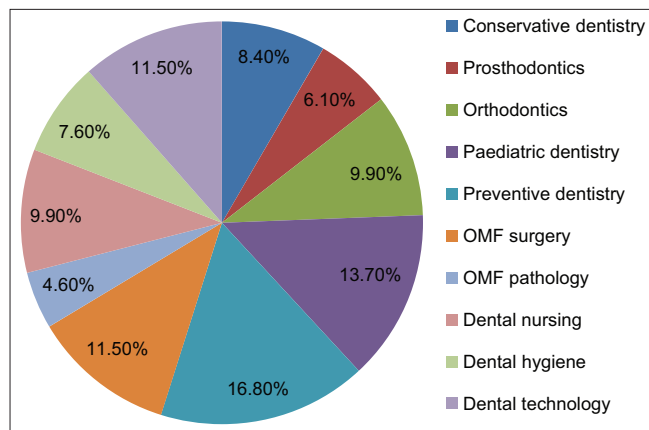


Figure 1: Distribution of participants according to speciality

Table 1: Risk assessment score according to specialties

Risk of exposure	Speciality	Mean risk assessment score
Low risk of exposure	Dental technology	2.1±0.26
	Oral and maxillofacial pathology	3.0±0.63
	Preventive dentistry	5.0±0.31
	Prosthodontics	5.0±0.41
	Dental nursing	5.2±1.48
	Orthodontics	6.1±0.49
High risk of exposure	Dental hygiene	7.0±0.47
	Paediatric dentistry	9.0±0.34
	Oral and maxillofacial surgery	9.0±0.38
	Conservative dentistry	9.0±0.45

Table 2: Relationship between dental speciality and positive corona virus disease 2019 diagnosis, contact with coronavirus disease 2019 positive patient and performing mandatory isolation

Speciality	Personnel with positive COVID-19 diagnosis (%)	<i>P</i>	Had contact with COVID-19 positive patient (%)	<i>P</i>	Performed mandatory isolation (%)	<i>P</i>	Total dental personnel (%)
Conservative dentistry	2 (25.0)	0.107	9 (17.3)	0.000	7 (18.4)	0.002	11 (8.4)
Prosthodontics	0		6 (11.5)		4 (10.5)		8 (6.1)
Orthodontics	0		2 (3.8)		0		13 (9.9)
Paediatric dentistry	0		5 (9.6)		4 (10.5)		18 (13.7)
Preventive dentistry	1 (12.5)		15 (28.8)		12 (31.6)		22 (16.8)
OMF surgery	3 (37.5)		4 (7.7)		4 (10.5)		15 (11.5)
OMF pathology	0		1 (1.9)		1 (2.6)		6 (4.6)
Dental nursing	2 (25.0)		9 (17.3)		4 (10.5)		13 (9.9)
Dental hygiene	0		1 (1.9)		1 (2.6)		10 (7.6)
Dental technology	0		0		1 (2.6)		15 (11.5)
Total	8 (100.0)		52 (100.0)		38 (100.0)		131 (100.0)

COVID-2019: Corona virus disease 2019, OMF: Oral and maxillofacial

posters (84.6%) and ensuring the use of facemasks (100.0%). Trainees in paediatric dentistry reported high compliance with implementing staff sick leave (83.3%), temperature checks for patients at check-in (100.0%), implementing proper hand hygiene (100.0%), placement of instructive posters (83.3%) and ensuring the use of facemasks (100.0%).

Trainees in preventive dentistry reported high compliance with postponement of dental procedures in patients with the recent history of respiratory symptoms (100.0%), not allowing accompanying individuals into the dental office (86.4%) and ensuring the use of facemasks (100.0%). Trainees in OMF surgery reported high compliance with booking appointments for non-emergency patients to prevent crowd in the dental office (86.7%), implementing staff sick leave (80.0%), implementing proper hand hygiene (100.0%), and providing a large, well ventilated waiting area (80.0%), placement of instructive posters (80.0%), ensuring the use of facemasks (93.3%) and implementation of PPEs (86.7%). Trainees in OMF pathology only reported high compliance with ensuring the use of facemasks by everyone entering the dental clinic (100.0%). Dental nurses reported high compliance with booking appointments for non-emergency patients to prevent crowd in the dental office (84.6%), temperature checks for patients at check-in (92.3%), implementing proper hand hygiene (84.6%), placement of instructive posters (92.3%), ensuring the use of facemasks (100.0%) and implementation of PPEs (92.3%).

