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Awareness of Potential Oral and Systemic Risk Factors for Covid-19 Among Dentists

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ABSTRACT

Aim: Although the pathophysiological pathways have not been fully elucidated, it is assumpted that the systemic comorbidity variables described for periodontal disease may also apply to COVID-19. It was aimed to assess dentists' knowledge in the triangle of systemic comorbidities, oral-periodontal health, and COVID-19 and to contribute to patient care.

Methods: A questionnaire containing 17 statements obtained from hypotheses in the current literature was sent to dentists via email. The first part of the survey contains demographic questions, including age, gender, speciality, years in professional experience, and institutional affiliation, while the second part contains statements assessing dentists' knowledge about oral and systemic candidate risk factors related to COVID-19. Responses were set up as "agree", "disagree", and "undecided". Intraclass Correlation Coefficient (ICC) was calculated for each item. An ICC value of 0.80 or higher was considered satisfactory.

Results: 68.8% (n=353) of 513 dentists were female, 66.7% (n=342) were between the ages of 24-40, 67.3% (n=345) had a professional history of 10 years or more, and 49.9% (n=256) were specialists. 56.5% of participants agree that there may be common risk factors for periodontal disease and COVID-19. 74.1% of participants agree that improving oral care levels could reduce complications arising from COVID-19. The systemic diseases/conditions for severe COVID-19 that received the highest "agree" responses in the presence of periodontal disease were Diabetes (90.1%), Tuberculosis (87.7%), and AIDS (86.7%). The highest "undecided" responses were for independent statements created for relationships with necrotizing oral manifestations with fever upon COVID-19 diagnosis (42.3%), vesiculobullous lesions/ulcers (41.7%), atherosclerotic diseases (42.1%), and liver diseases (40.2%). The highest "disagree" response was for the presence of vesiculobullous lesions/ulcers with a COVID-19 diagnosis (17%). Compared to male, female participants used the "agree" statement more for independent statements given for AIDS, presence of common risk factors, pregnancy, and atherosclerosis ($p<0.01$) and for oral care level, COPD, liver diseases, and rheumatoid arthritis ($p<0.05$). The specialists of Periodontology gave more "agree" responses for statements about the course of COVID-19 with oral care level, periodontal disease and dysbiotic flora, the course of COVID-19 with periodontal disease and pregnancy, and the course of atherosclerosis-COVID-19.

Conclusions: Within the limitations of the time of our study and the participating dentist population, it was observed that a sufficient correlation could not be established between COVID-19 and oral/periodontal health and the presence of systemic comorbidities, and there's a need to raise awareness through necessary training/seminar programs.

Keywords: Covid-19, Periodontal Disease, Dentists, Questionnaire.

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Introduction

COVID-19 is an acute respiratory infection caused by coronavirus 2 (SARS-CoV-2) and transmitted through airborne droplets and aerosols.[1] The binding of the spike protein on the surface of SARS-CoV-2 to the angiotensin-converting enzyme 2 (ACE-2) receptor found on the human cell membrane facilitates transmission.[2] This enzymatic expression occur both in the lungs and in many other organs such as kidneys, testes, female breasts, liver, and cardiovascular and gastrointestinal systems. Therefore, it is presumed that SARS-CoV-2 could affect multiple organs in the body.[3,4] The receptors to which the proteins used by SARS-CoV-2 bind to infect cells are also abundantly present in the oral cavity.[5,6]

The ulcerated pocket epithelium in periodontitis may facilitate COVID-19 entry, either directly through this damaged epithelium or indirectly by the upregulation of ACE-2 receptor expression induced by periodontal pathogens.[1,7] SARS-CoV-2 RNA has been detected in dental calculus, supragingival, and subgingival plaque biofilms of severe COVID-19 patients.[8,9] The presence of SARS-CoV-2 in cadaver biopsies of periodontal tissue indicates a relationship between COVID-19 and periodontitis.[10] Periodontitis could also serve as a source of systemic infection, possibly exacerbating severe COVID-19

through a cytokine storm.[1,7,11] In COVID-19 patients with periodontitis, oral and respiratory bacteria can potentially spread to the lower respiratory tract through aspiration.[12] Therefore, many researchers emphasized that the oral cavity acts as a reservoir for SARS-CoV-2.[1,5]

