Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Frequency and pattern of outpatient dental visits during the COVID-19 pandemic at hospital and community clinics

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Supplemental material is available online.

ABSTRACT

Background. The authors aimed to measure the frequency of dental visits before and during the COVID-19 pandemic and to evaluate whether dental visits can be predicted from demographic characteristics, socioeconomic status, oral problem diagnoses, and dental service providers.

Methods. Participants for this retrospective study were patients visiting dental care providers at hospital- and community-based outpatient clinics in Alberta, Canada. Data were retrieved from electronic databases from March 12, 2020, through September 30, 2020, and from the same period for 2018 and 2019. The COVID-19 lockdown was declared for March 12 through May 14, 2020. Data were analyzed using analysis of variance test and multiple logistic regression at $\alpha = 0.05$.

Results. From a total of 14,319 dental visits, 5,671, 5,036, and 3,612 visits occurred in 2018, 2019, and 2020, respectively. The mean (standard deviation) frequency of daily visits was 36.69 (15.64), 32.09 (15.51), and 24.24 (14.78), respectively. Despite the overall decrease, the frequency of visits for infections, salivary problems, and temporomandibular disorders increased during the COVID-19 pandemic in 2020. Dental visits during the pandemic were associated with more complicated oral diagnoses and dental services as well as higher economic status.

Conclusions. During the COVID-19 pandemic, the frequency of dental visits decreased specifically during lockdown. Patients with complicated problems requiring urgent treatments mainly visited dental clinics. Reduced access to care was observed primarily among socially disadvantaged groups.

Practical Implications. Although guidelines and related recommendations have been effective in restoring the compromised dental system during the COVID-19 pandemic, additional modifications are needed to promote in-person visits to improve the oral health status of patients.

Key Words. Dental visit; oral health; COVID-19; pandemic.

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Severe acute respiratory syndrome coronavirus 2 is a novel virus responsible for COVID-19 infection, which affects the upper airways.[1] Fever, cough, fatigue, and loss of smell and taste are the main clinical symptoms of the infection.[2] COVID-19, a major health crisis worldwide, was declared a pandemic by the World Health Organization (WHO).[3] Health care workers are at high risk of being exposed to the virus and constitute 9% of all infected people.[4] Similarly, dental care practitioners have a higher likelihood of exposure to the coronavirus owing to direct exposure to saliva, blood, and a variety of aerosol-generating dental procedures.[4,5] As a result, numerous countries issued restrictions to prevent the spread of COVID-19. Consequently, dentists were advised by WHO to provide only emergency treatments that were essential for preserving a patient's oral function, managing severe pain, or maintaining the patient's quality of life. It was advised that nonurgent procedures, such as examinations, prophylaxis, preventive care, and esthetic treatments, be delayed until there was a substantial reduction in COVID-19 community transmission.[6]

Following the advice of WHO, dentists implemented strict measures developed by their local health authorities to prevent transmission of the virus. To minimize occupational hazards, dentists adapted new triage, evaluation, and treatment systems alongside teledentistry. Through this

approach, an actual emergency was first identified and, if possible, pharmacotherapy was followed immediately.[7] If a patient required hands-on dental treatment, dentists asked a series of screening questions and checked for clinical symptoms of COVID-19. Only patients who met the negative COVID-19 screening criteria and who could be treated with low—aerosol-generating procedures would be seen in private clinics equipped with level 1 personal protective equipment. In case of the presence of a symptom or need for aerosol-generating procedures, patients were to be treated in hospital clinics with adequate infrastructure and level 2 personal protective equipment implementation.[7]

Owing to the restrictions imposed on delivery of dental treatments, and considering the financial and psychological burdens secondary to the COVID-19 pandemic, many people were likely to avoid nonemergency dental treatments.[8-10] Researchers reported that patient anxiety levels increased during the COVID-19 pandemic and that there was a strong relationship between patients' perceptions about the COVID-19 pandemic and their motivation to attend a dental appointment. Except for those patients who receive regular treatments, such as orthodontics, others would only visit in case of emergency.[11,12]

Since March 11, 2020, which marked the beginning of the COVID-19 pandemic, Alberta dentists were using teledentistry more broadly and were allowed to prescribe medications. In addition, similar to many other regions, a system of triage was implemented, starting with a patient phone call for symptoms and risk factors, which was followed with remote and pharmaceutical management, physical assessment in the office, referrals, and finally non—aerosol-generating versus aerosol-generating procedures. However, lack of in-person patient examination meant that the cause of a dental problem could not be assessed properly and addressed in a timely manner.