Dental hygienists reported high compliance with booking appointments for non-emergency patients to prevent crowd in the dental office (100.0%), implementing staff sick leave (100.0%), not allowing accompanying individuals into the dental office (90.0%), and providing a large, well ventilated waiting area (100.0%), removing reading materials, toys and other objects not easily disinfected but may be handled by others (80.0%), placement of instructive posters (100.0%), ensuring the use of facemasks (100.0%), implementation of PPEs (100.0%), preparing dental materials and instruments before treatment begins (100.0%) and treating patients in an isolated and well-ventilated room (100.0%). All specialities

reported low compliance with the use of telephone triage, teleconferencing or teledentistry (<50%).

Table 3 shows the distribution of dental personnel compliance to COVID-19 pre-treatment guidance relative to all participants. A compliance rate of 105 or more (>80%) of total participants signifies high compliance among participants. However, from Table 3 below, it can be observed that overall high compliance with pre-treatment guidance was only seen with ensuring the use of facemasks (Cprior 15).

During-treatment compliance was also measured both relative to speciality and relative to all participants. For compliance with during-treatment guidance relative to speciality, all specialties only reported high compliance with implementing proper hand hygiene (83.3%-100.0%). Table 4 shows the distribution of dental personnel compliance to COVID-19 during-treatment guidance relative to all participants. A compliance rate of 105 or more (>80%) of total participants signifies high compliance among participants. However, from Table 4 it can be observed that overall high compliance with during-treatment guidance was only seen with implementing proper hand hygiene (Cduring 1).

Post-treatment compliance was also measured both relative to specialty and relative to all participants. For compliance with post-treatment guidance relative to specialty, trainees in conservative dentistry, prosthodontics, orthodontics, paediatric dentistry, OMF surgery, as well as dental nurses and dental hygienists reported high compliance with all post-treatment guidance (>80%). However, trainees in preventive dentistry reported high compliance with only cleaning of reusable facial protective equipment after use (81.8%) and trainees in OMF pathology reported high compliance with only ensuring laundry and medical waste are managed appropriately (100.0%).

Table 5 shows the distribution of dental personnel compliance with COVID-19 post-treatment guidance relative to all participants. From Table 5 it can be observed that overall high compliance

(105 or more participants) with post-treatment guidance was not seen for any of the post-treatment guidance measured.

It is important to note that some questions might not apply to some specialties affecting the compliance rate

reported by these specialties. This was noted during the assessment of compliance by trainees in OMF pathology for all proposed practice guidance and noted for majority of specialties when compliance with during-treatment guidance was assessed.

Table 3: Dental personnel compliance with coronavirus disease 2019 pretreatment guidance according to speciality

