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Professional exposure and the risk of covid-19 infection among Saudi dentists during the first semester of the pandemic: A cross-sectional study

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ABSTRACT

Objective: To explore practice changes among dentists during the first six months of the COVID-19 pandemic (March-August 2020) and to estimate the risk of occupational COVID-19 infection in association with the professional risk factors. *Method:* A cross-sectional study was involved 321 dentists working in public or private center in Western Saudi Arabia. An online, questionnaire was disseminated through social media professional groups, collecting data on the participant's practice during the exposure period, COVID-19 status and the suspected source of infection if applicable, besides data on other professional parameters and occupational exposure. *Result:* Of the total participants, 191 (59.3%) declared having worked during the study period, among whom the prevalence of COVID-19 infection was 10.5% (95% CI=6.5% - 15.7%), of them 15.0% suspected having acquired the infection from an infected patient. The prevalence of COVID-19 was higher among participants who declared having practiced during March (16.3% vs. 4.3%) and April (16.5% vs. 6.3%) compared to those who were not on duty during these two months, respectively ($p<0.05$). All COVID-19 positive participants were working in facilities not requiring patients to be tested prior treatment ($p=0.015$). Further, the COVID-19 infection rate was relatively higher among participants who declared performing treatment that require hand-piece operation (12.7% vs. 2.4%; $p=0.081$). *Conclusion:* The prevalence of COVID-19 infection among dentists was estimated as 10-fold the prevalence in the general population, and the risk of infection was time-dependent and was associated with the preventive measures implemented by the facility and the type of procedures performed by the dentist.

Keywords: COVID-19, Dentist, Infection, Incidence, Occupational, Prevalence, Saudi Arabia

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1. INTRODUCTION

The global health crisis resulting from the COVID-19 pandemic not only accounts the specific morbidity and mortality, but englobes considerable impact on the delivery of overall healthcare services (Ahmad et al., 2021; Hallal, 2020; Velavan and Meyer, 2020). First months of the pandemic were marked by dramatic decline in both the delivery and utilization of healthcare services, impacting almost all dimensions ofthe preventive, planned and emergency care (Alene et al., 2020; Al-Zahrani et al., 2021; Hartnett et al., 2020; Moynihan et al., 2021; Richards et al., 2020; Weiss et al., 2021). This period has witnessed tremendous efforts to educate, prepare and protect the healthcare providers to conciliate between preventing the nosocomial dissemination of the virus and the continuity of healthcare delivery, while ensuring the safety of healthcare providers (Ağalar and Öztürk Engin, 2020; Cinar et al., 2020; Jazieh, 2020).

Similar to the other health services, dental care witnessed drastic decline in the number of visits and delivered procedures, notably during March 2020 to August 2020 (Kranz et al., 2021). However, due to predominant respiratory tropism and transmission of the virus through aerosol and droplets, dental practitioners remained exposed to significantly higher risk of COVID-19 infection. Indeed, dental procedures generate aerosols and droplets as a result of the frequent per procedure irrigations and cooling (Checchi et al., 2021; Epstein et al., 2021; Fallahi et al., 2020; To et al., 2020). Consequently, dentists and dental hygienists were listed among the extra-hospital professions with highest risk of COVID-19 infection. Globally, dental care was suspended in number of settings before specific comprehensive guidelines could be implemented to protect dental manpower from the risk of infection (Baghizadeh Fini, 2020; Froum and Froum, 2020; Ramírez-Mora et al., 2020; Warnakulasuriya, 2021).

In Saudi Arabia, the Ministry of Health (MOH) has published "Dental Emergency Protocol during COVID-19 Pandemic", which constituted the reference guidelines and recommendations to all dental practitioners, in line with the international guidelines. The protocol provided a comprehensive approach in dental care facilities, by stating on emergent and urgent care, non-urgent care and advice and self-care (Alharbi et al., 2020; Saudi Arabia Ministry of Health, 2020). The early Saudi experience regarding the implementation of these specific measures showed high responsiveness and adherence levels among majority of the dentists and dental clinics, indicating adequate preparedness and perception about the pandemic and the related preventive measures (Al-Khalifa et al., 2020). Despite these measures, levels of anxiety and fear to acquire COVID-19 infection at the workplace remained high among dental care professionals, notably at the early phase of the pandemic. Several professionals wished to suspend their practice or close their clinics for an indefinite time (Ahmed et al., 2020). Yet, no studies have been conducted so far to estimate the incidence of COVID-19 infection and its relation with dental practice during the early phase of the pandemic in Saudi Arabia.

