Compliance to recommended face-coverings during the COVID-19 pandemic among Canadian dentists and dental hygienists

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LIST OF ABBREVIATIONS

IPC	INFECTION PREVENTION AND CONTROL
OHCP	ORAL HEALTHCARE PRACTITIONER
SARS-COV	SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS
HCP	HEALTHCARE PROVIDER
AGP	AEROSOL GENERATING PROCEDURE
PPE	PERSONAL PROTECTIVE EQUIPMENT

Abstract

Background: During the COVID-19 pandemic, all Canadian dental and dental hygiene regulators recommended enhanced infection prevention and control (IPC). Among a range of enhanced IPC strategies, the focus was on the type and combination of face-coverings oral health care providers (OHCPs) should use under different circumstances. Further, the regulatory bodies frequently updated their IPC strategies through various pandemic stages. Although some studies have reviewed them, little is known about the evolution of the face-covering recommendation in the IPC strategy as the COVID-19 outbreak patterns varied. Furthermore, there is a lack of research on IPC implementation during COVID-19. A way to measure implementation would be to calculate the compliance of OHCPs.

Objectives: 1) To document and compare face-covering recommendations in IPC strategies provided by various provincial dental and dental hygiene regulatory bodies in Canada during different phases of the COVID-19 pandemic; 2) To estimate the rate of compliance with the recommended face-coverings, among dentists and dental hygienists (DHs) in Canada, after the resumption of non-essential oral health care provision.

Methods: We retrospectively reviewed the IPC strategies shared by dental (n =78) and dental hygiene (n= 57) regulatory bodies from 10 provinces and three territories of Canada from March 2020 to January 2022. This information was compared to the face-covering data from two prospective cohort studies on dentists (n=644) and DHs (n=876) practicing in Canada over the period from July 2020 to January 2022. We assigned a face-covering compliance score for the self-reported combination of mask and eye protection based on the provincial IPC strategy applicable to the participants' date of response. The proportion of participants who are compliant at different levels were estimated along with the corresponding 95% confidence intervals for each data collection points.

Results: The overall median number of IPC strategies shared by the regional regulatory bodies over the study period was nine, with a maximum of 21 from Nova Scotia and a minimum of one from Nunavut. During the initial phases of COVID-19, five out of 12 provinces recommended using both glasses/goggles and visors for aerosol-generating procedures (AGPs). In contrast, only three out of 10 provinces recommended it in the following urgent care phase. Similarly, the mask recommendation changed, with seven out of 12 provinces strictly specifying N95 respirator or superior, in contrast, 11 out of 13 provinces allowed alternative masks on resuming non-essential care. Throughout the study duration, the

proportions of fully compliant participants averaged 36.5% (CI of 23.6% to 51.7%), and 66.7% (CI of 57.7% to 74.7%) among dental hygienists. The compliance rate for dentists showed considerable variance over the study period ranging from 59.2% (CI, 53.2% to 65.0%) to 84.8% (CI, 80.1% to 88.6%). On the other hand, the compliance rate for DHs showed only minor variation across time.

Conclusion: Analysis of the provincial COVID-19-specific enhanced IPC guidelines for OHCPs revealed the difference in re-opening strategy and face-coverings recommended during the same time frame for dentists and DHs across Canada. There was a drop in compliance for both dentists and DHs in the winter of 2021, and a considerable difference in the pattern of compliance of the two professionals. The findings of this study are an important contribution in terms of overall comprehensive knowledge concerning the IPC guideline documents and their implementation among the OHCPs during the COVID-19 pandemic.

Résumé

Contexte : Durant la pandémie de la COVID-19, tous les organismes réglementaires canadiens des soins dentaires et de l'hygiène buccodentaire ont recommandé une meilleure prévention et un meilleur contrôle des infections (PCI). En ce qui concerne les stratégies de PCI, l'accent a été mis sur les types et la combinaison de masques que les prestataires de soins de santé buccale (PSB) devraient utiliser sous de différentes circonstances. En outre, les organismes réglementaires ont fréquemment mis à jour leurs stratégies PCI au cours des différentes phases de la pandémie.

