

The use of panoramic radiographs to address the oral health needs of vulnerable Canadian populations

Fabiana T Almeida*, DDS, MSc, PhD; Silvia Gianoni-Capenakas*, DDS, MSc; Heidi Rabie[§], DMD; Rafael Figueiredo*^{§,¶}, DDS, MSc, FRCDC; Camila Pacheco-Pereira*[¶], DDS, MSc, PhD, OMF, FRCDC

ABSTRACT

Background: The high demand for oral health care services among vulnerable individuals combined with limited available resources requires a rethinking of the provision of oral health services. This study aimed to determine the usefulness of the dental panoramic radiograph (DPR) as an imaging tool to assess oral health and prioritize dental interventions in vulnerable patients. **Methods:** This observational and retrospective study evaluated charts of patients who attended Public Health Dental Clinics (PHDC), Alberta Health Services (AHS), in Calgary, Canada, between January 2018 and December 2019. Data collected included sex and age at the time of image acquisition. The following radiographic findings were gathered: the number of missing, present, decayed, restored, and impacted teeth; periapical lesions; retained root; periodontal bone loss; odontogenic and non-odontogenic lesions in the jaws; carotid calcification; and incidental radiographic findings with clinical relevance. **Results:** Of the 526 DPRs evaluated, 57.4% were from male patients and 42.6% were from female patients, with a mean age of 38.5 years. The average number of present teeth in females and males was 23.7 and 22.6, respectively. The most prevalent dental-related finding was periodontal bone loss (81.5%), followed by periapical lesions (59.6%) and impacted teeth (27%). Among non-dental findings, osseous lesions of the jaws were found in 10.4% of the patients, and carotid atheroma had a frequency of 3.2%. **Conclusion:** The DPR is a useful adjunct to the clinical exam in this specific population. It provides an opportunistic overview of their oral health and necessary support to establish priorities in oral health care in a public health setting.

RÉSUMÉ

Contexte : La forte demande de services de santé buccodentaire chez les personnes vulnérables, combinée aux ressources limitées disponibles, nécessite de repenser la prestation des services de santé buccodentaire. Cette étude vise à déterminer l'utilité de la radiographie panoramique comme outil d'imagerie pour évaluer la santé buccodentaire et prioriser les interventions dentaires chez les patients vulnérables. **Méthodes :** Cette étude observationnelle et rétrospective a évalué les dossiers des patients qui ont fréquenté les cliniques dentaires de santé publique d'Alberta Health Services (AHS) à Calgary, au Canada, entre janvier 2018 et décembre 2019. Les données recueillies comprenaient le sexe et l'âge au moment de l'acquisition de l'image. Les résultats radiographiques suivants ont été recueillis : nombre de dents manquantes, présentes, cariées, réparées et incluses; lésions périapicales; racine résiduelle; perte osseuse parodontale; lésions odontogéniques et non odontogéniques dans les mâchoires; calcification carotidienne; et résultats radiographiques accessoires pertinents sur le plan clinique. **Résultats :** Parmi les 526 radiographies panoramiques évaluées, 57,4 % provenaient d'hommes et 42,6 % de femmes, avec un âge moyen de 38,5 ans. Le nombre moyen de dents présentes chez les femmes et les hommes était de 23,7 et 22,6, respectivement. La découverte la plus courante liée aux soins dentaires était la perte osseuse parodontale (81,5 %), suivie des lésions périapicales (59,6 %) et des dents incluses (27 %). En ce qui concerne les résultats non liés aux soins dentaires, des lésions osseuses des mâchoires ont été repérées chez 10,4 % des patients, et l'athérome carotidien avait une fréquence de 3,2 %. **Conclusion :** La radiographie panoramique est un complément utile à l'examen clinique dans cette population particulière. Elle donne un aperçu de leur santé buccodentaire et le soutien nécessaire pour établir les priorités en matière de soins buccodentaires dans un contexte de santé publique.