Hence, we conducted this study to explore practice modifications among the dentists during the first six months of the pandemic (March 2020 to August 2020), and to estimate the incidence risk of occupational COVID-19 infection in association with the intra-professional exposure factors. Such data would enable appraising the actual dentists'practice behavior in response to the health crisis and the MOH guidelines, and to determine the patterns of practice behavior and other professional factors associated with occupational COVID-19 infection.

2. METHODS

Design and Population

A cross-sectional study was conducted between 01-Sep-2020 and 30-Sep-2020, involving all dentists working in public or private clinics or hospitals in the Western region of Saudi Arabia. This particular area was chosen because it was declared as one of the highest infectious areas in Saudi Arabia during this period. The study included general dentists, and all-specialty dental specialists and consultants of both genders; whereas dentistry interns and externs, dental assistants and paramedical staff were excluded. Institutional review board of King Abdulaziz University, Jeddah, Saudi Arabia ethically approved this study (Number 78-08-20).

Tool and Procedure

A semi-structured questionnaire was designed and edited in English language and divided into two parts, defining two levels of participation. Part I explored the level of dental care offered between March 2020 and August 2020, by collecting data on the level of experience (general dentist, specialist and consultant), and specialty and investigating the corresponding patterns of absenteeism during each month. Part II was divided into 3 sub-sections: 1) professional parameters including sector (public vs. private), setting (hospital vs. clinic); 2) occupational exposure to COVID-19 including the level of compliance with the MOH guidelines, whether the work facility required patients to be tested before receiving treatments, and whether the participant performed treatments that required hand-piece operation; and 3) COVID-19 status including the participant's suspected source of infection (from a patient vs.

no vs. do not know). Participants who declared being absent between March 2020 and August 2020 were excluded from part II of the questionnaire.

Participation in the study was voluntary and identification information was not collected from the study participants. The questionnaire was edited for online survey using Google Form, and the online link was disturbed to dentists, using different professional social media networks including direct e-mail andWhatsApp groups. Besides the survey link, the call for participation included a brief presentation of the study objectives and importance and a statement on the voluntary and anonymous nature of the participation, along with a confidentiality commitment. The participation was openbetween 01-Sep-2020and 30-Sep-2020 and the survey link was deactivated on 01-Oct-2020 12.00AM. During the survey period, several recall messages were posted in the social media groups.

Statistical methods

The database was automatically generated on Microsoft Excel. Data was cleaned, coded and transferred into SPSS, version 21.0 for Windows (SPSS Inc., Chicago, IL, USA) for statistical analysis. Frequencies and percentages were calculated on the categorical variables and presence rates were calculated for each month, separately. A participant was considered being on duty if he/she declared being present at least one month between March 2020 and August 2020; and the association between the participant's level and specialty and being in duty was analyzed using chi-square test. The prevalence of COVID-19 infection was calculated among on-duty participants and was expressed with 95% confidence interval (95%CI). The association of COVID-19 infection with professional and exposure factors was analyzed using chi-square or Fisher's exact test, as applicable. A p-value of < 0.05 was considered to reject the null hypothesis.

3. RESULTS

Professional characteristics and practice during the study period

Three hundred and twenty-two dentists have responded to the questionnaire. Majority of the participants were general dentists (42.5%) and consultants (39.1%). The most frequent specialty was restorative dentistry (16.8%), followed by endodontics (9.6%) and pedodontics (9.3%). Of the total participants, 191 (59.3%) declared having worked during the study period. The percentage of participants who were on-duty during the study period was significantly higher among consultants ($p<0.001$) compared to their counterparts, and varied significantly across the specialties ($p<0.001$) (Table 1).