Bien que certaines études aient examiné les stratégies de PCI, peu d'entre elles se sont penchées sur l'évolution de la recommandation de couvre-visages dans ces stratégies de PCI au long de la pandémie de COVID-19. En outre, il manque de recherches sur la mise en œuvre des stratégies de PCI au cours de la pandémie de la COVID-19. En tant que tel, le calcul de la conformité des PSB aux normes réglementaires est une méthode de mesure de la mise en œuvre.

Objectifs : 1) Documenter et comparer les recommandations de couverture du visage dans le cadre des stratégies de PCI fournies par divers organismes réglementaires provinciaux des soins dentaires et de l'hygiène dentaire au Canada au cours des différentes phases de la pandémie de la COVID-19 ; 2) Estimer le taux de conformité aux recommandations de couverture du visage parmi les dentistes et les hygiénistes dentaires au Canada à la suite de la reprise des prestations de soins buccodentaires non essentiels.

Méthodes : Nous avons examiné rétrospectivement les stratégies communes de prévention et de contrôle des infections entre les organismes réglementaires des soins dentaires (n =78) et de l'hygiène dentaire (n= 57) de 10 provinces et de trois territoires du Canada de mars 2020 à janvier 2022. Ces informations ont été comparées aux données portant sur la couverture du visage provenant de deux études de cohorte prospectives sur les dentistes (n = 644) et sur les hygiénistes dentaires (n = 876) exerçant au Canada au cours de la période de juillet 2020 à janvier 2022. Nous avons attribué un score de conformité à la couverture du visage en nous basant sur les réponses auto-rapportées des participant·e·s portant sur la combinaison du port du masque et de protection des yeux conformément à la stratégie de PCI applicable à la date de leurs réponses. La proportion de participant·e·s qui sont conformes à différents niveaux a été estimée ainsi que les intervalles de confiance (IC) à 95 % correspondants pour chaque point de collecte de données.

Résultats : Le nombre médian global de stratégies de PCI partagées par les organismes réglementaires régionaux au cours de la période d'étude était de neuf, avec un maximum de 21 en Nouvelle-Écosse et un minimum d'une au Nunavut. Au cours des phases initiales de la pandémie de la COVID-19, cinq provinces sur douze ont recommandé l'utilisation de lunettes et de visières pour les procédures générant des aérosols (PGA). En revanche, seules trois provinces sur dix en ont recommandé l'utilisation lors de la phase subséquente des soins urgents.

De même, la recommandation relative au masque a changé avec sept provinces sur douze ayant strictement indiqué le port d'un masque respiratoire N-95 ou supérieure, alors que onze provinces sur treize autorisaient le port des masques alternatifs lors de la reprise des soins non-essentiels. Pendant toute la durée de l'étude, les proportions de participant·e·s totalement conformes étaient en moyenne de 36,5 % (IC de 23,6 % à 51,7 %), et de 66,7 % (IC de 57,7 % à 74,7 %) chez les hygiénistes dentaires. Le taux de conformité chez les dentistes a connu une variation considérable au cours de la période d'étude, allant de 59,2 % (IC, 53,2 % à 65,0 %) à 84,8 % (IC, 80,1 % à 88,6 %). D'autre part, le taux de conformité des hygiénistes dentaires n'a montré que des variations minimales au fil du temps.

Conclusion : Une analyse des directives provinciales de soins intensifs améliorés spécifiques au COVID-19 pour les PSB a révélé des différences dans la stratégie de réouverture et les couvertures du visage recommandées pour les dentistes et les hygiénistes dentaires à travers le Canada pendant la même période. Une baisse de la conformité chez les dentistes et chez les hygiénistes dentaires a été constatée au courant de l'hiver 2021, ainsi qu'une différence considérable au sein du modèle de conformité chez les deux groupes de personnels professionnels. Les résultats de cette étude constituent une contribution importante en ce qui concerne les connaissances globales concernant les documents de directives de PCI et de leur mise en œuvre parmi les PSB durant la pandémie de la COVID-19.

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Manuscript I:

Personal protective equipment during COVID-19: A natural history of dental and dental hygiene regulatory guidance in Canada.

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Manuscript II:

Compliance with face-covering recommendations among Canadian dentists and hygienists, during COVID-19.