Keywords: dental care; health services; oral health; public health; radiography, panoramic
CDHA Research Agenda categories: risk assessment and management; access to care and unmet needs

PRACTICAL IMPLICATIONS OF THIS RESEARCH

- The dental panoramic radiograph is an appropriate and valuable diagnostic tool among vulnerable populations. It helps to identify not only the chief oral health complaint but also other concerns that may be related to systemic health issues.
- Using dental panoramic radiographs as an adjunct to clinical examination in dental public health settings offers essential support for establishing priorities, especially for transient populations during their initial, and sometimes only, professional oral health care appointments.

*School of Dentistry, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, AB, Canada

[§]Provincial Oral Health Office, Provincial Population and Public Health, Alberta Health Services, Edmonton, AB, Canada

[¶]Drs Pacheco-Pereira and Figueiredo contributed equally as senior authors of this paper

Correspondence: Dr Fabiana T Almeida; fabiana@ualberta.ca

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INTRODUCTION

In Canada, professional oral health care can often be limited to those who can afford it, either out of pocket or through dental insurance plans funded as an employment benefit. The public health care system has limited programs and resources to address the oral health needs of eligible groups of the population, and it is not effectively meeting the demand of vulnerable groups.¹

Studies have shown that vulnerable populations who face challenges in accessing oral health care have significant oral health needs compared to those who have routine access to care. These include a high prevalence of missing and decayed teeth, periodontal disease, oral pain, infections, and other dental-related conditions in need of urgent care.²⁻⁴ The greater burden of oral conditions and diseases experienced by vulnerable individuals can be explained by different factors and circumstances, apart from the financial barrier to care, including the presence of systemic health conditions; drug misuse; personal issues; and socioeconomic challenges.¹⁻⁶ These barriers and challenges arising from life circumstances often make it difficult to commit to good oral health and to attend regular dental or dental hygiene appointments.

In Alberta, Canada, there are some indications that individuals with challenges in accessing oral health care tend to rely on hospital emergency departments (EDs) as a source of treatment for dental pain and odontogenic infections. However, EDs are not usually equipped or suitably prepared for dental interventions. Indeed, the level of oral health care in EDs rarely involves much more than symptomatic advice or prescriptions for antibiotics and analgesics. It is certainly possible that the higher rates of ED visits for non-traumatic oral health problems reflect the delay in receiving treatment for oral diseases earlier in their course.⁵⁻⁷ Given the risk factors for vulnerable people with limited access to oral health care, it is expected that their oral health is worse than the general population and that they will present with various oral health problems at their initial dental or dental hygiene visit.⁵

The Alberta Health Services (AHS) Public Health Dental Clinics (PHDC) provide outpatient oral health care for select vulnerable individuals, typically low-income individuals who do not qualify for dental insurance or government benefits. Since 2014, a referral system directing patients from hospital EDs and the Outpatient Parenteral Antibiotic Therapy (OPAT) program to PHDC has been in place in Alberta.⁶ In 2020, before the disruption of the delivery of oral health care services due to the COVID-19 pandemic, patients referred by EDs and OPAT represented 15% of the annual total number of patients seen at PHDC.

The high demand for oral health care services among vulnerable individuals combined with low dental appointment attendance rates and limited available resources requires a rethinking of the provision of oral health care services provided by PHDC at the initial

patient encounter. Opportunistically, PHDC use the dental panoramic radiograph (DPR) as an adjunct diagnostic tool to complement the clinical examination, intending to identify and maximize the dental procedures provided at the first appointment. At PHDC, the DPR allows the dentists, at the same appointment, to assess the maxillomandibular complex and prioritize treatments for the most urgent issues. This study aimed to determine the usefulness of the DPR examination in assessing and prioritizing oral health interventions among patients with dental emergencies. Another aim was to identify the frequency of dental and non-dental related radiographic findings requiring immediate or further attention to mitigate health risks to the population investigated.

METHODS

This cross-sectional and retrospective study was approved by the Research Ethics Board at the University of Alberta (Pro00099058) and followed the *Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) reporting guidelines. The data collection process was reviewed and approved by AHS Data Disclosure Agreement, Health System Access.