Pretreatment compliance	Dental speciality (%)									Total (%)
	Conservative	Prosthetics	Orthodontics	Paediatric	Preventive	OMFS	OMFP	Nursing	Hygiene	
Cprior 1	2 (4.3)	4 (8.5)	3 (6.4)	5 (10.6)	12 (25.5)	10 (21.3)	1 (2.1)	9 (19.1)	1 (2.1)	47 (100.0)
Cprior 2	6 (7.6)	6 (7.6)	10 (12.7)	11 (13.9)	10 (12.7)	13 (16.5)	2 (2.5)	11 (13.9)	10 (12.7)	79 (100.0)
Cprior 3	7 (8.0)	5 (5.7)	13 (14.9)	13 (14.9)	22 (25.3)	11 (12.6)	1 (1.1)	8 (9.2)	7 (8.0)	87 (100.0)
Cprior 4	5 (8.1)	3 (4.8)	10 (16.1)	11 (17.7)	12 (19.4)	11 (17.7)	1 (1.6)	5 (8.1)	4 (6.5)	62 (100.0)
Cprior 5	1 (3.7)	3 (11.1)	6 (22.2)	3 (11.1)	5 (18.5)	1 (3.7)	1 (3.7)	4 (14.8)	3 (11.1)	27 (100.0)
Cprior 6	9 (9.8)	5 (5.4)	11 (12.0)	15 (16.3)	17 (18.5)	12 (13.0)	3 (3.3)	10 (10.9)	10 (10.9)	92 (100.0)
Cprior 7	4 (5.7)	3 (4.3)	11 (15.7)	12 (17.1)	15 (21.4)	11 (15.7)	2 (2.9)	10 (14.3)	2 (2.9)	70 (100.0)
Cprior 8	6 (7.2)	4 (4.8)	12 (14.5)	18 (21.7)	17 (20.5)	11 (13.3)	0	12 (14.5)	3 (3.6)	83 (100)
Cprior 9	1 (2.9)	2 (5.7)	6 (17.1)	15 (42.9)	3 (8.6)	3 (8.6)	0	4 (11.4)	1 (2.9)	35 (100.0)
Cprior 10	10 (10.3)	5 (5.2)	12 (12.4)	18 (18.6)	17 (17.5)	15 (15.5)	2 (2.1)	11 (11.3)	7 (7.2)	97 (100.0)
Cprior 11	7 (9.0)	5 (6.4)	8 (10.3)	11 (14.1)	16 (20.5)	12 (15.4)	0	9 (11.5)	10 (12.8)	78 (100.0)
Cprior 12	4 (6.7)	3 (5.0)	8 (13.3)	11 (18.3)	8 (13.3)	11 (18.3)	0	8 (13.3)	7 (11.7)	60 (100.0)
Cprior 13	1 (2.1)	3 (6.3)	8 (16.7)	10 (20.8)	6 (12.5)	7 (14.6)	0	5 (10.4)	8 (16.7)	48 (100.0)
Cprior 14	9 (9.7)	6 (6.5)	11 (11.8)	15 (16.1)	16 (17.2)	12 (12.9)	2 (2.2)	12 (12.9)	10 (10.8)	93 (100.0)
Cprior 15	11 (9.6)	8 (7.0)	13 (11.3)	18 (15.7)	22 (19.1)	14 (12.2)	6 (5.2)	13 (11.3)	10 (8.7)	115 (100.0)
Cprior 16	11 (12.5)	6 (6.8)	8 (9.1)	10 (11.4)	15 (17.0)	13 (14.8)	3 (3.4)	12 (13.6)	10 (11.4)	88 (100.0)
Cprior 17	5 (7.7)	5 (7.7)	8 (12.3)	9 (13.8)	10 (15.4)	10 (15.4)	1 (1.5)	7 (10.8)	10 (15.4)	65 (100.0)
Cprior 18	5 (11.1)	5 (11.1)	4 (8.9)	3 (6.7)	7 (15.6)	6 (13.3)	0	5 (11.1)	10 (22.2)	45 (100.0)
Total	11 (8.4)	8 (6.1)	13 (9.9)	18 (13.7)	22 (16.8)	15 (11.5)	6 (4.6)	13 (9.9)	10 (22.2)	131 (100.0)

Cprior: Compliance with pretreatment guidance, OMFS: Oral and maxillofacial surgery, OMFP: Oral and maxillofacial pathology, Prosthetics: Prosthodontics

Table 4: Dental personnel compliance with coronavirus disease 2019 during-treatment guidance according to speciality