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1. INTRODUCTION

The Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is a highly contagious viral illness. The first case was reported in December 2019 in Wuhan city in China, and spread rapidly across the world to cause over 750,000 cases and approximately 36,000 deaths by March 2020(1). During the early phase of the pandemic in Wuhan, though the majority of the affected persons developed mild or moderate symptoms, one in five developed severe symptoms requiring ventilation support in intensive care units(2). Consequently, bold public health policies such as full society 'lock-down', confinement of infected individuals, and social distancing were put in action to minimize the morbidity and fatality numbers.

Characteristics of SARS-CoV-2 that contributed to the rapid increase in cases were (i) relatively long incubation period, (ii) a high proportion of asymptomatic cases, (iii) ability to survive on surfaces for up to three days, and (iv) transmission by direct or indirect contact with contaminated respiratory droplets and aerosols(3),(4). Reports from several countries communicated the overwhelming burden on their healthcare system, due to less capacity and most importantly high proportion of infected healthcare providers (HCPs)(5). Oral healthcare providers (OHCPs), a sub-group of HCPs were considered as the occupational group that is at the highest risk of SARS-CoV-2 cross-infection(6). The literature consistently supported this statement, with a plethora of studies highlighting aerosol generation during routine oral healthcare procedures, and the closeness of OHCPs to the patients(7),(8).

To date countries from across the world have implemented fairly similar policies and infection prevention and control (IPC) guidelines to reduce the risk of SARS-CoV-2 transmission in an oral healthcare setting(9). However, the policies and guidelines differed on two dimensions: (i) timing of implementation, and (ii) magnitude of implementation. Furthermore, the foundational scientific evidence behind these policies was fast-changing and often of poor quality, particularly during the early phases of the COVID-19 pandemic(10). Therefore, IPC policies and guidelines across the world were frequently updated and revised to stay relevant. In Canada, 13 different jurisdictions (10 provinces and 3 territories) were publishing policies and IPC guidelines because the healthcare system is under provincial and territorial jurisdiction. A review of 13 IPC guidelines from the initial phase of the pandemic has been published(11), however little is known about the difference in timing of implementation of oral

healthcare policies, and the updated and revised versions of the IPC guideline documents across Canadian provinces and territories.

Implementation of policies and IPC guidelines was one of the important factors in managing the transmission of SARS-CoV-2 in healthcare settings. A method to evaluate implementation success is to conduct a study evaluating compliance with those policies and guidelines. During the COVID-19 pandemic, face-covering measures such as respirators, routine surgical masks, goggles, and face-shields were considered effective protective physical barriers against contaminated respiratory droplets from landing on exposed nasal, ocular, and oral mucosa(12). The IPC guideline documents for OHCPs focused on recommending the appropriate combination of face-covering measures for aerosol-generating procedures (AGPs). However, as previously stated, the IPC documents were frequently updated including the face-covering recommendations. Hence, a study evaluating the compliance of OHCPs to the face-covering combinations would provide essential information about the implementation of fast-changing policies and guidelines during a pandemic situation.

While our group has previously reported a lower incidence of COVID-19 infection in dentists(13) and dental hygienists (14) practicing in the community in Canada, as compared to the general population, little is understood about the reasons behind these low incidence rates. Furthermore, little is known about the changes in IPC guidelines published by dental and dental hygienist regulatory authorities during the pandemic and how those professionals complied with elements of those guidelines. Therefore, our study aimed to review the primary, updated, and revised IPC guideline documents published by dental and dental hygienist regulatory authorities in Canada, and to evaluate the compliance of OHCPs i.e., dentists and dental hygienists with these IPC guidelines.

2. LITERATURE REVIEW

2.1 COVID-19

2.1.1 Coronavirus

Coronaviruses (CoVs) are a family of viruses that cause upper respiratory tract and intestinal illnesses in humans and animals(15). Seven different types of human coronaviruses have been found across the world, however, three have the potential to cause serious and fatal diseases in people(16). These are severe acute respiratory syndrome coronavirus (SARS-CoV) which was first identified in 2002-2003 and caused SARS(17); middle eastern respiratory syndrome coronavirus (MERS-CoV), which emerged in 2012 and caused MERS; and, most recently, the SARS-CoV-2 that emerged in December 2019 and causes coronavirus disease (COVID-19).