The sample consisted of AHS-PHDC patients 18 years or older referred from EDs and OPAT to PHDC. The patient files included in this investigation are from patients who received oral health care services between January 2018 and December 2019, before the onset of the COVID-19 pandemic. Patients with dental problems not associated with trauma visiting EDs or OPAT in Calgary, Alberta, were referred through a coupon system, which allows patients to be treated at no charge in the PHDC outpatient setting. Due to the high oral health needs of the target population, a consultation protocol was adopted to effectively address the most urgent issues during the first encounter of these patients with a dentist. The protocol for PHDC establishes that ED-referred patients meeting the prescription criteria have a DPR taken following their clinical examination and medical chart review. Patient records without a DPR were not considered for this analysis. DPRs were acquired in two different Planmeca ProOne® (Planmeca Inc, Helsinki, Finland) machines using the same standardized acquisition parameters.

The information gathered for this analysis was retrieved from PHDC electronic medical records (Power Practice Software, Coquitlam, BC, Canada) and imaging software (2020 Patterson Dental Supply, USA). Data collected included the electronic medical record identification number for each patient; the date of the DPR acquisition; sex and age of patients at image acquisition; and information regarding the procedures performed. After file selection, patient records were anonymized; a new data file was coded and transferred to an Excel spreadsheet for qualitative analysis to maintain privacy and confidentiality.

Dental panoramic radiograph evaluation

The radiographic evaluation of relevant findings followed a standardized, itemized template to ensure a systematic analysis of the DPR. The digital images were electronically evaluated using a 17-inch computer screen displaying the imaging software. A general dentist (SGC), who received training to ensure a consistent interpretation, was responsible for data collection. Questionable image observations due to the superimposition of structures and ghost images inherent to panoramic radiographs were crosschecked by one of the oral maxillofacial radiologists involved in the study (FTA).

The anonymized DPRs were blinded and evaluated to complement the patient's clinical information. The radiographic findings were recorded according to the following criteria: the number of missing or present teeth; the total number of visible extensive/grossly decayed, restored, and impacted teeth; the presence of periapical pathology; retained roots; periodontal bone loss status; osseous lesions in the jaws (e.g., idiopathic osteosclerosis, cemento-osseous dysplasia); carotid calcifications; and other findings with clinical relevance (e.g., dentigerous cysts). An impacted tooth was considered as a tooth that failed to fully erupt into the oral cavity within its expected developmental period, covered by bone or gum. Periodontal bone loss was solely classified as vertical and/or horizontal bone loss.

Descriptive statistical analysis for reporting means and standard deviation for the total sample subdivided by sex was conducted. The Shapiro-Wilk test was used to test normality; non-parametric tests (Kruskal-Wallis and Dwass-Steel-Critchlow-Fligner) evaluated differences between sexes. All statistical analyses were performed using the software Jamovi 1.6.13 (www.jamovi.org) at a 0.05 significance level.

RESULTS

A total of 553 DPRs were retrieved based on the time-period criteria established for this project. Twenty-seven (27) images were then excluded from analysis due to radiographic acquisition errors and/or the presence of metallic artifacts (e.g., facial piercings, earrings, eyeglasses) that interfered with the image quality and interpretation of findings. Of the remaining 526 DPRs evaluated, 302 images were from males (57.4%) and 224 from females (42.6%) patients. The patients' ages ranged from 18 to 84 years, with a mean age of 38.5 years.

Table 1 shows the average number of present, decayed, and restored teeth. Periapical lesions are also displayed per patient and stratified by sex and age. Females had an average of 23.7 teeth present and males had an average of 22.6 teeth. There was a decrease in the average number of teeth present in patients over 60 years (19.6 teeth present) compared to patients under 60 years (23.5 teeth present).