Data on the pattern and frequency of dental visits, dental services, oral diagnosis, and patient characteristics before and during the pandemic are lacking. Therefore, our aim was to measure the frequency of dental patients' visits before and during the pandemic as well as during and after lockdown and to determine whether dental visits during the pandemic could be predicted on the basis of demographic characteristics, socioeconomic status, service providers, and diagnoses of oral problems.

METHODS

Ethical Approval

This study was reviewed and approved by the Health Research Ethics Board of the University of Alberta (Pro00095759).

Study design and participants

Participants in this retrospective cohort study were patients visiting dental care providers at hospital and community health center dental clinics in Alberta, Canada. Data were retrieved for participants who visited dental clinics from March 12, 2020, (the day after WHO characterized COVID-19 as a pandemic[3]) through September 30, 2020, and the same period for 2018 and 2019. Linkage of all extracted information defined the following 2 main cohorts: dental patients during the pandemic and dental patients before the pandemic in 2018 and 2019. Furthermore, the pandemic period was divided into lockdown phase from March 12 through May 14, 2020, during which private dental offices were closed, and from May 15, 2020, onward, when dentists were permitted to return to full provision of services as part of the stage 1 relaunch strategy in Alberta.

Data sources

The National Ambulatory Care Reporting System was the source of our data, which exists in all provinces in Canada. The deidentified electronic health records processed by the Canadian Institute for Health Information are available to researchers on their request and after they obtain ethics approval and sign the data disclosure agreement with the provincial health. The data set contains information for all hospital- and community-based ambulatory care, such as day surgery, emergency departments, and outpatient and community-based affiliated clinics, and contains demographic characteristics, socioeconomic status, service providers, diagnosis, and procedure interventions. Up to 10 diagnoses, conditions, problems, or circumstances were coded using the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada*.[13] The use of these codes

ABBREVIATION KEY

NA: Not applicable.
TMD: Temporomandibular disorders.
WHO: World Health Organization.

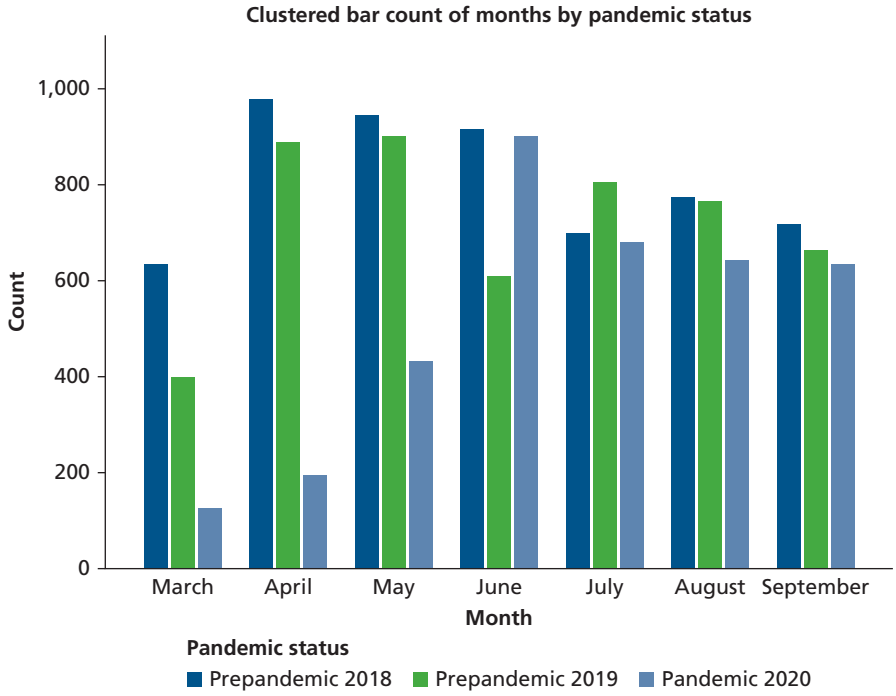


Figure 1. The distribution of frequency of dental visits.

for disease classification is standard in most hospital clinical settings across Canada. This medical classification system was used to code and classify diseases, signs or symptoms, and procedures associated with hospital use.[14] The codes used to retrieve data in our study can be found in the Appendix (available online at the end of this article).

Data analysis

Descriptive

The Statistical Package for the Social Sciences (Version 25.0, IBM) was used to perform the analyses. The descriptive analysis was reported for the continuous data as mean (standard deviation [SD]) and as frequency and percentage for the discrete data. The frequency of dental visits was calculated before and during the pandemic and during and after lockdown.