In some study results revealed increased intensive care admissions and mortality rates in severe periodontitis patients suffered from COVID-19.[13,14] Furthermore, researches have shown that the presence of alveolar bone loss and caries associated with apical periodontitis in individuals with a systemic disease can lead to worsening of COVID-19 complications.[13,15] Individuals suffered from periodontitis are 4.7 times more likely to develop coronavirus disease.[16] Acute periodontal lesions, particularly necrotizing forms, are predicted to emerge in association with COVID-19.[6,17,18] Also, non-specific oral lesions, such as dry mouth, oral vesiculobullous or pustular lesions, lip necrosis, fissured tongue, or erythematous or hemorrhagic mucosal lesions, have also been associated with COVID-19.[6,18] Gender (male), smoking/alcohol consumption, hypertension, obesity, diabetes, cardiovascular diseases, chronic obstructive pulmonar disease, chronic kidney and liver diseases, cancer, immunological disorders, Acquired Immune Deficiency Syndrome (AIDS), and atherosclerotic disorders have been cited as common risk factors for both periodontitis and COVID-19.[1,7,13]

Based on the assumption that the existence of a bidirectional relationship between periodontal diseases and systemic diseases may affect the course of COVID-19, this study aimed to evaluate the knowledge and awareness of dentists regarding the possible effect of periodontal diseases and systemic diseases comorbidity on the course of COVID-19.

Methods

Study design and population

This cross-sectional survey-based study protocol was approved by The Istanbul Aydin University Ethics Committee for Non-interventional Researches (Ethics Committee No. 2021/352). The study conducted between February 2021 and March 2021 in accordance with the Declaration of Helsinki of 1975, seventh revised version in 2013. The research population consisted of 513 dentists who were met all inclusion criteria listed below.

Inclusion criteria for the study were as follows;

- Graduated from a faculty of dentistry.
- Being between the ages of 23-60
- Speaking Turkish as native language
- Being a member of the Turkish Dental Association
- Being volunteer to participate

Data collection tool

A 2-sectioned questionnaire which was structured regarding utilized the information at the hypothesis level in the current literature, was sent to the dentists via e-mail. Section A included demographic questions including age, gender, expertise, work experience in the profession, institutional affiliation. To evaluate dentists' knowledge of oral and systemic candidate risk factors for COVID-19, Section B was structured with 17 statements. These statements classified in 3 distinct subsections and could be responded with one of the possible options were as "Agreed, Undecided or Disagreed". Subsection G consisted of only one statement (G1) that evaluated general information about the virus family from which COVID-19 originates. While Subsection P included 6 statements (P1-6) which asked for assessing the relationship between COVID-19 and periodontal disease and the presence of oral findings, Subsection S consisted of 10 statements (S1-10) that placed for effect of systemic comorbidities on the course of COVID-19 with periodontal disease.

An expert panel consisting of a public health specialist, an internal medicine specialist, two periodontists and a non-specialist dentist was assigned for content validation of the questionnaire in line with the Lawshe method.[19] Following the panel's recommendations, a revised version of the data collection tool was developed. This amended version of was e-mailed to ten dentists who were randomly selected from Dental Health Research and Training Centers both of Beykent University and of Istanbul Aydin University. These dentists did not participate for the study. The Intraclass Correlation Coefficient (ICC) was calculated for test-retest reliability and inter-responder reliability for each item. An ICC value of 0.80 or higher was deemed satisfactory.[20] Subsequently, an URL supplied for direct access to the data collection tool prepared digitally in Google forms and URL was shared to all registered members of the Turkish Dental Association via membership e-mailing system. To avoid duplicate inclusion, e-mailing list of participants were provided to only one author (SEM) in accordance with relevant data protection regulations.

Statistical analysis

Sample size

Before the study, a power analysis was conducted to determine the appropriate sample size for the study. Similar studies in the literature conducted with sample sizes ranging from 245-568 subjects.[21,22] The total number of participants was 376, as determined by the G-POWER algorithm, with an effect size of 0.17, 95% power, and a margin of error of 0.5. Since the study was conducted with a single group, the required sample size for this study was established as n=376. The study had a participation of 513 dentists.

Data Analysis

The SPSS (Statistical Package for Social Sciences) 24.0 software was utilized for the statistical analysis of the research data. Descriptive statistical data were represented as frequency, mean, and percentage. The Student t-test was applied for the comparison of quantitative data with normal distribution between two groups, while the One-Way Anova test was chosen for comparisons among more than two groups. The Pearson Chi-Square test was applied to evaluate responses based on demographic categories. Significance was set at $p<0.05$ and $p<0.01$ level.