Table 2 summarizes the total number and frequency (%) of DPR findings for dental and non-dental related

Table 1. Distribution of periapical lesions and the total average number of present, decayed, and restored teeth by sex and age

Patient population (N = 526)	Total
Total average number of teeth present	23.1
Male	22.6
Female	23.7
Patients over 60 years of age	19.6
Male	18.8
Female	20.5
Patients ages 18 to 59 years	23.5
Male	23.1
Female	24.1
Total average number of decayed teeth	6.8
Male	7.4
Female	6.0
Patients over 60 years of age	6.8
Male	8.7
Female	4.8
Patients ages 18 to 59 years	6.8
Male	7.2
Female	6.2
Total average number of restored teeth	4.1
Male	3.5
Female	4.9
Patients over 60 years of age	5.5
Male	3.5
Female	7.7
Patients ages 18 to 59 years	4.0
Male	3.5
Female	4.6
Total average number of periapical lesions	1.5
Male	1.6
Female	1.3
Patients over 60 years of age	1.9
Male	2.2
Female	1.6
Patients ages 18 to 59 years	1.4
Male	1.5
Female	1.2

issues. Radiographically, 798 periapical lesions defined as rarefying osteitis or apical periodontitis (an umbrella term for periapical cyst, granuloma or abscess) were identified from 314 patients, representing a prevalence of 59.6% among all DPRs analysed and an average of 2.5 lesions per patient. Retained root, defined as dental root with no crown attached (with or without apical periodontitis), was present in 127 images, totaling 468 residual roots, representing a

Table 2. Frequency of dental and non-dental panoramic radiographic findings

DPR findings (N = 526)	Total number of radiographs	% of radiographs
Periapical lesions/Rarefying osteitis ^a	314	59.6
Retained root	127	24.1
Periodontal bone loss	429	81.5
Impacted teeth	142	27.0
Osseous lesions of the jaws	55	10.4
Carotid atheroma	17	3.2

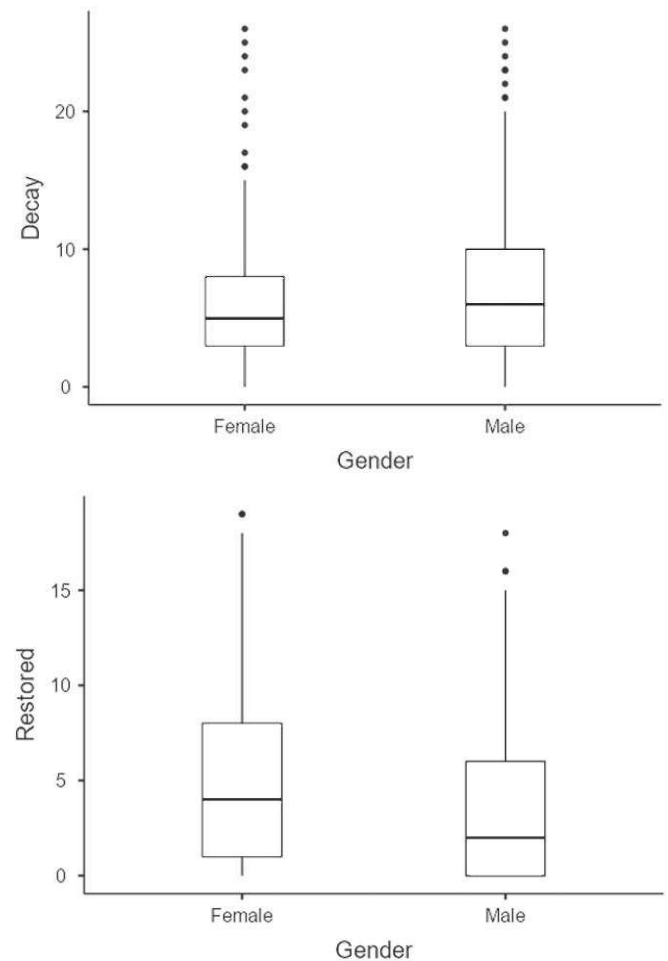
^aRarefying osteitis is an umbrella term for periapical cyst, granuloma or abscess

prevalence of 24.1% and an average of 3.7 retained roots per patient. Periodontal bone loss was identified in 429 DPRs—81.5% of the sample analysed. From this finding, 99.3% of the patients presented some degree of generalized horizontal bone loss; localized vertical bone loss was seen in 7.6% ($n = 33$) of the patients. A total of 278 impacted teeth were observed in 142 patients (27%), in which 137 patients (26%) presented with 1 or more impacted third molars. Five (5) patients (1%) presented with impacted upper canines. Dentigerous cysts associated with impacted teeth were an important incidental finding observed in 10.5% ($n = 15$) of the patients with impacted teeth.