Treatment compliance	Dental speciality (%)									Total (%)
	Conservative	Prosthetics	Orthodontics	Paediatric	Preventive	OMFS	OMFP	Nursing	Hygiene	
Cduring 1	10 (9.4)	7 (6.6)	12 (11.3)	15 (14.2)	19 (17.9)	15 (14.2)	5 (4.7)	13 (12.3)	10 (9.4)	106 (100.0)
Cduring 2	2 (6.5)	2 (6.5)	2 (6.5)	1 (3.2)	12 (38.7)	5 (16.1)	0	2 (6.5)	5 (16.1)	31 (100.0)
Cduring 3	8 (34.8)	2 (8.7)	1 (4.3)	4 (17.4)	4 (17.4)	0	0	3 (13.0)	1 (4.3)	23 (100.0)
Cduring 4	0	1 (3.8)	9 (34.6)	1 (3.8)	7 (26.9)	4 (15.4)	0	4 (15.4)	0	26 (100.0)
Cduring 5	1 (2.6)	2 (5.1)	8 (20.5)	7 (17.9)	4 (10.3)	7 (17.9)	1 (2.6)	9 (23.1)	0	39 (100.0)
Cduring 6	1 (3.2)	1 (3.2)	1 (3.2)	6 (19.4)	15 (48.4)	4 (12.9)	0	3 (9.7)	0	31 (100.0)
Cduring 7	0	2 (10.5)	0	1 (5.3)	3 (15.8)	4 (21.1)	1 (5.3)	2 (10.5)	6 (31.6)	19 (100.0)
Total	11 (8.4)	8 (6.1)	13 (9.9)	18 (13.7)	22 (16.8)	15 (11.5)	6 (4.6)	13 (9.9)	10 (22.2)	131 (100.0)

Cduring: Compliance with guidance during dental treatment, OMFS: Oral and maxillofacial surgery, OMFP: Oral and maxillofacial pathology, Prosthetics: Prosthodontics

Table 5: Dental personnel compliance with coronavirus disease 2019 posttreatment guidance according to speciality

Posttreatment compliance	Dental speciality (%)									Total (%)
	Conservative	Prosthetics	Orthodontics	Paediatric	Preventive	OMFS	OMFP	Nursing	Hygiene	
Cafter 1	9 (8.7)	8 (7.7)	13 (12.5)	18 (17.3)	16 (15.4)	13 (12.5)	4 (3.8)	13 (12.5)	10 (9.6)	104 (100.0)
Cafter 2	10 (9.8)	7 (6.9)	13 (12.7)	18 (17.6)	18 (17.6)	13 (12.7)	0	13 (12.7)	10 (9.8)	102 (100.0)
Cafter 3	9 (8.7)	7 (6.7)	13 (12.5)	16 (15.4)	17 (16.3)	13 (12.5)	6 (5.8)	13 (12.5)	10 (9.6)	104 (100.0)
Total	11 (8.4)	8 (6.1)	13 (9.9)	18 (13.7)	22 (16.8)	15 (11.5)	6 (4.6)	13 (9.9)	10 (22.2)	131 (100.0)

Cafter: Compliance with posttreatment guidance, OMFS: Oral and maxillofacial surgery, OMFP: Oral and maxillofacial pathology, Prosthetics: Prosthodontics

Compliance with guidance for dental technologists was assessed separately. About 87% of dental technologists reported that all impressions, bite registrations and models were disinfected in the dental clinic before they were sent to the laboratory; while two (13.3%) of them were uncertain. All (100%) dental technologists reported that they checked for organic materials like blood or saliva before working on an impression, bite registration or model. They all also reported that they disinfect all impression materials sent to the lab and they always wore gloves for disinfection. The most commonly used disinfectant reported was sodium hypochlorite used by all (100%) dental technologists who participated in this study.

DISCUSSION

Several studies^[17,18] have described dental personnel as health workers at high risk of contracting COVID-19 due to their close proximity to patients' oral environment while performing dental treatments. It has also been established that different dental specialties have different risks of exposure to COVID-19^[19-21] and results of this study confirmed this, as high risk of exposure to COVID-19 was reported in specialties that routinely perform AGPs such as conservative dentistry, paediatric dentistry, oral and maxillofacial surgery, and dental hygiene specialty. This was similar to results reported by Bizzoca *et al.*^[21] who confirmed a high risk of exposure to COVID-19 for these groups of dental personnel. However, Bizzoca *et al.*^[21] added that dental personnel who practiced periodontology when categorised as a separate specialty from preventive dentistry are also at high risk of COVID-19 exposure due to treatments such as open curettage and alveolar bone surgeries.