Results

The demographic characteristics of the study is presented in Table 1. Based on Table 1, 68.8% (n=353) of the participants in the study were female and mean age of population was 38.84. Considering distribution of age groups, 22.6% (n=116)

were 30 years-old or younger, 44.1% (n=226) were between the ages of 31-40. Moreover, 67.3% (n=345) of the participants, had a professional work experience period 10 years or over. While 50.1% (n=257) of the participants did not have a specialty, 49.9% (n=256) did have. The type of institutions participants worked were as follows: 26.1% (n=134) of at a university hospital, 17.7% (n=91) of at a hospital belonged to Ministry of Health, and 56.2% (n=288) in a private clinic.

The distribution of responses was presented in Table 2. The statement "There may be common risk factors for periodontal disease and COVID-19" received 56.5% agreement, 8.8% disagreement, and 34.7% were uncertain. The following statements received 80% or higher agreement: "The presence of periodontal disease in individuals with diabetes can adversely affect the progression of COVID-19." (90.1%), "COVID-19 is caused by a newly identified coronavirus called SARS-CoV-2." (88.7%), "The presence of periodontal disease in individuals with tuberculosis can adversely affect the progression of COVID-19." (87.7%), and "The presence of periodontal disease in AIDS patients can adversely affect the progression of COVID-19." (86.7%).

The statement with the highest disagreement was: "Patients with painful vesiculobullous lesions and oral ulcers upon intraoral examination can be evaluated for COVID-19." (17%). The highest undecided responses were given for the statements: "The presence of necrotizing periodontal disease accompanied by high fever and similar presentations may suggest COVID-19." (42.3%), "The presence of periodontal disease in individuals with atherosclerosis can adversely affect the progression of COVID-19." (42.1%), "Patients with painful vesiculobullous lesions and oral ulcers upon intraoral examination can be evaluated for COVID-19." (41.7%), and "The presence of periodontal disease in individuals with liver disease can adversely affect the progression of COVID-19." (40.2%).

Gender

Responses each of "P1" (p=0.014; p<0.05), "P6" (p=0.002; p<0.01), "S3" (p=0.007; p<0.01), "S4" (p=0.015; p<0.05), "S5" (p=0.037; p<0.05), "S6" (p=0. 04; p<0.01), "S7" (p=0.022; p<0.05), "S8" (p=0.023; p<0.05), "S9" (p=0.07; p<0.01) were statistically different regarding gender. The agreement rate on each of above said nine statements was higher in women (Table 3.). No difference was found between the gender groups for the remained 11 statements (p>0.05).

Age

Responses to the “P5” differed significantly according to age (p=0.007; p<0.01). In the paired comparisons, the rate of agreement at the age of 30 and younger group was found to be lower than both of other two groups (p=0.001). In addition, significantly higher the rate of agreement for the "S4" than the age subgroup of 51-60 (p=0.045; p<0.05). The “S6" for the same age subgroup was shown a higher rate of agreement than both remained two age subgroups (p=0.001) (Table 4). The agreement rates of remained statements was not reveal any difference regarding age subgroups (p>0.05).

Years of professional experience

As shown in Table 4, the rate of agreement for “G1” was found to be lower in those with 0-4 years of professional experience compared to those with 5-9 years of professional experience. (p=0.043; p<0.05). In the pairwise comparisons for the statement "P1", the rate of agreement among those with 5-9 years of professional experience was higher than 0-4 years (p=0.047) and 10 years and over (p=0.048). For the statement "P5", the rate of agreement was higher in those with 10 years and over than in those with 0-4 years (p=0.032) and 5-9 years (p=0.033). Furthermore, for the statement "S4", the rate of agreement was found to be lower in those with 0-4 years of professional experience compared to those with 10 years or more (p=0.001; p<0.01). No statistically significant difference was found between the subgroups in terms of other statements (p>0.05) (Table 4).

Speciality

In the pairwise comparisons for the statement "G1" according to specialty, the rate of agreement of non-specialists was lower than both of periodontists (p=0.001) and of other specialists (p=0.001). The rates of agreement for the statements "P1" and “S3” was lower in non-specialists than in periodontists (respectively, p=0.041; p<0.05, p=0.029; p<0.05). Moreover, while for the statement "P3", the rate was higher in periodontology specialists than in other specialties (p=0.027; p<0.05), the rate of “S9” was higher in periodontists than both in remained specialists and non-specialists (for both, p=0.001; p<0.05). No difference was found between the groups for the remained statements (p>0.05) (Table 5).