From the non-dental related findings, 99 osseous jaw lesions were observed in 55 patients, representing a frequency of 10.4%. The most common osseous alteration found was idiopathic osteosclerosis, commonly known as “dense bone island,” in the mandible. Sclerosis osteitis associated with inflammatory reaction to pulpal necrosis was the most common periapical alteration found. Focal cemento-osseous dysplasia was found in 4 patients (0.7%). Regarding vascular calcifications requiring referral, carotid atheroma was observed in 17 patients (3.2%).

Pairwise comparisons evaluated differences between sexes. These tests showed no statistically significant differences between males and females in terms of teeth present ($p = 0.393$). Findings among males were statistically significantly higher for decayed ($p = 0.003$) and restored ($p < 0.001$) teeth when compared to the findings among females (Figure 1).

From the information gathered and recorded in the patients’ electronic medical records, 1704 surgical and restorative dental procedures were performed. Of all patients seen during the study period, most ($n = 339$, 64.3%) had only 1 dental appointment; 23.5% attended a second visit ($n = 124$); 8% attended a third visit ($n = 42$); and 4.2% returned for 4 or more appointments ($n = 21$). An average of 3.2 surgical and restorative dental procedures was provided per patient. Figure 2 shows the occurrence of the most common dental procedures provided based on

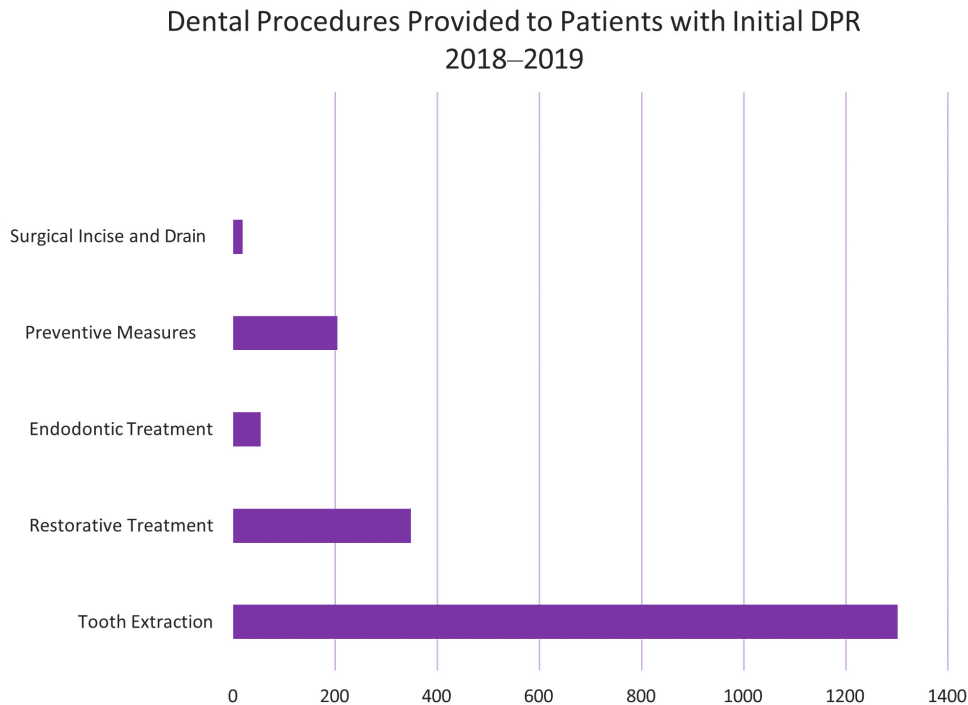
Figure 1. Distribution of decayed (A) and restored (B) teeth in females and males

priorities identified on each patient’s clinical examination and DPR. The most common dental procedure was tooth extraction (1,302 teeth), representing an average of 2.5 teeth per patient. Restorative dental treatment consisted of 348 fillings, and there were 54 endodontic treatments. Of the presenting cases, there were 18 patients (3.4%) requiring soft tissue incision and drainage due to the severity of their dental infection. Additionally, 728 bitewing and 1414 periapical radiographs were taken to assist in a final diagnosis and appropriate treatment planning for the patients willing to receive further restorative treatment.