Table 1 Participants' characteristics and presence in facility during the study period (N=322)

Parameter	Category	Total		On service during COVID-19 period		p-value
		N	%	N	%	
Total		322	100	191	59.3	-
Level	General Dentist	137	42.5	63	46.0	
	Specialist	59	18.3	31	52.5	
	Consultant	126	39.1	97	77.0	< 0.001*
Specialty	None	137	42.5	63	46.0	
	Restorative dentistry	54	16.8	33	61.1	
	Endodontics	31	9.6	22	71.0	
	Pedodontics	30	9.3	27	90.0	
	Prosthodontics	25	7.8	20	80.0	
	Orthodontics	20	6.2	13	65.0	
	Periodontics	12	3.7	3	25.0	
	Restorative D. + other	6	1.9	6	100.0	
	Oral Surgery	4	1.2	4	100.0	
	Oral Medicine	3	0.9	0	0.0	< 0.001*

*Statistically significant result ($p<0.05$)

Measure of the time exposure

The rates of dentists' presence in their facilities varied across the months, showing the lowest rates (24.5% to 30.4%) during the first trimester (between March 2020 and May 2020), followed by gradual increase from 40.1% to 49.4% from June 2020 to August 2020 (Figure 1). Of the total participants, 39.7% were in service three months or more during the 6-month study period (Figure 2).

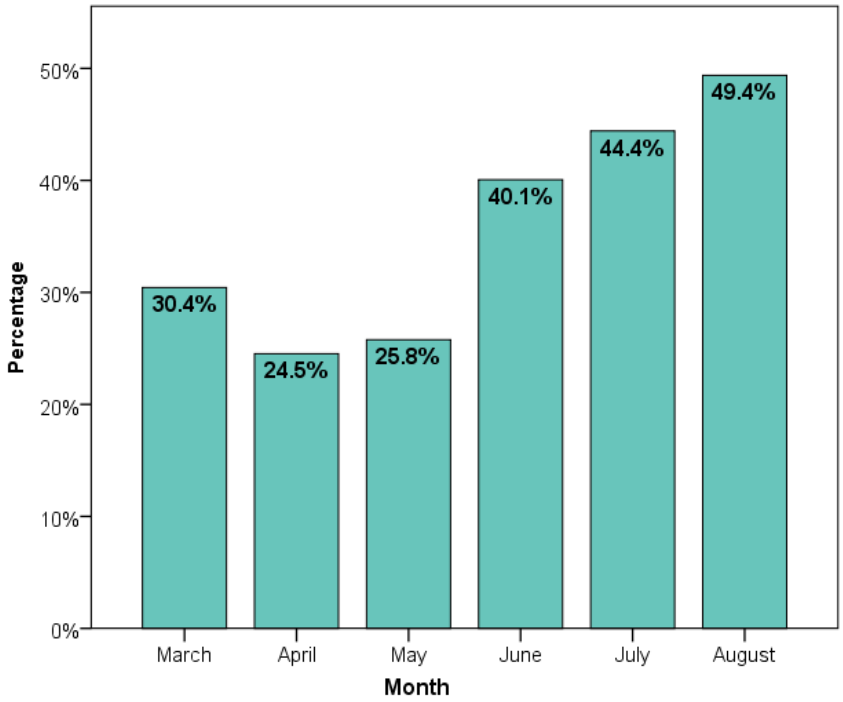

Figure 1 Percentage of dentists on duty during the study period; Bars represent the percentage of dentists who declared being on duty during the given month, in 2020.