Institutional affiliation

The answers given to the question "P1" differed significantly according to the institutional affiliation." In the pairwise comparisons for the statement "P4", the rate of agreement was higher among those working at the university hospital than both those working at the centers belonged to Ministry of Health (p=0.001; p<0.01) and those working in private practice or clinics (p=0.043; p<0.01). Furthermore, for the statement "S3", the rate of agreement was higher among those working at university hospitals than those working at private practices or clinics (p=0.031; p<0.01). But, for the statement "S8", the rate of agreement was higher among those working at the centers belonged to Ministry of Health than those working in private clinic (p=0.010; p<0.05). For the statement "S9", the rate was higher among those working in university hospitals than those working in private clinics (p=0.019; p<0.05). No statistically significant difference was found between the groups for the other statements (p>0.05) (Table 4).

Table 1: Demographic distribution

	N	%
Gender		
Male	160	31.2
Female	353	68.8
Age		
≤ 30 years	116	22.6
31-40 years	226	44.1
41-50 years	92	17.9
51-60 years	49	9.6
≥ 61 years	30	5.8
Professional experience (years)		
0-4	80	15.5
5-9	88	17.2
≥10	345	67.3
Branch of Speciality		
General dentistry	257	50.1
Maxillofacial surgery	31	12.1
Maxillofacial radiology	10	3.9
Endodontics	29	11.3
Orthodontics	21	8.2
Pedodontics	16	6.3
Periodontics	83	32.4
Prosthodontics	45	17.6
Restorative dentistry	21	8.2
Institutional affiliation		
University	134	26.1
Ministry of health	91	17.7
Private clinic	288	56.2

Table 2: Distribution of responses to the questionnaire statements

			Agree		Disagree		Undecided	
			N	%	N	%	N	%
PERIODONTAL RISK	G1	The agent for COVID-19 is a newly identified coronavirus called SARS-CoV-2.	455	88.7	41	8.0	17	3.3
	P1	Improving the level of oral care and reducing the oral bacterial load can reduce the complications of COVID-19	380	74.1	53	10.3	80	15.6
	P2	Periodontal pockets may be reservoirs for SARS-CoV-2.	291	56.7	39	7.6	183	35.7
	P3	Patients with periodontal disease with more severe COVID-19 disease may develop oral dysbiosis and more pathogenic flora structure.	301	58.7	8	1.6	204	39.8
	P4	In necrotic periodontal disease, accompanied by high fever, and similar tables, the presence of COVID-19 can be considered.	239	46.6	57	11.1	217	42.3
	P5	Patients with painful vesiculosal lesions and oral ulcers can be evaluated for COVID-19.	212	41.3	87	17.0	214	41.7
	P6	There may be common risk factors for periodontal disease and COVID-19.	290	56.5	45	8.8	178	34.7
SYSTEMIC RISK	S1	In individuals with diabetes, the presence of periodontal disease may adversely affect the course of COVID-19.	462	90.1	12	2.3	39	7.6
	S2	In individuals with obesity, the presence of periodontal disease may adversely affect the course of COVID-19.	398	77.6	21	4.1	94	18.3
	S3	In pregnancy, the presence of periodontal disease, gestational diabetes, pre-eclampsia and other factors can also adversely affect the course of COVID-19.	333	64.9	23	4.5	157	30.6
	S4	In individuals with chronic obstructive lung disease, the presence of periodontal disease may adversely affect the course of COVID-19.	340	66.3	22	4.3	151	29.4
	S5	The presence of periodontal disease in smokers may adversely affect the course of COVID-19.	393	76.6	40	7.8	80	15.6
	S6	The presence of periodontal disease in AIDS patients may adversely affect the course of COVID-19.	445	86.7	7	1.4	61	11.9
	S7	In individuals with liver disease, the presence of periodontal disease may adversely affect the course of COVID-19.	276	53.8	31	6.0	206	40.2
	S8	In individuals with rheumatoid arthritis, the presence of periodontal disease may adversely affect the course of COVID-19.	275	53.6	35	6.8	203	39.6
	S9	In patients with atherosclerosis, the presence of periodontal disease may adversely affect the course of COVID-19.	261	50.9	36	7.0	216	42.1
	S10	In individuals with tuberculosis, the presence of periodontal disease may adversely affect the course of COVID-19.	450	87.7	9	1.8	54	10.5