Inferential

The Kolmogorov-Smirnov test was used to verify the normality of the collected data. One-way analysis of variance and Bonferroni post hoc tests were used to measure the differences in dental visits among the 3 periods. In addition, to determine the factors important in predicting dental visits during the pandemic, pandemic status (outcome measure) was dichotomized into prepandemic and pandemic, and the following predictors were used in the binary logistic regression analysis:

- age: 5 categories of 0 through 18, 19 through 40, 41 through 60, 61 through 80, and 81 through 100 years;
- sex: female or male;
- residential zone: Calgary, central, Edmonton (capital), north, south;
- economic status: 5 categories of 1 (the best) through 5 (the worst) based on residential postal code;
- service provider: dental hygienist, dentist, oral surgeon, or pediatric dentist;
- oral diagnosis: caries and dental problems, cleft and fractures, cysts, examination, infections and lesions, orthodontic problems, periodontal problems, salivary problems, or temporomandibular disorders.

In the first model, age and sex were included. Residential zone and economic status were added to the second model. Finally, service providers and oral diagnosis were incorporated into the third

Table 1. Descriptive analysis of the predictors in the study.

	PREPANDEMIC, NO. (%)			
PREDICTOR	**2018**	**2019**	**PANDEMIC (2020), NO. (%)**	**TOTAL, NO. (%)**
Visit Type				
Outpatient	5,658 (39.5)	5,016 (35.0)	3,605 (25.2)	14,279 (99.7)
Emergency	13 (0.1)	20 (0.1)	7 (0.0)	40 (0.3)
Sex				
Female	2,620 (18.3)	2,319 (16.2)	1,811 (12.6)	6,750 (47.1)
Male	3,051 (21.3)	2,716 (19.0)	1,801(12.6)	7,568 (52.9)
Residential Zone				
Calgary	2,732 (19.3)	2,477 (17.5)	1,272 (9.0)	6,481 (45.8)
Central	350 (2.5)	343 (2.4)	291 (2.1)	984 (6.9)
Edmonton	1,214 (8.6)	1,082 (7.6)	1,354 (9.6)	3,650 (25.8)
North	666 (4.7)	666 (4.7)	506 (3.6)	1,838 (13.0)
South	648 (4.6)	417 (2.9)	148 (1.0)	1,213 (8.6)
Service Provider				
Dental hygienist	342 (2.4)	161 (1.1)	6 (0.0)	509 (3.6)
Dentist	2,443 (17.1)	1,767 (12.3)	841 (5.9)	5,051 (35.3)
Oral surgeon	2,232 (15.6)	2,617 (18.3)	2,487 (17.4)	7,336 (51.2)
Pediatric dentist	654 (4.6)	491 (3.4)	278 (1.9)	1,423 (9.9)
Oral Diagnosis				
Caries and dental problems	2,545 (17.8)	2,162 (15.1)	1,145 (8.0)	5,852 (40.9%)
Cleft and fractures	88 (0.6)	112 (0.8)	45 (0.3)	245 (1.7)
Cysts	467 (3.3)	644 (4.5)	587 (4.1)	1,698 (11.9)
Examination	942 (6.6)	623 (4.4)	127 (0.9)	1,692 (11.8)
Infections and lesions	778 (5.4)	814 (5.7)	1,030 (7.2)	2,622 (18.3)
Orthodontic problems	543 (3.8)	452 (3.2)	379 (2.6)	1,374 (9.6)
Periodontal problems	244 (1.7)	181 (1.3)	121 (0.8)	546 (3.8)
Salivary problems	44 (0.3)	26 (0.2)	132 (0.9)	202 (1.4)
Temporomandibular disorders	20 (0.1)	22 (0.2)	46 (0.3)	88 (0.6)
Age Category, Y				
0-18	2,698 (18.8)	2,517 (17.6)	1,482 (10.3)	6,697 (46.8)
19-40	1,004 (7.0)	963 (6.7)	895 (6.3)	2,862 (20.0)
41-60	1,051 (7.3)	814 (5.7)	639 (4.5)	2,504 (17.5)
61-80	797 (5.6)	617 (4.3)	540 (3.8)	1,954 (13.6)
81-100	121 (0.8)	125 (0.9)	56 (0.4)	302 (2.1)
Economic Status				
Best	929 (7.0)	867 (6.5)	676 (5.1)	2,472 (18.6)
Good	959 (7.2)	913 (6.9)	727 (5.5)	2,599 (19.5)
Normal	977 (7.3)	872 (6.6)	646 (4.9)	2,495 (18.7)
Bad	1,062 (8.0)	926 (7.0)	659 (5.0)	2,647 (19.9)
Worst	1,297 (9.7)	1,095 (8.2)	707 (5.3)	3,099 (23.3)

model. Akaike information criterion was applied to compare the models and to determine which one was the best fit for data, and the Nagelkerke R^2 was reported for the final model. A 95% CI and P value $< .05$ were considered to be statistically significant.