2.1.2 Global and Canadian Epidemiology of COVID-19

The SARS-CoV-2 viral strain was first discovered in Wuhan, China, where it caused an epidemic of 2,761 cases and 80 deaths as of 26th January 2020(18). Unlike SARS and MERS, COVID-19 spread internationally within one month of being identified(19), so much so that the World Health Organization (WHO) declared it a public health emergency of international concern on 30th January 2020(20). A global alarm was raised when attention was directed to the rate of spread of infection at 118,000 confirmed cases, and the rate of fatality at 4,291 deaths in a short span of three months(21). Moreover, evident community transmissions across 114 countries and, alarming levels of severity paved the way for WHO to announce it as a pandemic on 11th March 2020(21).

Canada reported its first COVID-19 case on 25th January 2020(22). The first epidemic wave peaked in mid-April 2020, and Quebec (QC) was the worst hit province, reporting more than 5,500 deaths up till July 2020, followed by Ontario (ON)(23). It was not long before the second peak hit in December 2020 during which 3.4% of individuals diagnosed with COVID-19 were dying(23). During this time, Alberta (AB), Manitoba (MB), and Saskatchewan (SK) experienced the highest case count per 100,000 population(24). Concurrently, on 14th December 2020, the public health authorities began rolling out vaccines for highly susceptible individuals, and healthcare workers(25). Despite the numerous public health interventions established by the government, COVID-19 mutated and progressed into the years 2021 and 2022 with the delta and omicron variants. Since the onset, 3.9 million COVID-19 cases have been documented in Canada up to the time of writing this i.e., 27th June 2022(24).

Apart from a handful of countries that did not report any COVID-19 cases, the high transmissibility of the virus went on to affect every nation across the globe with a distinct time of onset, incidence rate, and fatality rate. Nonetheless, evidence from the early phases of the pandemic demonstrated that the high-risk population groups were similar globally. To elaborate, although COVID-19 is seen in all age groups, severity levels are higher amongst those older than 75 years of age(26). Furthermore, critically ill patients who required ICU admission were commonly immuno-compromised or affected with comorbidities such as hypertension, diabetes, obesity, and heart diseases(27),(28). Most importantly, occupational exposure to SARS-CoV-2 among healthcare workers (HCWs), with the added shortage of personal protective equipment (PPE) kits put enormous pressure on healthcare systems worldwide. As a result, collective global efforts were made to control the further spread of this infection using fresh information and past knowledge about the transmission dynamics of coronavirus.

2.1.3 Transmission of SARS-CoV-2

The initial hypothesis about the animal-to-human mode of transmission of the SARS-CoV-2 virus was applicable only to the group of people who had the earliest infections in Wuhan(19). Soon after the emergence of numerous cases with no history of animal contact scientists started speculating other modes of transmission. According to the literature published in the early stages, the virus clearly showed person-to-person mode of transmission(29). This, along with evidence of its ability to transmit during the 5 to 14-day incubation period(30) and, with current literature reporting 44% of the transmissions occurring in the pre-symptomatic phase(31), was the reason for the drastic increase in the daily number of cases of COVID-19 at the beginning of the pandemic.

In addition to the mode of transmission, which gives us knowledge about the point of entry and exit of the virus when transmitting, published literature discusses three main routes taken by SARS-CoV-2 to spread from person-to-person, namely direct contact, droplets, and aerosols(32). To elaborate droplets that are coughed, sneezed, or released while talking are large (> 5-10μm)(33) and that causes them to fall to the ground immediately or linger for a while close to where they were released(34). Although this limits the radius of virus dissemination through contaminated droplets of infected persons, it is still a potent route as the virus from the droplet can penetrate the exposed mucosa of the oral or nasal cavity or conjunctiva if there has been direct contact with the droplets (35) or indirect transmission from virus-contaminated objects or surfaces(36). As droplets are generated inadvertently by humans,

WHO considers droplets and contact to be the primary routes of community transmission of SARS-CoV-2(37).

On the other hand, aerosols (droplets of < 5μm) are not the main route by which the virus spreads in the general population(34). To explain, aerosols are generated only during special experimental or clinical conditions such as during aerosolizing medical procedures or treatments, for example, tracheostomy and endotracheal intubation(37). Findings from simulation studies have reported that SARS-CoV-2 can remain viable in aerosols for up to three hours(38). It is these virus-containing aerosols that persist in the closed environment for a longer time, at higher concentrations, as well as have the potential to penetrate deep into the alveoli to cause lower respiratory tract infections(39), therefore causing an increased rate of transmission of COVID-19 particularly in the healthcare settings.