G: General statement; P: Periodontal risk statements; S: Systemic risk statements

Table 3: Evaluation of the answers given to the statements by gender

		Gender				[a]p
		Male (n=160)		Female (n=353)		
		N	%	N	%	
P1	Agreed	107	66.9	273	77.3	***0.014****
	Disagreed	25	15.6	28	7.9	
	Undecided	28	17.5	52	14.7	
P6	Agreed	76	47.5	214	60.6	***0.002****
	Disagreed	23	14.4	22	6.2	
	Undecided	61	38.1	117	33.1	
S3	Agreed	90	56.3	243	68.8	***0.007****
	Disagreed	12	7.5	11	3.1	
	Undecided	58	36.3	99	28.0	
S4	Agreed	101	63.1	239	67.7	***0.015****
	Disagreed	13	8.1	9	2.5	
	Undecided	46	28.7	105	29.7	
S5	Agreed	113	70.6	280	79.3	***0.037****
	Disagreed	19	11.9	21	5.9	
	Undecided	28	17.5	52	14.7	
S6	Agreed	127	79.4	318	90.1	***0.004****
	Disagreed	3	1.9	4	1.1	
	Undecided	30	18.8	31	8.8	
S7	Agreed	72	45.0	204	57.8	***0.022****
	Disagreed	13	8.1	18	5.1	
	Undecided	75	46.9	131	37.1	
S8	Agreed	72	45.0	203	57.5	***0.023****
	Disagreed	15	9.4	20	5.7	
	Undecided	73	45.6	130	36.8	
S9	Agreed	65	40.6	196	55.5	***0.007****
	Disagreed	13	8.1	23	6.5	
	Undecided	82	51.2	134	38.0	

[a]Pearson Chi-Square ***p<0.01* **p<0.05*

Table 4: Evaluation of the answers according to age, institutional affiliation, and professional experience

		Age (years)										
		≤30 (n=116)		31-40 (n=226)		41-50 (n=92)		51-60 (n=49)		≥60 (n=30)		
		N	%	N	%	N	%	N	%	N	%	[a]p
	Agreed	34	29.3	91	40.3	45	48.9	25	51.0	17	56.7	
P5	Disagreed	23	19.8	35	15.5	11	12.0	12	24.5	6	20.0	***0.007****
	Undecided	59	50.9	100	44.2	36	39.1	12	24.5	7	23.3	
	Agreed	93	80.2	140	61.9	59	64.1	29	59.2	19	63.3	
S4	Disagreed	6	5.2	10	4.4	3	3.3	2	4.1	1	3.3	***0.038****
	Undecided	17	14.7	76	33.6	30	32.6	18	36.7	10	33.3	
	Agreed	107	92.2	198	87.6	84	91.3	34	69.4	22	73.3	
S6	Disagreed	0	0	6	2.7	1	1.1	0	0	0	0	***0.001****
	Undecided	9	7.8	22	9.7	7	7.6	15	30.6	8	26.7	
		Professional Experience (years)										
		0-4 (n=80)				5-9 (n=88)				≥10 (n=345)		
		N		%		N		%		N	%	[a]p
	Agreed	64		80.0		81		92.0		310	89.9	
G1	Disagreed	9		11.3		6		6.8		26	7.5	**0.026***
	Undecided	7		8.8		1		1.1		9	2.6	
	Agreed	57		71.3		73		83.0		250	72.5	
P1	Disagreed	4		5.0		7		8.0		42	12.2	**0.029***
	Undecided	19		23.8		8		9.1		53	15.4	
	Agreed	23		28.7		27		30.7		162	47.0	
P5	Disagreed	18		22.5		16		18.2		53	15.4	**0.006****
	Undecided	39		48.8		45		51.1		130	37.7	
	Agreed	64		80.0		63		71.6		213	61.7	
S4	Disagreed	2		2.5		8		9.1		12	3.5	**0.001****
	Undecided	14		17.5		17		19.3		120	34.8	
		Institutional affiliation										
		Academic (n=134)				Public (n=91)				Private clinic (n=288)		
		N		%		N		%		N	%	[a]p
	Agreed	126		94.0		77		84.6		252	87.5	
G1	Disagreed	4		3.0		6		6.6		31	10.8	**0.001***
	Undecided	4		3.0		8		8.8		5	1.7	
	Agreed	73		54.5		44		48.4		122	42.4	
P4	Disagreed	14		10.4		3		3.3		40	13.9	**0.013***
	Undecided	47		35.1		44		48.4		126	43.8	
	Agreed	100		74.6		65		71.4		168	58.3	
S3	Disagreed	5		3.7		2		2.2		16	5.6	**0.010***
	Undecided	29		21.6		24		26.4		104	36.1	
	Agreed	83		61.9		58		63.7		134	46.5	
S8	Disagreed	7		5.2		3		3.3		25	8.7	**0.006****
	Undecided	44		32.8		30		33.0		129	44.8	
	Agreed	86		64.2		39		42.9		136	47.2	
S9	Disagreed	4		3.0		8		8.8		24	8.3	**0.005****
	Undecided	44		32.8		44		48.4		128	44.4	