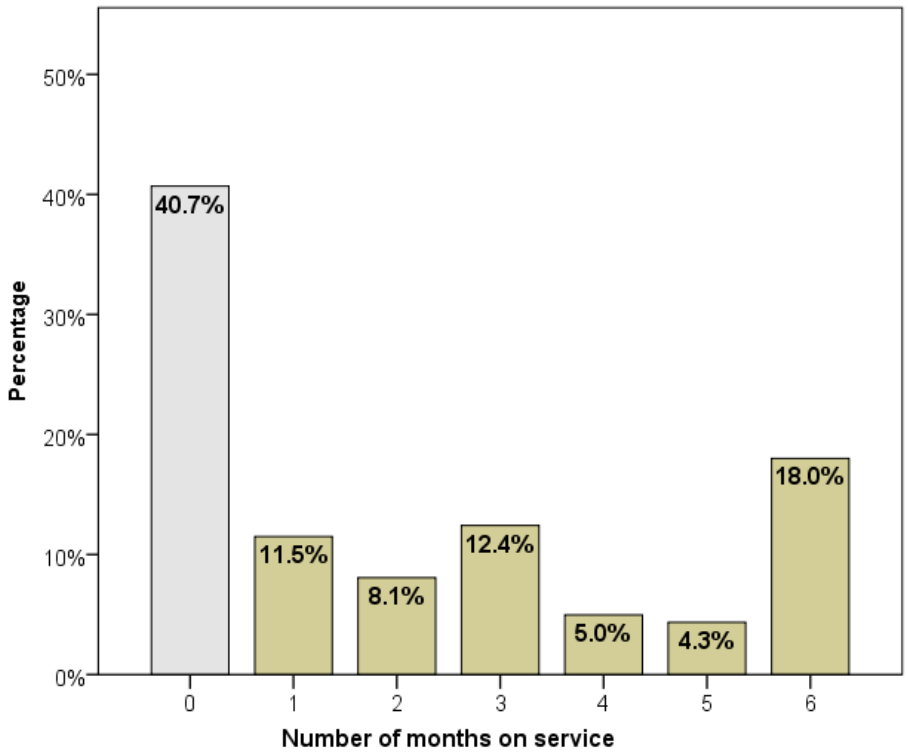

Figure 2 Number of months on service of the dentists during the period March-August 2020; Bars represent the percentage of dentists corresponding to the number of months worked between March and August 2020.

Professional and exposure data

By focusing on participants who have worked during the study period (N=191), two-third (67.0%) have worked for 3 months or more, and majority had full-time or part-time service at the public sector (78.0%), with an exclusive or partitioned affiliation to a dental clinic (65.9%). Further exposure data showed high compliance rate to MOH COVID-19 measure (95.3%); however, 78.5% declared having performed treatments that require hand-piece operation (TRHO) during the study period. On the other hand, only 19.9% reported that their work facility required patients to be tested before receiving treatment (Table 2).

Table 2 Professional and exposure data (N=191)

Parameter	Category	Frequency	Percentage
No. months of exposure	1	37	19.4
	2	26	13.6
	3	40	20.9
	4	16	8.4
	5	14	7.3
	6	58	30.4
Sector	Public	102	53.4
	Private	42	22.0
	Both	47	24.6
Setting	Hospital	65	34.0
	Dental clinic	87	45.5
	Both	39	20.4
Compliance with MoH COVID-19 measures	No	9	4.7
	Yes	182	95.3
Work facility requires patient to be tested for COVID-19 before treatment	No	153	80.1
	Yes	38	19.9
Performed treatments that require hand-piece operation	No	41	21.5
	Yes	150	78.5

MoH: Ministry of Health

Professional and exposure factors associated with COVID-19 infection among dentists

The prevalence of COVID-19 infection among dentists who were practicing during the study period was 10.5% (95%CI=6.5% - 15.7%). Infection rate was relatively higher among general dentists (15.9%) compared to their counterparts (<9%). However, this difference was not statistically significant (p=0.222). On the other hand, participants who declared having practiced during March 2020 (16.3% vs. 4.3%) and April 2020 (16.5% vs. 6.3%) had significantly higher infection rates compared to those who were not on duty during these two months (p<0.05). Likewise, infection rate was significantly higher among those who practiced for ≥ 5 months (p < 0.001). Of note, all infected participants were working in facilities that did not require patients to be tested (p=0.015). Further, the COVID-19 infection rate was relatively higher among participants who declared performing TRHO (12.7% vs. 2.4%) compared to their counterparts, and the result approachedthe level of statistical significance (p=0.081) (Table 3). Among the 20 COVID-19 positive participants, 3 (15%) were suspected having acquired the infection from an infected patient, while 6 (30%) were not sure (Figure 3).