The study by Froum and Froum^[20] reported no incidence of COVID-19 among dental personnel over a 6-month period which agreed with the results of a survey by the ADA which stated that <1% of dentists nationwide had tested positive for COVID-19.^[22] Despite the high risk of exposure of dental personnel to COVID-19, this low exposure was explained by the fact that standard precautions and disinfection protocols in dental offices have been in existence decades before the COVID-19 pandemic.^[22] Due to this reason, there were very little adjustments needed in the practices of most dental personnel, especially in developed countries, making compliance to COVID-19 dental practice guidance relatively easy.^[22] However, this study reported 6.1% of participants contracting COVID-19 over a 3-month period. This is a relatively high incidence rate which may be explained by the poor compliance to mandatory isolation performed by dental personnel who had confirmed or suspected contact with a confirmed COVID-19 positive patient and by the low level of compliance to pre and during treatment COVID-19 guidance. The high incidence of COVID-19 seen among participants could also be because majority of the proposed guidance are not routinely practiced in developing countries^[23] which made adjustments to these new guidance challenging.

The level of compliance to COVID-19 dental practice guidance is said to be the major determinant in the incidence of COVID-19 among dental personnel.^[22] This study reported compliance at different stages of dental treatment; pre-treatment, during treatment and post-treatment. Low-to-moderate compliance was noted for the majority of pre-treatment, and during treatment guidance while only moderate compliance was noted for post-treatment guidance [Tables 3-5]. This may be explained by the lack of resources needed for guidance implementation and by the fact that not all recommended guidance are applicable to all specialties. Dental technologists reported high compliance with their specific guidance for practice. This result was different from the results seen among participants who were clinicians and this difference may be explained by the fact that the materials needed by dental technologist for effective compliance including gloves, facemasks, disinfectants, etc., are cost-effective and readily available.

Although we were unable to locate studies that reported on the percentage of dental personnel' who complied with COVID-19 guidance, the study by Lange *et al.*^[24] and Ozturk *et al.*^[25] reported that although the use of PPEs was commonplace in dental practice, complete compliance with recommended guidelines were not yet achieved. Conversely, the ADA survey^[22] reported that the majority of dentists already practiced said guidance which was different from the results of this study. These conflicting results could be as a result of the higher socio-economic class of American dentists and the fact that the guidance was made specifically for the American population. We, therefore, recommend that a more economical guidance be set up, tailored specifically to dental personnel in developing countries, which will not negate the already established guidelines by the WHO, CDC and ADA but proffer modifications of the standard COVID-19 precautions considering the limitations of this environment. Furthermore, due to the high cost of COVID-19 testing, we recommend stricter adherence to the 14 days isolation period following suspected or confirmed contact with a COVID-19 patient. The importance of mandatory isolation following COVID-19 exposure must be reinforced as this will help curb the spread of the disease in dental practice.

CONCLUSION

Dental personnel are at a high risk of exposure to COVID-19 due to their proximity to their patients' oral cavities. This risk is increased by AGPs routinely performed by trainees in conservative dentistry, paediatric dentistry, and oral and maxillofacial surgery, as well as dental hygienists. Due to this increased risk, several dental practice regulatory bodies have proposed guidelines for the dental practice to avoid the spread of COVID-19 in the dental clinic. Compliance with this guidance significantly reduces the incidence of COVID-19 transmission in the dental clinic. The Dental center of The Lagos University Teaching Hospital reported a low to moderate compliance with pre-treatment and during treatment guidance

as well a low level of adherence to mandatory isolation following suspected or confirmed contact with a COVID-19 positive patient. This led to a relatively high incidence of COVID-19 transmission in the dental clinic during the 3-month study period.

Data availability statement

The datasets analysed during the current study can be made available from the corresponding author on reasonable request.

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Conflicts of interest

There are no conflicts of interest.

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