[a]Pearson Chi-Square ***p<0.01* **p<0.05*

Table 5: Evaluation of the answers according to branch of speciality

		Speciality						
		General dentistry		Periodontics		Other specialties		
		N	%	N	%	N	%	[a]p
G1	Agreed	212	82.5	80	97.6	163	93.7	***0.001****
	Disagreed	31	12.1	1	1.2	9	5.2	
	Undecided	14	5.4	1	1.2	2	1.1	
P1	Agreed	180	70.0	69	84.1	131	75.3	***0.018****
	Disagreed	36	14.0	1	1.2	16	9.2	
	Undecided	41	16.0	12	14.6	27	15.5	
P3	Agreed	156	60.7	57	69.5	88	50.6	***0.006****
	Disagreed	7	2.7	0	0	1	0.6	
	Undecided	94	36.6	25	30.5	85	48.9	
S3	Agreed	150	58.4	65	79.3	118	67.8	***0.010****
	Disagreed	15	5.8	2	2.4	6	3.4	
	Undecided	92	35.8	15	18.3	50	28.7	
S9	Agreed	110	42.8	58	70.7	93	53.4	***0.001****
	Disagreed	23	8.9	2	2.4	11	6.3	
	Undecided	124	48.2	22	26.8	70	40.2	

[a]*Pearson Chi-Square* **p<0.01* **p<0.05*

Discussion

Within the period and population of this cross-sectional study, it was found that Turkish dentists were unable to establish an adequate relationship between the oral manifestations that may be associated with COVID-19, the possible effects of periodontal diseases, and the impact of periodontal diseases on the course of COVID-19 in the presence of systemic comorbidities.

The COVID-19 classification was answered correctly by 88.7% of the dentists. The highest "agreed" responses were given by dentists with 5-9 years of work experience, dentists working at universities and periodontists, while the lowest "agreed" responses were given by dentists with 0-4 years of professional experience, dentists working for Ministry of Health and non-specialized dentists. In the study by Karayürek *et al.,* 79.3% of the participants answered the question correctly.[23] The reason for the higher response rate in our study may be the increase in the general knowledge level of dentists one year after the outbreak of the pandemic.

For the statement "There may be common risk factors for periodontal disease and COVID-19", 56.5% of dentists answered "agreed", 8.8% answered "disagreed" and 34.7% were undecided. The first officially known COVID-19 case in Turkey was detected on March 10th 2020. This study was conducted between February and March 2021, when the first shock moments related to COVID-19 were overcome and clinical results started to be reported. Sensitive populations, age groups, risk factors that will be more affected from COVID-19 disease were mostly presented as hypotheses in the literature, and large clinical results could not be fully reported because they were not yet available. While some of the statements we created had current content related to COVID-19 (diabetes, smoking, pregnancy, tuberculosis(TBC)) others were hypotheses that were less found in the literature.[13,24,25]

Duruk *et al*. reported that 96.27% of Turkish dentists obtained information about COVID-19 through their personal websites/social media accounts, whilst only 26.65% of them attended an informative meeting about COVID-19. [26] They also reported that 91.37% of them were informed through the Ministry of Health, WHO and professional organizations and/or their social media accounts.[26] Considering these sources, the statements in the questionnaire (diabetes, TBC and AIDS) with high agreement (80% and above) were predictable. An important limitation of this study was that the information sources of the dentists regarding COVID-19 were not assessed.