DISCUSSION

This study evaluated the usefulness of the DPR in public health dental clinics that provide treatment to low-income and vulnerable populations in Alberta, Canada. All the DPRs included in this study were from patients with urgent oral health problems referred from hospital EDs and OPAT. In Canada, the universal health care system does not include the provision of dental care except for limited services to those meeting specific criteria under designated programs.

Figure 2. Dental procedures based on priorities identified on clinical examination and after DPR



The barriers to professional oral health care coupled with the availability of EDs encourage people to use hospitals for treatment of oral health problems. However, EDs are designed to provide care only for health problems that require urgent medical attention and not for continuous, long-term health concerns. This phenomenon of inappropriate utilization of EDs by populations with lower socioeconomic status occurs across the country despite differences in provincial dental public health programs.

Alberta ED visits for oral health concerns not associated with trauma represent 1.2% of all ED visits, an average of approximately 27,000 dental-related visits per year.⁵ In Alberta, among these ED visits, the most prevalent primary diagnosis is ICD-10-CA code K04 “diseases of the pulp and periapical tissues” (such as an episode of acute periapical abscess or irreversible pulpitis).⁵ The dental referral coupon system, put in place as a collaborative effort between PHDC and EDs, has the objective to mitigate ED visits for oral health problems and provide a definitive resolution of those issues in non-acute health care settings. ED settings without appropriate infrastructure (such as a dental office) and dentists are limited to providing only palliative oral health care, mainly analgesia prescriptions and oral/parenteral antibiotics.⁶

Additionally, for a variety of reasons, a behavioural pattern among vulnerable populations of accessing oral health care only in emergencies has been observed.⁷ This pattern often leads individuals to seek treatment for the most urgent dental issues at a given time. The use of DPR

as an adjunct to the clinical examination in dental public health settings has helped clinicians to opportunistically establish priorities for appropriate oral health care and necessary referrals during the first appointment.

The findings of this study confirm that, in a low-income population with many other competing priorities, oral health care is not a high priority.^{8,9} Indeed, 64.3% of the patients investigated in this study attended only the first appointment despite other oral health issues identified. Specifically, a strong trend towards urgent surgical procedures such as extractions, followed by some pursuit of restorative procedures, such as fillings and root canals needed, was observed. In contrast, very mild compliance with recommendations for complete exams and scaling appointments, despite the demonstrated high burden of periodontal disease, was noted. The non-compliant behaviour of the patients served by PHDC illustrates the usefulness of DPR as an adjunctive tool to aid in the identification of oral health problems other than the chief complaint, such as periodontal disease, which is considered a widespread public health concern in Canada and globally by the World Health Organization. Periodontitis can lead to tooth loss, other serious systemic health complications, and possible non-symptomatic dental emergencies that must be addressed at what is often their only appointment.

Recently, a large Canadian study (N = 6,252) conducted by MacDonald and Yu¹⁰ assessed the prevalence of findings from primary DPRs taken of completely symptom-free patients presenting for the first time at general dental

practices in Alberta for a check-up or for dental hygiene services alone. The study reported that 32.1% of patients required further assessment or treatment.¹⁰ Results from this current retrospective study are consistent with the findings of the MacDonald and Yu study in that the DPRs provided essential information beyond the diagnosis of the chief complaint by detecting additional dental issues. For example, periapical lesions that are usually related to dental pain were present in 59.6% of the patients, with an average of 2.5 lesions per patient. In addition, approximately 90% of the patients presented with periodontal disease—a global problem linked to inequalities in social circumstances. Although patients came with one chief complaint, 3.2 dental procedures were completed for each patient at a single appointment, all identified by a thorough clinical examination followed by the DPR. The most common dental procedures performed were tooth extractions, endodontic treatment, and restorative dentistry. The ability to create awareness of overall oral health and provide additional treatment rather than addressing only the patient's chief complaint represents an important opportunity for the population served in dental public health settings. Equally important is the impact on the health system resulting from visits to already busy EDs for oral health concerns. It was observed that 20% to 26% of vulnerable individuals who seek relief from oral health problems in EDs do so repeatedly, generating costs to provincial health systems.^{5,11}