According to a consensus from the early stages of the pandemic, the basic reproduction rate (R_0) for SARS-CoV-2 from January to May 2020 was estimated to be between two to three(40). This is to say, an infected person has the likelihood to transmit the infection to two to three susceptible individuals who they come in contact with. To be able to understand the higher transmissibility of SARS-CoV-2, note that a systematic review reported that the 2009 H1N1 pandemic and seasonal influenzas had a median R_0 of 1.46, and 1.27 in community settings, respectively. This estimation of R_0 of an infectious disease is critical for governments to implement strategies that can limit the spread within communities. For example, quarantine is an effective method to curb R_0. Having said this, during the COVID-19 pandemic we saw global efforts, such as travel restrictions, social distancing, working from home, restricting social gatherings, and complete shutdown of restaurants, thus forcing millions of people to stay at home to reduce the impact of the epidemic.

2.1.4 The burden of COVID-19 among healthcare providers (HCPs)

One group of workers who could not work from home was HCPs. They were expected to go to clinics and hospitals every day to keep the health system from succumbing to the high influx of patients. Even though health authorities recommended prioritizing emergency and urgent care, non-essential or elective care could not be postponed indefinitely. Moreover, based on the above-mentioned transmission routes, the population of HCPs is without a doubt at a higher risk of infection in comparison to the general population. To emphasize, due to the nature of their work, many HCPs are in close proximity to COVID-19 patients for long durations, and a majority of the time these patients have peak viral load when seeking care(41),(42). One study

comparing the incidence of infection between the general population and HCPs in the UK and USA, recorded an 11-fold increased risk in the latter group (adjusted HR 11.61, 95% CI 10.93–12.33)(43). Furthermore, numbers reported from individual countries in the available literature supported this claim. For example, i) Italy reported 13,121 infected HCPs as of April 7th, 2020(44); ii) in the USA, HCPs accounted for 19% of infected people(45); iii) in France, 31,171 HCPs were infected as of June 21st, 2020(46); iv) in Canada, where 19.4% of COVID-19 cases were HCPs as of July 23rd, 2020, although that reduced to 4.5% as of January 14th, 2022(47); and v) in China, infection rates ranging from 3.5% to 29% among HCPs in different hospitals in Wuhan(48) were reported.

2.2 Risk among oral healthcare providers (OHCPs) in the era of COVID-19

While all frontline HCPs are at high risk of COVID-19 infection, given the physical closeness of OHCPs and patients during treatment and the common use of aerosol-generating procedures (AGPs) in dental care, concerns about transmission of the virus during dental treatment were widely discussed around the world. So much so that New York Times reported that dentistry was the most at-risk profession for SARS-CoV-2 in comparison to other healthcare occupations(6). This encouraged researchers to better understand the transmission of SARS-CoV-2 in a dental setting. Up until now several simulation studies(49),(50), and literature reviews(51),(52),(53),(54) have been published to provide scientific evidence on the potential risk in dental setting. The next section will review the current literature that acknowledges the high possibility of transmission of SARS-CoV-2 when performing everyday dental procedures and, otherwise.

2.2.1 Droplets, direct contact, and proximity of OHCPs and patient

It has previously been mentioned in section 2.1.3 and demonstrated by a study that, person-to-person is a potent mode of transmission of SARS-CoV-2, and when it happens in healthcare settings it is termed nosocomial transmission(3).

While providing oral healthcare, close contact is inevitable between the OHCP, patient, and staff. Most of all, the inability to assess the infection status of every patient with a diagnostic test before dental treatment leaves the OHCPs vulnerable. In addition, with studies consistently reporting the detection of SARS-CoV-2 in saliva(55),(56),(57), it increases the amount of exposure and ultimately the risk of virus transmission in OHCPs as they come in direct contact with the oral mucous membrane, saliva, blood, and bio-fluids of patients. Furthermore, dental procedures such as extraction, drilling of decayed tooth surfaces, and, drainage of abscesses

require patients to spit or gargle during and after, which is bound to expose the practitioner and staff to contaminated saliva and respiratory droplets. In summary, close contact with infected individuals whether symptomatic or asymptomatic and, respiratory droplets released during treatment procedures, and when coughing, sneezing, talking are some of the means of contagion in a dental setting(58).