Table 2. Bonferroni post hoc tests to compare the frequency of dental visits between prepandemic (2018 and 2019) and pandemic (2020) periods.

VARIABLE	YEAR I	YEAR J	MEAN DIFFERENCE (I-J)	STANDARD ERROR	95% CI
Pandemic Period (Whole Data)	2020	2019	−7.85	1.62	−11.74 to −3.95
		2018	−12.44	1.62	−16.35 to −8.53
	2019	2018	−4.59	1.45	−8.08 to −1.11
Pandemic Period, Excluding Lockdown	2020	2019	−1.74	1.83	−6.14 to 2.66
		2018	−5.80	1.84	−8.08 to −1.11
	2019	2018	−4.05	1.58	−7.87 to −0.24
Lockdown	2020	2019	−23.66	2.96	−30.85 to −16.48
		2018	−30.09	2.96	−37.28 to −22.91
	2019	2018	−6.42	2.88	−13.41 to 0.56

RESULTS

From the 14,319 dental visits, female patients and male patients constituted 47.1% and 52.9%, respectively. Mean (SD) age was 29.30 (24.31) years for female patients and 29.30 (24.91) years for male patients.

Frequency of dental visits

Overall, records of 14,319 dental visits were evaluated and 5,671, 5,036, and 3,612 occurred in 2018, 2019, and 2020, respectively. The distribution of frequency of dental visits in each month is depicted in Figure 1. In addition, Table 1 presents the frequency of dental visits before and during the pandemic based on the following factors: admission type, age, sex, residential zone, economic status, service provider, and oral diagnosis. The noteworthy finding was that even though the frequency of dental visits decreased during the pandemic for all the variables, the number of patients reporting infections and lesions, salivary problems, and temporomandibular disorders increased during the pandemic. The trends of dental visits based on the included factors are depicted in Figure 2.

Dental visits took place in 223, 227, and 149 days in 2018, 2019, and 2020. Mean (SD) frequency of dental visits in each day was 36.69 (15.64), 32.09 (15.51), and 24.24 (14.78), respectively. There were significant differences among the 3 periods ($P < .001$), and the pairwise comparisons were significant for all years (Table 2).

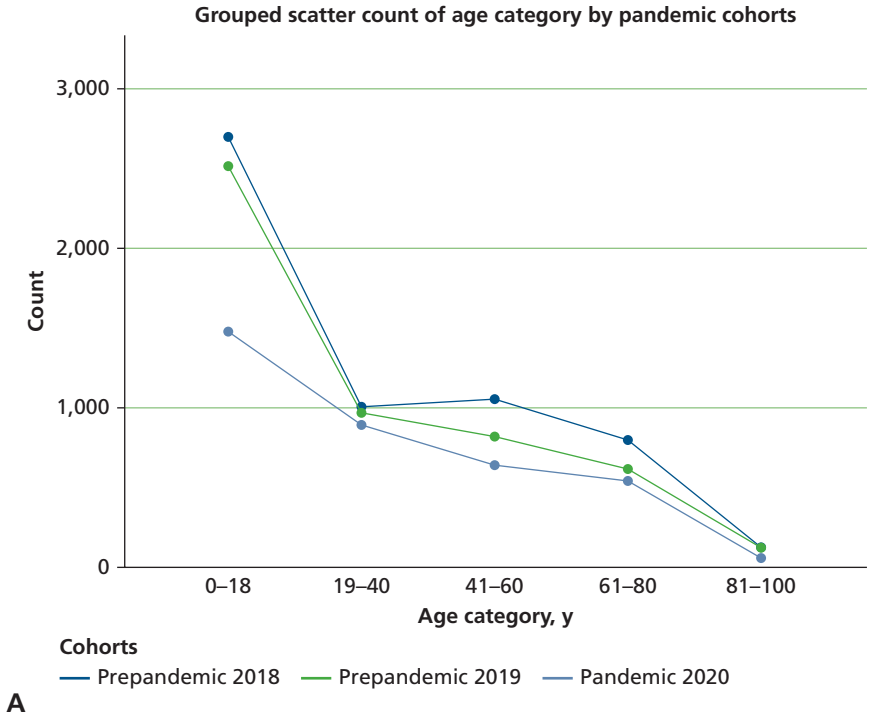
When the lockdown period was excluded, the dental visits took place in 174, 178, and 105 days in 2018, 2019, and 2020; the mean (SD) frequency of dental visits in each day was 35.15 (15.25), 31.09 (15.24), and 29.35 (13.67), respectively. There were significant differences among the 3 periods and the post hoc test revealed that pairwise comparison was significant between 2019 and 2018 (95% CI, −7.87 to −0.24) and between 2020 and 2018 (95% CI, −8.08 to −1.11), but not between 2020 and 2019 (95% CI, −6.14 to 2.66) (Table 2).