There are different studies in the literature evaluating dentists' knowledge of the relationship between periodontal/oral health and systemic diseases/conditions. In a recent survey conducted in 2008 with nearly 2000 USA dentists found that hypertension (85.8%), cardiovascular disease (76.8%), diabetes (76.6%), hepatitis (71.5%), and HIV infection (68.8%) had significant clinical implications for the majority of dentists.[27] Another study reported high dentist awareness of the relationship between periodontal disease, diabetes (84.4%) and heart disease (70.2%).[28] Dentists' awareness was lower for the association of periodontal disease with respiratory tract disease (24.4%), kidney disease (31.6%) and stroke (37%).[28] Paquette *et al.* reported that dentists evaluated the evidence as strong for the association between cardiovascular disease (71.1%) diabetes mellitus (67.0%) and pregnancy complications (38.1%), but found the evidence insufficient for respiratory diseases, osteoporosis and obesity.[29] Nazir *et al.* stated that women's awareness of the relationship between periodontal health and systemic diseases was higher compared to men, and this awareness stood out for negative pregnancy outcomes, diabetes, and rheumatoid arthritis.[28] Based on outcomes of the presented

study, women participants opted the response of “agree” more for the common systemic comorbidities presented for COVID-19. Moreover, women consented on the statements asked the relationships between both periodontal disease and COVID-19, and each of the conditions/diseases listed as pregnancy, COPD, smoking, HIV, liver diseases, RA, atherosclerosis. But, the effect of higher ratio of women participants should be taken into account in the interpretation of the outcomes. Although the rate of male physicians is higher according to the Turkish Dentists Association data(2022), the participation rate in the study may also indicate that women allocate more time for academic development[28] and have more curiosity and interest in the subject. Considering all these findings, greater pre-awareness, especially in women, may have formed the basis for associating COVID-19 and comorbidities. Another limitation of this study is that a preliminary questionnaire prepared with statements independent from COVID-19 did not conduct. In this study, similar to the relevant literature given above, the highest "agree" responses were noticed especially for diabetes (90.1) and AIDS. "Agreed" option was less favored for smoking (76.6), obesity (77.6), pregnancy (64.9), liver disease (53.8), RA (53.6) and atherosclerosis (50.9.)

Physician awareness questionnaires, which measure the general knowledge level, anxiety levels, and attitudes about the vaccine, covering the transmission routes and countermeasures related to COVID-19, have been reported. Karayürek *et al.* reported that specialized dentists had higher levels of knowledge, and age and work experience did not have an effect on the level of knowledge.[23] Similarly, Gambhir *et al.* found that education level and health sector profile were associated with average knowledge levels in India.[21] They reported that dentists who continued their academic life have higher scores because they had the opportunity to access and achieve more regular information without any relationship with work experience in profession.[21] In this study, dentists with periodontology expertise, compared to dentists without expertise, gave more "agreed" answers for "COVID-19 course with oral care level", "periodontal disease and COVID-19-pathogenic flora", "periodontal disease and pregnancy and COVID-19 course", "atherosclerosis and COVID-19”. Presented study seems to support these two studies in terms of increasing the level of knowledge of academic continuity. Unlike these studies, the institution, work experience and age, together with the specialty, appears to be effective on the level of knowledge of dentists.

Another situation that may indirectly effect the level of knowledge may be the relationship between the institution and the level of fear and anxiety. It has been reported that dentists working under the Ministry of Health experience relatively more anxiety due to their employment to be taken as a risk factor at home, while dentists working at universities had the highest perceived anxiety and fear due to the risk that the COVID-19 pandemic would adversely effect their academic attendance.[23] Although the fear and anxiety levels of dentists working in private clinics were reported to be low, economic concerns in particular were challenging for these dentists. [23] Karaaslan *et al*. found that more than half (52.6%) of dentists working in their private clinics stated that they only cared for emergency patients during the pandemic period.[30] Most of the dentists (97.4%) stated that the pandemic had a negative impact on their economic situation.[30]According to outcomes of the study conducted by Tunçer and Karkaç in February 2021, 59% of dentists working in their own clinics and 50% of those working in public or private institutions reported that they reduced the number of patients during the pandemic period.[31] While the rate of only emergency caregivers was 8.8% among those working in their own clinic, it was determined as 32.4% of those working in an institution.[31] Other economic issues for dentists could be listed as difficulty in accessing protective equipment, having COVID, having a chronic illness, and having to interrupt their work for these reasons.[26,31] The decrease in the rates of emergency patient care among dentists working in their own clinics has been interpreted as the fact that dentists had to work for economic reasons in the later stages of the pandemic. 56.2% of the participants in this study worked in private practice/clinics, 26.1% in university hospitals, and 17.7% in the ministry of health. Other factors that may influence on the responses to the questionnaire statements; dentists themselves or their relatives having COVID-19, having a chronic disease could be listed as only emergency patient/normal patient care processes (awareness of oral manifestations).