2.2.2 Aerosols in an oral healthcare setting

Contaminated respiratory droplets as discussed previously can cause dissemination of virus within a short range, while aerosols that are droplets of smaller size can travel over long distances and stay airborne for longer periods of time(38). In everyday dental care, on the application of high-velocity rotary instrumentation under irrigation, ultrasonic scalers, and air-water syringes there is a splatter of aerosols contaminated with saliva and other bio-secretions. It is this, difficult to contain, aerosol production during dental procedures the cause of concern for cross-infections between practitioner and patient. Moreover, the majority of the time, patient saliva is contaminated with blood even when blood is not visible(59), therefore aerosols can also contain blood. These aerosols land on the skin, nasal and ocular mucosa of the dental practitioner and staff, and also contaminate various surfaces in the operatory.

Not forgetting the patients who are also at the risk of contracting infection, when visiting OHCPs for treatment during local outbreaks of COVID-19. Virus-contaminated aerosols can put the next patient at risk of exposure to contaminated air if the appointment is within the three-hour window. In a dental operatory, it is the patient who has to be without a mask therefore, the most vulnerable to contaminated droplets and aerosols from previous patients. Another factor that emphasises the intra-operatory risk for patients is the fact that the angiotensin-converting enzyme-2 (ACE-2), a key enzyme that facilitates cellular entry of SARA-CoV-2 virus, is highly expressed in the oral tissues, especially the tongue(60),(61). Therefore, exposed oral mucosa, is regarded as a potential route of entry for the viral infection.

2.2.3 Contaminated surfaces in an oral health care setting

Respiratory droplets and aerosols are forcibly ejected during AGPs, spitting, gargling, and talking, and then travel in a trajectory until they contact a surface or fall on the floor(62). This contaminates surfaces near the spittoon, the dental instruments in the operatory, and the suction line. Apart from dental operatory, evidence shows that the virus can remain infectious on frequently touched surfaces like door handles, switches, and work stations(63). More specifically, the virus has been shown to stay infectious longer (up to 72 hours) on plastic and

stainless steel surfaces, which are common materials used in dental operatories (38). This can result in self-inoculation by touching contaminated surfaces and then touching exposed mucosa of the nose, eyes, mouth, or open skin wounds.

On account of the points mentioned so far, it is evident that the potential for SARS-CoV-2 transmission while performing AGPs in dental and other health care settings is over-and-above what is experienced in a general community setting. The transmission of the virus can happen from patient to practitioner or staff and vice versa, as well as patient to patient and between HCPs/OHCPs.

2.2.4 Incidence and prevalence of COVID-19 among OHCPs

The preceding scientific evidence subsequently encouraged researchers to gather data to estimate the rate and risk of transmission of SARS-CoV-2 in dental settings. Therefore, since the onset of the COVID-19 pandemic in March 2020 studies have been conducted worldwide to estimate the prevalence and incidence of COVID-19 among OHCPs. A cross-sectional study conducted in April 2020, among dentists practicing in France reported that 1.9% of the participating 4,172 dentists had ever tested positive for COVID(64). On the other hand, a USA-based cross-sectional study conducted in June 2020, reported that 16.6% of the 2,175 participating dentists had ever tested positive for COVID(65). Another cross-sectional survey of dentists, dental hygienists, and dental assistants from around the world conducted in August and September 2020, reported that 18.2% of the 1154 participants admitted to COVID-19 infection(66). One more cross-sectional study from the Czech Republic communicated that 25.5% of the participating 2,716 dentists admitted to testing positive for COVID-19 from the onset of the pandemic to June 2021(67). A different study from October 2020 focusing on the prevalence of COVID-19 among dental hygienists, practicing in the US and Puerto Rico, reported that 3.1% of the 4,776 participants ever tested positive or had been diagnosed with COVID-19(68). Lastly, the estimated incidence rate of COVID-19 among practicing dentists was determined by two separate longitudinal studies conducted in the USA and Canada. The study from the USA reported the range of weighted monthly incidence rate from 0.2% to 1.1% among a cohort of 2,196 participating dentists from June to November 2020(69). A study on a cohort of dentists practicing in Canada reported an incidence rate of 5.10 per 100,000 person-days (95% CI, 1.86 to 9.91 per 100,000 person-days) during the study period from July 2020 to February 2021(13).