Considering the lockdown period, the dental visits took place in 49, 49, and 44 days in 2018, 2019, and 2020, respectively; the mean (SD) frequency of dental visits in each day was 42.14 (15.98), 35.71 (16.10), and 12.04 (9.18), respectively. There were significant differences among the 3 periods ($P < .001$) and post hoc test revealed that pairwise comparison was significant between 2020 and 2018 (95% CI, −37.28 to −22.91) and 2020 and 2019 (95% CI, −30.85 to −16.48), but not between 2019 and 2018 (95% CI, −13.41 to 0.56) (Table 2).

Predictors of dental visit

All predictors were entered into the multiple logistic regression models, except for admission type because less than 1% were emergency patients and 99.7% were outpatients.

The results of multiple logistic regression regarding prepandemic and pandemic periods are presented in Table 3. Age and sex were not associated with dental visits during the pandemic. On the contrary, the risk associated with dental visits in Calgary (95% CI, 0.42 to 0.53; odds ratio [OR], 0.48) and south regions (95% CI, 0.39 to 0.59; OR, 0.47) decreased compared with the capital city of Edmonton. In addition, the frequency of dental visits for patients with best (95% CI, 1.04 to



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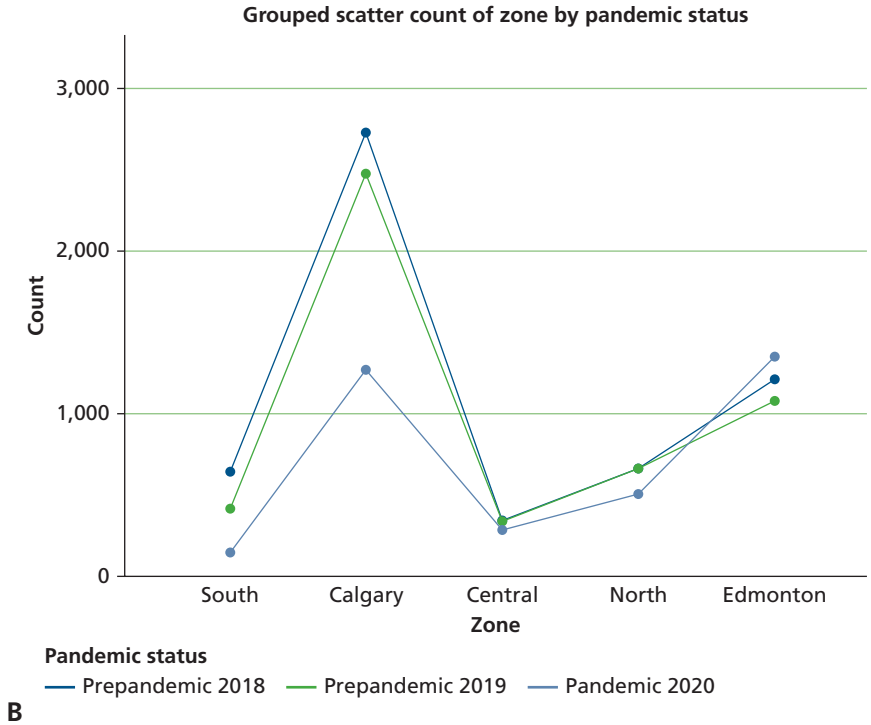
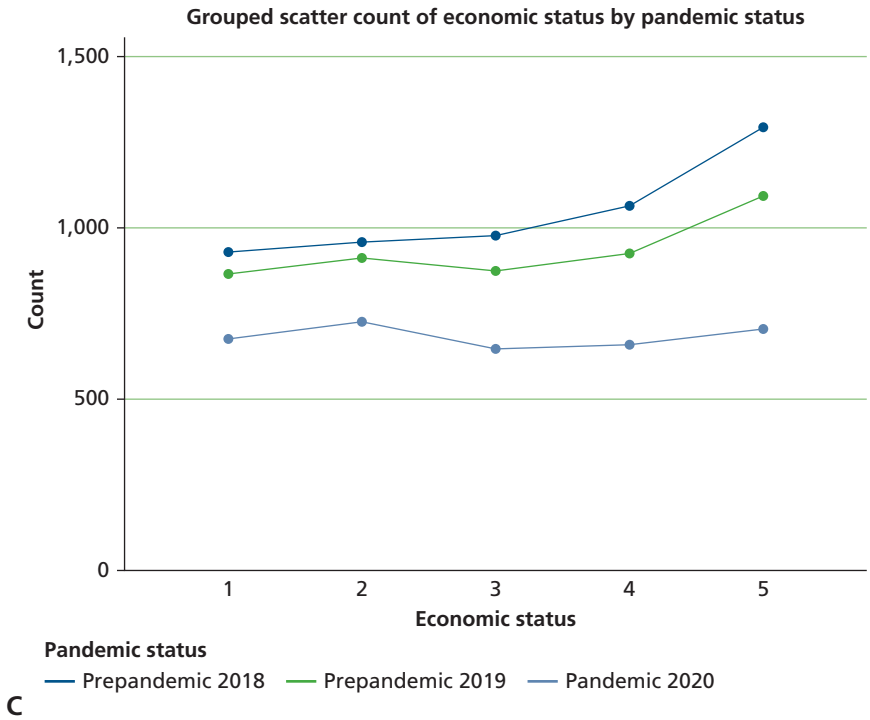