We got the highest agreement rate for the relationship between oral care level and COVID-19 for statements in the oral manifestations-COVID-19-periodontal disease triangle, The statements with the lowest agreement rate were given for the presence of vesiculobullous lesion/ulcer in the mouth and necrotizing periodontal disease in the diagnosis of COVID-19, independently. Iranmanesh *et al*. reported that more common and severe oral lesions sere seen in older ages and patients with severe COVID-19.[6] While taste disturbance was the most common and first described oral symptom, the oral manifestations associated with COVID-19 were ulcers, erosions, bullae, vesicles, pustules, and fissures, or depapilla tongue, macule, papule, plaque, pigmentation, halitosis, white areas, necrosis, petechiae, edema, erythema, spontaneous bleeding. The most affected sites were reported as tongue, labial mucosa, and palatal region, respectively. The suggested diagnoses for the lesions were listed as aphthous stomatitis, herpetiform lesions, candidiasis, vasculitis, Kawasaki-like, mucositis, drug eruptions, and necrotizing periodontal diseases.[6] Fidan *et al.* reported that the most common lesion in patients with COVID-19 was aphthous lesions, most commonly seen on the tongue, and oral lesions were found in 2/3 of the patients.[32] Tuter *et al.* reported that the most common oral symptom was dry mouth; however, oral ulcers, tongue lesions and swelling of the gingiva, tooth and implant loss, and taste disorders were found in their study conducted between February 2021-March 2021 in COVID-19 patients.[33] They also reported that patients who stated that they received periodontal treatment before COVID-19 had fewer oral complaints and symptoms compared to patients who did not receive periodontal treatment.[33] Poor oral hygiene, opportunistic infections, stress, immunosuppression, vasculitis, and increased inflammatory response were considered to be the most important predisposing factors for the onset of oral lesions in COVID-19 patients.[6]

Di Spirito *et al.* drew attention to the need to evaluate the putative role of both SARS-CoV-2 in oral lesion formation and periodontitis and the periodontal microbiome in the course of worsening and reactivations of COVID-19 in their review.[18] Besides periodontal necrotizing lesions, the most severe stages of periodontitis, have been associated with higher rates of hospitalization, need for ventilation, and mortality.[14,34] It has been hypothesized that periodontitis, poor oral hygiene, and the periodontal microbiome may be risk factors for complications and worsening of disease forms from COVID-19.[7,11,18] It seems important to systematically integrate the maintenance of oral hygiene and active periodontal treatments into interdisciplinary treatment in patients with mild to moderate COVID-19 and when possible, especially in severe cases.[1,7,11,18] It has been reported that in the control of the reservoir function of periodontal pockets for possible SARS-CoV-2, periodontal treatment together with the provision of oral antisepsis with chlorhexidine and hydrogen peroxide may contribute to reducing the risk of re-infection in patients with recovered COVID-19 as a result of balancing periodontal pathogens and viral microbial load in favor of health.[5,35]

From the first announcement days of the COVID-19 pandemic, the way of spreading from the infected patient by coughing or the aerosol environment during dental procedures has made dental professionals the most risky profession, and especially in the first periods, most dentists limited patient care only to emergency protocols determined by the ministry of health. On May 5th, 2023, WHO announced that the global impact of the COVID-19 pandemic has waned. However, the effects of the process in patients with COVID-19 who are reported as “long-COVID” or prolonged COVID and what will happen after the reactivation of the virus remain unclear.[36] With a revision in the Turkish Dental Education Core Curriculum on October 2021, COVID-19 was included in the topics of "core diseases and conditions". It could be suggested for the future to organize trainings and seminars to increase the knowledge level of graduated dentists about common systemic comorbidity factors and oral manifestations about COVID-19 and periodontitis, which have not yet been fully clarified.

Conclusions

Within limitations of the study, the outcomes highlighted that dentists, who work in the oral cavity due to the nature of their profession and are the most risky occupational group in terms of COVID-19 transmission, have insufficient awareness of the possible bidirectional interrelationships between oral health and COVID-19.

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