Importantly, the DPR evaluation identified incidental findings such as osseous lesions (10.4%) that could not be identified at the clinical examination. Dentigerous cysts were found in 10.5% of the patients with impacted teeth. While dentigerous cysts are generally asymptomatic, they may expand and have the potential to displace or resorb adjacent teeth; they could also develop into odontogenic keratocysts or malignant transformations.¹² Therefore, patient awareness, follow-up appointments, and referrals are recommended and should be the standard of practice. The most common osseous alterations found—idiopathic osteosclerosis, also known as dense bone island—and focal cemento-osseous dysplasia are asymptomatic and rarely require follow-up.¹³⁻¹⁵ However, fibrous-osseous entities and sclerosing osteitis should be ideally further investigated through a periapical radiograph instead of an extraoral imaging modality such as DPR.

It is important to emphasize that, while DPRs can identify additional oral health concerns, the ability to access specialized dental services may be limited among low-income earners. Cost is a significant driver for public access to oral health care and, according to the latest Canadian Health Measures Survey (CHMS), 32% of the population reported not having any dental insurance and having to pay out of pocket for oral health care services.¹ This figure is possibly much higher, taking into consideration not only the date of the latest CHMS but the impact of the COVID-19 pandemic on employment rates

and associated benefits. Despite DPRs being recommended by the American Dental Association¹⁶ and endorsed by the Canadian Dental Association, their availability is limited in some dental community clinics. Moreover, asymptomatic oral health issues are not accorded high importance by vulnerable populations with so many other competing priorities.

Other non-dental-related findings identified by DPRs may also require follow-up and/or referral. For instance, the identification of external carotid artery calcification is associated with an increased risk of cardiovascular diseases.¹⁷ The current study showed a prevalence of 3.2% for this finding. The significance of carotid atheroma observed incidentally on images depends on the patient's age, previous cardiovascular events, smoking history, and blood pressure status.^{18,19} A referral to the primary care physician for further cardiovascular risk assessment should be given for patients who present with this radiographic finding.

DPR utilization in public health settings should not replace intraoral radiographs. However, given the logistic, financial, and social challenges facing many walk-ins, transient, and mentally challenged patients who utilize the services of public health dental clinics, DPR is a rapid, cost-effective, easy extraoral acquisition, and requires minimal patient collaboration. As described previously, at PHDC, DPR is used to identify and plan to address the chief complaint, reveal the overall health status of the oral cavity, and detect potential issues posing risks to the well-being and quality of life of patients. Bitewing and periapical intraoral radiographs were further requested when indicated at the dentist's discretion. These additional radiographs were taken to reach a final diagnosis on specific cases and elaborate an appropriate treatment plan.

The DPR offers a broad and effective view of the maxillomandibular complex at one single low dose of ionizing radiation exposure.²⁰ Moreover, its role in primary dental care has been enhanced during the COVID-19 pandemic as an extraoral imaging modality with no potential for aerosol generation.²¹ Ten years of using DPR at PHDC has demonstrated that it is a very practical and essential clinical tool considering both time constraints and usefulness in prioritizing dental services provided to a specific population group. Future action on quality assurance improvement will be useful in technical areas such as image acquisition to improve image quality. In addition, training for the prompt identification of bone pathology and soft tissue calcifications in the head and neck by the oral health care team would be beneficial.

CONCLUSION

The panoramic radiograph has been demonstrated to be an appropriate and useful diagnostic tool in PHDC due to the high burden of oral disease among vulnerable populations and the limited opportunities to address their multiple oral health issues. The use of DPR as an adjunct to clinical

examination in a dental public health setting provides the necessary support to establish priorities in treatment planning. A viable referral pathway for dental and non-dental related issues requiring specialized services should be explored and prioritized.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

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