B

Figure 2. Trend of dental visits before and during pandemic considering the study factors. **A.** Frequency of dental visits before and during the pandemic for different age categories. **B.** Frequency of dental visits before and during pandemic for different residential zones. **C.** Frequency of dental visits before and during pandemic for different economic statuses (1 = best, 5 = worst). **D.** Frequency of dental visits before and during pandemic for different service providers. **E.** Frequency of dental visits before and during pandemic for different oral diagnoses.

1.36; OR, 1.19) and good (95% CI, 1.10 to 1.42; OR, 1.25) economic status decreased less than patients with the worst economic status.

Although the frequency of visits to pediatric dentists (95% CI, 2.47 to 3.65; OR, 3.00) and oral surgeons (95% CI, 2.72 to 3.37; OR, 3.03) was 3 times higher during the pandemic, the frequency of visits to dental hygienists decreased significantly (95% CI, 0.05 to 0.28; OR, 0.12).



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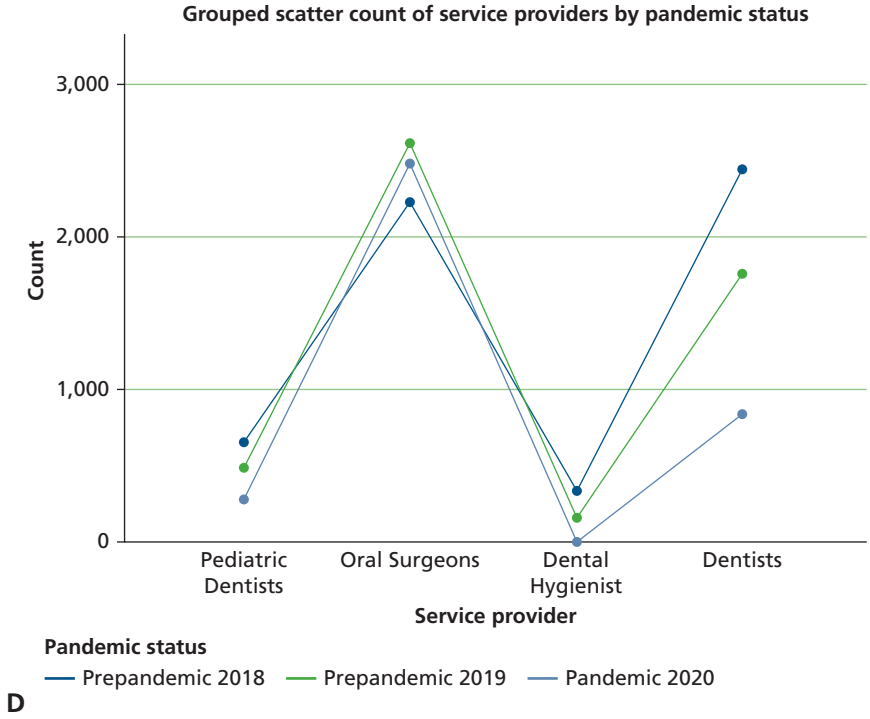