Table 3 Professional and exposure factors associated with COVID-19 infection among dentists (N=191)

Factor	Category	COVID-19 infection				p-value
		No		Yes		
		N	%	N	%	
Total	(N=191)	171	89.5	20	10.5	-
Level	General Dentist	53	84.1	10	15.9	
	Specialist	29	93.5	2	6.5	

	Consultant	89	91.8	8	8.2	0.222
Specialty	None	53	84.1	10	15.9	
	Restorative dentistry	31	93.8	2	6.1	
	Endodontics	20	90.9	2	9.1	
	Pedodontics	25	92.6	2	7.4	
	Prosthodontics	19	95.0	1	5.0	
	Orthodontics	11	84.6	2	15.4	
	Periodontics	3	100.0	0	0.0	
	Restorative D. + other	6	100.0	0	0.0	
	Oral Surgery	3	75.0	1	25.0	
	Oral Medicine	-	-	-	-	0.660
March	No	89	95.7	4	4.3	
	Yes	82	83.7	16	16.3	0.008* F
April	No	105	93.8	7	6.3	
	Yes	66	83.5	13	16.5	0.023*
May	No	97	89.8	11	10.2	
	Yes	74	89.2	9	10.8	0.883
June	No	57	91.9	5	8.1	
	Yes	114	88.4	15	11.6	0.615 F
July	No	45	93.8	3	6.3	
	Yes	126	88.1	17	11.9	0.414F
August	No	27	84.4	5	15.6	
	Yes	144	90.6	15	9.4	0.340 F
No. months	1	32	86.5	5	13.5	
	2	26	100.0	0	0.0	
	3	39	97.5	1	2.5	
	4	16	100.0	0	0.0	
	5	7	50.0	7	50.0	
	6	51	87.9	7	12.1	< 0.001*
Sector	Public	89	87.3	13	12.7	
	Private	39	92.9	3	7.1	
	Both	43	91.5	4	8.5	0.535
Setting	Hospital	58	89.2	7	10.8	
	Dental clinic	75	86.2	12	13.8	
	Both	38	97.4	1	2.6	0.163
Compliance with MoH measures	No	9	100.0	0	0.0	
	Yes	162	89.0	20	11.0	0.601F
Facility requires patient tested	No	133	86.9	20	13.1	
	Yes	38	100.0	0	0.0	0.015*F
Performed treatments that require hand-piece operation?	No	40	97.6	1	2.4	
	Yes	131	87.3	19	12.7	0.081 F

*Statistically significant result ($p<0.05$); test used: F Fisher's exact test, otherwise chi square test was used.

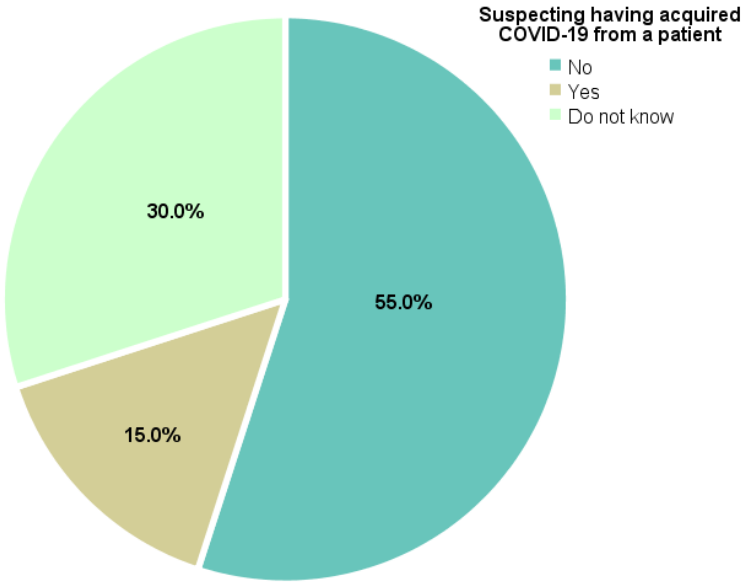

Figure 3 Suspected sources of COVID-19 infection among COVID-19 positive dentists (N=20)

4. DISCUSSION

Summary of findings

The present study probed into two endpoints relating the dentists' response and exposure to COVID-19 pandemic, in association withspecific professional factors of occupational infection. Findings showed substantial decline in the number of dentist's on-duty especially during the first three months of the pandemic. This was significantly marked among the general dentists and specialistscompared to the consultants. As part of secondary endpoint, 10.5% prevalence of COVID-19 infection was observed among dentists who were on duty during the exposure period. Being on duty during the months of March 2020 and April 2020 was associated with significantly increased risk of infection. Additionally, the prevalence of COVID-19 infection was significantly higher among dentists who were working in facilities not requiring the patient to be tested before treatment; while performing TRHO was associated with relatively increased risk of COVID-19 infection. Further, the occupational source of COVID-19 was estimated among 15.0% of the cases.