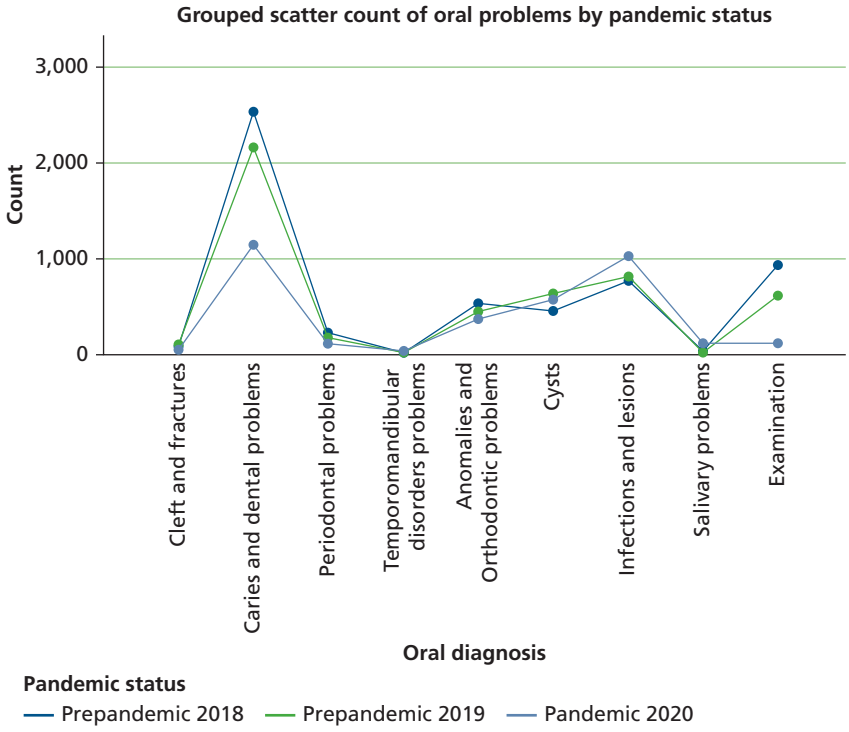
D

Figure 2. Continued.

Oral diagnosis had the strongest association with the pandemic period, and all of the diagnoses were increased compared with dental examinations. The detailed analysis and related ORs and 95% CIs are shown in Table 3.

DISCUSSION

To the best of our knowledge, we are the first researchers to comprehensively evaluate the frequency of dental visits before and during the COVID-19 pandemic and during and after the lockdown period. Our results indicated that the number of days and frequency of dental visits decreased during



E

Figure 2. Continued.

the pandemic. These findings are important because only visits to community- and hospital-based dental clinics, which were open and providing dental services to patients during the pandemic, were included in our study.

Several factors could have contributed to the lower frequency of dental visits during the pandemic. First, at the beginning of the pandemic, the information on COVID-19 was scarce, and the fear of exposure in dental settings and consequent morbidities discouraged many people from routine visits and examinations. The American Dental Association recommended on April 1, 2020, that "dentists keep their offices closed to all but urgent and emergency procedures until April 30 at the earliest."[15] In addition, the public and professional guidelines for the work environment had not been developed fully. For example, it was only on April 27, 2020 that the American Dental Association's Task Force on Dental Practice Recovery developed the Return to Work Interim Guidance Toolkit to help dentists protect themselves, their staff members, and their patients while practicing dentistry.[15] In addition, the Centers for Disease Control and Prevention's interim infection prevention and control guidance for dental settings during COVID-19 was first published on May 19, 2020.[15]

There were also some other limitations for patients visiting dental offices, even when they were open and functional. Access to dental clinics has become challenging for certain people and groups who commute mainly via public transportation. Due to safety concerns, the primary reason for travel changed, and there was also a shift from public to private and community transport.[16] In lieu of in-person visits, teledentistry and new triage protocols were developed. On the basis of the Centers for Disease Control and Prevention's guidelines, all patients needed to be screened for symptoms of COVID-19; if symptoms existed, nonemergent oral health care should be delayed and relevant instructions provided.[17] In addition, it was recommended that, whenever possible, aerosol-generating procedures be reduced, including but not limited to the use of high-speed dental handpieces, air and water syringes, and ultrasonic scalers. In case of necessity, the 4-handed dentistry technique should be adapted, using high-evacuation suction as well as dental rubber dams to reduce the generated aerosols.[17,18]

Our results indicated that not only did the frequency of dental visits decrease, but the pattern of visits changed. More patients visited oral surgeons and pediatric dentists than general dentists, but

Table 3. Multiple logistic regression for determining the factors important in predicting the pandemic period.*

FACTORS	*P* VALUE	ODDS RATIO	95% CI
Age Category, Y			
81-100 [Reference]	NA†	NA	NA
0-18	.11	1.34	0.93 to 1.92
19-40	.32	1.19	0.83 to 1.72
41-60	.06	1.40	0.97 to 2.03
61-80	.17	1.06	0.97 to 1.15
Sex			
Male [Reference]	NA	NA	NA
Female	.17	1.06	0.97 to 1.15
Residential Zone			
Calgary	< .01	0.47	0.42 to 0.53
Central	.08	0.86	0.72 to 1.01
Edmonton [Reference]	NA	NA	NA
North	.13	1.11	0.96 to 1.27
South	< .01	0.48	0.39 to 0.59
Economic Status			
Worst [Reference]	NA	NA	NA
Best	.01	1.192	1.04 to 1.36
Good	< .01	1.253	1.10 to 1.42
Normal	.16	1.099	0.96 to 1.25
Bad	.84	1.013	0.88 to 1.15
Service Providers			
Dental hygienist	< .01	0.12	0.05 to 0.28
Dentist [Reference]	NA	NA	NA
Oral surgeon	< .01	3.03	2.72 to 3.37
Pediatric dentist	< .01	3.00	2.47 to 3.65
Oral Diagnosis			
Caries and dental problems	< .01	3.04	2.45 to 3.79
Cleft and fractures	< .01	2.13	1.43 to 3.17
Cysts	< .01	5.08	4.06 to 6.35
Examination [Reference]	NA	NA	NA
Infections and lesions	< .01	5.94	4.78 to 7.38
Orthodontic problems	< .01	3.56	2.82 to 4.50
Periodontal problems	< .01	3.31	2.45 to 4.48
Salivary problems	< .01	13.74	9.45 to 19.99
Temporomandibular disorders	< .01	9.58	5.86 to 15.66

* Nagelkerke $R^2 = 0.178$. † NA: Not applicable.

fewer sought care from dental hygienists, which is in line with guidelines and policies persuading patients to schedule urgent treatments. In addition, during the pandemic period, all types of oral health problems increased compared with oral examinations. The frequency of visits for infections and lesions increased during the pandemic (n = 1,030) compared with 2018 (n = 778) and 2019 (n = 814), despite the decrease in overall visits. It seems that although recommendations, such as teledentistry, have been effective in restoring the compromised dental system and bridging the gap

between oral health care providers and patients,[19-21] additional modifications are needed to safely and efficiently provide oral health care to patients in a timely manner.

Another important finding of our study was that people with better economic status visited dental clinics more frequently than socially disadvantaged groups during the pandemic. Overall, visits to dental clinics in Edmonton, the capital city, were higher than in other residential zones. Therefore, there should be a particular focus on access to care for disadvantaged groups and remote communities, and efforts should be made to eliminate barriers to receiving timely oral health care and providing education on visiting dental clinics during the pandemic.

Our study had limitations. Although administrative data are collected for nonresearch purposes, they can provide large, demographically diverse cohorts at a fraction of the time and cost. However, there is some skepticism about the validity of administrative databases, including the accuracy of billing codes used to categorize diagnoses and procedures. Administrative data can also be unwieldy to work with, as data are often stored raw and not in analysis-ready format, which requires data cleaning and management. Therefore, administrative data should be used in research with caution and an understanding of their limitations.[22] In our study, we only had access to hospital- and community-based outpatient clinics. Data on private clinics, which were closed during the lockdown, were not available. Future studies need to evaluate whether the patterns for community and outpatient clinics also apply to private clinics.

CONCLUSIONS

During the pandemic, the frequency of dental visits decreased, specifically during the lockdown. Patients with complicated problems requiring urgent treatments visited mainly dental clinics. Reduced access to care was observed among socially disadvantaged groups. Although guidelines and related recommendations were effective in managing dental visits during the pandemic, additional modifications are needed to promote in-person visits to improve the oral health status of patients. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: https://doi.org/10.1016/j.adaj.2021.09.007.

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APPENDIX

***International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada*[13] codes used to retrieve data**

A690, A691, B002, B009, B370, B379, J329, K000, K001, K002, K003, K004, K005, K006, K007, K008, K009, K010, K011, K020, K021, K022, K023, K024, K025, K028, K029, K030, K031, K032 K033, K034, K035, K036, K037, K038, K039, K040, K041, K042, K043, K044, K045, K046, K047, K048, K049, K050, K051, K052, K053, K054, K055, K056, K060, K061, K062, K068, K069, K0700, K0701, K0702, K0703, K0704, K0705, K0708, K0709, K0711, K0712, K0713, K0714, K0718, K0718 K0719, K072, K073, K074, K075, K0760, K0761, K0762, K0763, K0764, K0768, K0769, K078, K079, K080, K081, K082, K083, K0880, K0881, K0882, K0883, K0887, K0888, K089, K090, K091, K092, K098, K099, K100, K101, K102, K103, K108, K109, K110, K111, K112, K113, K114, K115, K116, K117, K118, K119, K120, K121, K122, K123, K130, K131, K132, K133, K134, K135, K136, K137, K140, K141, K142, K143, K144, K145, K146, K148, K149, K20, L039, Q36, Q37, S0151, S025, S032, T180, T652, Z012.