Decline in dental care delivery during the pandemic

The first COVID-19 case was detected on 02-Mar-2020 in Saudi Arabia. This was followed by a succession of major events including public awareness raising campaigns, cancellation of international flights, suspension of Umrah pilgrimage, and curfew and lockdown measures to control the transmission of virus at the national level (Ebrahim and Memish, 2020; Saudi Arabia Ministry of Health (MOH), 2020). This period was further characterized by the limitation of care services delivery, which enabled the implementation of several telemedicine services to ensure care continuity (Hassounah et al., 2020). Closure of dental clinics was recommended by the MOH, with the exception of emergency dental care. These recommendations were in line with the international dental organizations (American Dental Association, 2020; National Services Scotland, 2020). Thus, non-urgent dental care and procedures were postponed. Recommendation was given to patients to useteleconsultation triage platforms to identify urgent cases and plan care accordingly (Al-Khotani et al., 2020). Findings from the present study support the implementation of such measures.

In the western region, a 40% decline in the number of dentists who were on duty during the six first months of the pandemic was observed. The presence rate was even lower (24.5% to 30.4%) during the first three months of the crisis. On the other hand, the percentage of on-duty dentists during the exposure period was significantly higher among consultants (77.0%), followed by specialists (52.5%) compared to general dentists (46.0%). This may be explained by emergency and urgent procedures being most of the time carried out by specialists and consultants, which resulted in general dentists having less constraint to implement closure measures. In line with these findings, dental care seeking behavior has witnessed a dramatic change during the same period, notably for non-urgent care. A local study that was carried out during the lockdown period (April 202– June 2020) showed that up to 44.7% of individuals would refrain from going to dental clinic in case of emergency of urgent dental care, depending on the care

situation while 13% to 27% declared that they would go only if advised so after a teleconsultation. On the other hand, majority (75.8% to 87.6%) declared not willing to go to dental clinic in case of non-urgent care or dental procedures (Meisha et al., 2021).

In line with these observations, a national study from the United States estimated the changes in weekly dental clinic visits during 05-Jan-2020 and 29-Aug-2020 with reference to the same period from 2019. While the first trimester of 2020 displayed up to 150% increase in the number of visits with reference to 2019, a sharp fall was observed in March 2020, reaching 40% (60% decline) as the lowest point during the last week of March and the whole month of April, and prolonging until June (Kranz et al., 2021) these figures concord well with the percentage of on-duty dentists in the present study.

The risk of occupational COVID-19 infection among dentists

The present study showed that 10.5% of the dentists who were on duty during the exposure period have acquired COVID-19.Among these, 15% suspected having acquired the infection from a patient. These observations should be interpreted with extreme caution, taking into account the study design limitation and eventual biases. The design of the present study does not allow concluding to a causal relationship, as dentists who were not on duty during the exposure period were not interviewed regarding their COVID-19 status. Additionally, in the absence of randomized sampling and inclusion and given the voluntary nature of the study, a selection bias might have occurred where the likelihood of participation might differ significantly depending on the COVID-19 infection status of the individual. This might lead to over or under estimation of the prevalence of infection. Nevertheless, the prevalence rate of COVID-19 infection in Saudi Arabia as of 31-Aug-2020 was less than 1%, with a total 319,932 confirmed cases (World Health Organization., 2021). By disregarding the above mentioned limitation, the comparative figures would suggest a 10-fold risk of COVID-19 infection among dentists with reference to the general population, which appears to be over estimated. Internationally, a study from France (Jungo et al., 2021), which included 4,172 dentists and 1,868 dental assistants during April 2020, showed 1.9% and 0.8% of laboratory-confirmed COVID-19 cases respectively, which is lower than that reported in the present study.

The same study reported that 45.9% of the symptomatic COVID-19 positive respondent suspected an occupational source of their infection. Another nationwide study from the United States estimated 3.1% prevalence of COVID-19 infection among 4,776 included dental hygienists from 50 states (Estrich et al., 2021). It is to be noted that the US study was conducted at the end of September 2020 and first week of October 2020, which might explain the reason for relatively higher infection rate compared to the French study. On the other hand, estimates of occupational COVID-19 infection by profession showed that dental and oral care professions had the highest prevalence ratios, including dental hygienists (2.7), oral and maxillofacial surgeons (2.7), oral dental assistants (2.6), and general dentists (2.6). Such risk level was associated with higher disease exposure and physical proximity inherent to the nature of the profession (Zhang, 2021).

Importance of infection prevention and control efforts in dental practices

The present study demonstrated that all COVID-19 positive dentists were working in facilities that did not implement testing requirement among patients prior to treatments, and the statistical association was significant. The MOH Dental Emergency Protocol during COVID-19 Pandemic stipulated that all patients should be screened for COVID-19 triage questions including contact and symptoms information to identify suspected cases, who should be submitted to the specific MOH guidelines for testing and quarantine (Saudi Arabia Ministry of Health, 2020). In the present study, 80.1% of the participants declared that their facility required the patients to be tested prior to treatments and 95.3% declared adhering to the other preventive measures recommended by the MOH. Comparably, reports from the USA showed variable levels of implementation and adherence to different infection prevention and control measures during September 2020. For example, levels of implementation were relatively high regarding screening for known or suspected COVID-9 cases among the patients (94%), checking patients' (97%) and hygienists' temperatures (87%), and physical protection during care (75%); while they were significantly lower regarding the implementation of teledentistry (14.8%), use of personal protective equipment while treating patients (55.7%) (Estrich et al., 2021).

Care-related risk of occupational COVID-19 infection

The present study showed relatively higher incidence risk of COVID-19 infection among dentists who declared having performed TRHO during the exposure period. Although no causation relationship could be established from the present study design, it is evidenced that the hand-pieces were associated with a high risk of exposure by the dentists or oral surgeons to blood- or saliva-contaminated splatter and this risk is even higher in case of using high-speed air-turbine hand-pieces compared to the use of low-speed or contra-angle ones. Such risks were formerly assessed for several viral and bacterial pathogens and are by extension applicable to SARS-COV2 (Gallagher et al., 2020; Hu et al., 2007). Based on such evidences, it was recommended that the use of such

apparatuses during the pandemic should be restricted to mandatory or emergency cases to reduce the risk of infection among the personnel (Kowalski et al., 2020; Meng et al., 2020). In the Saudi MOH Dental Emergency Protocol during COVID-19 Pandemic, it was stated that the use of dental hand-pieces without anti-retraction function should be prohibited during the pandemic, recommending the use of anti-retraction dental hand-pieces with specially designed anti-retraction valves or other anti-reflux designs (Saudi Arabia Ministry of Health, 2020).

Limitations

The study has two major limitations that impact the external validity of the findings. First, the lack of systematic and random sampling along with the voluntary participation might have induced a selection bias. Second, the cross-sectional and un-controlled design does not establish the causality relationship between the occupational exposure and the COVID-19 infections. Further, the present study did not assess the risk of community infection and the adherence with preventive measures in the community. Finally, the small sample size may further impact the external validity of the findings.

5. CONCLUSION

The first semester of the COVID-19 pandemic was associated with significant reduction in the practice among general dentists in the Western region of Saudi Arabia, while specialists and consultants were more frequently present in dental clinics. The prevalence of COVID-19 infection among dentists was relatively high, estimated as 10-fold the prevalence in the general population, and the risk of infection was likely to be higher among dentists who practiced during March 2020 and or April 2020. The importance of adequate implementation and adherence to the infection prevention and control measures should be emphasized and competent authorities should undertake systematic audits in dental clinics and hospitals to improve their compliance. The risk of occupational COVID-19 infection associated with hand-piece operation should be highlighted and adapted measures should be urgently implemented.

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Author Contributions

The two authors contributed equally in the study concept and design, intellectual content, data acquisition, analysis and review, manuscript preparation, review and editing; as well as approval of its final version. Consequently, both author act as guarantor for the validity of the content of the present manuscript.

Ethical approval

The study was approved by the Medical Ethics Committee of King Abdulaziz University, Jeddah, Saudi Arabia (ethical approval code: 78-08-20).

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Conflict of Interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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