With all these different studies adding to the pool of information, we now have a wide range (1.9% to 25.4%) of reported prevalence, estimated at different geographic locations, for different dental professions, and from different times during the pandemic. Plus, the scientific facts about the increased potential of transmission of SARS-CoV-2 in a dental office. All this information highlights the necessity of implementing working conditions that mitigate the spread of COVID-19 in dental settings.

2.3 Methods to reduce transmission in oral healthcare settings

According to the Centers for Disease Control and Prevention (CDC), along with the National Institute for Occupational Safety and Health (NIOSH), controlling exposure to infectious agents is essential to protect workers and clients. They broadly categorized the measures into five groups, graphically represented them in a hierarchical pyramid, with the most effective being on top and the least effective at the bottom (Figure 1). This section will focus on these broad categories in the context of OHCPs and COVID-19, based on information in the current literature.

2.3.1 Different infection prevention and exposure control measures

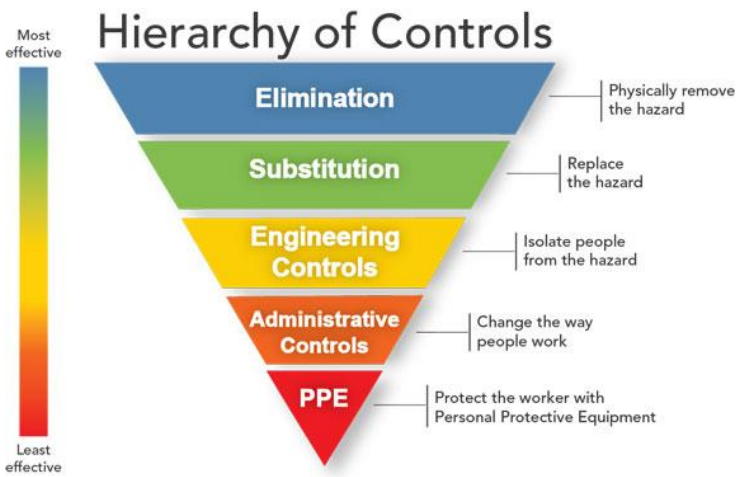


Figure 1: Hierarchy of control measures (source- JPEG file by NIOSH)

To begin with, elimination and substitution are both public health level measures. To explain, elimination includes strategies imposed at the peak of the pandemic, such as the suspension of non-essential elective oral care by dental regulatory bodies across multiple countries (9),(70). On the other hand, substitution includes introducing alternatives when elimination is in effect or after, to list a few: teledentistry(71),(72), use of hand instrumentation or chemico-mechanical approaches rather than rotary instruments(73), functioning on reduced capacity, seeing patients in designated COVID-19 clinics(74). Beyond these elimination and substitution strategies, engineering controls in the context of OHCPs and COVID-19 involve changes to the dental office layout and design that could contribute to reducing transmission. For example, closed operatories for suspected or confirmed COVID-19 patients(75), installing plexiglass barriers, and performing ventilation assessments and adjustments.

In addition to the standard universal precautions (based on 'anticipated exposure' to blood, body fluids, and/or secretions)(76), enhanced preventive steps (e.g., masks throughout the shift) were expected to be followed by OHCPs to control the high transmission rate of SARS-CoV-2. For instance, administrative controls embody risk mitigation strategies such as remote screening, patient temperature checks, social distancing, staggered appointments, pre-procedural mouth rinse, rubber dam, four-handed dentistry, extraoral suction, and airing the operatory in between appointments, to list a few. Out of these measures, PPE is defined as a combination of respirator, mask, gloves, protective eye cover, gown, headcover, and foot cover.

The strategies implemented under the elimination and substitution categories reduced in-person care provision by OHCPs, benefited the vulnerable populations as they did not have to leave their house or institutions, and allowed for care continuity to a limited extent for those who are in quarantine. However, majority of the oral health problems require a physical examination to confirm a diagnosis and cannot be handled solely by pharmacotherapy, therefore requiring in-person care after remote consultation. Furthermore, the engineering control recommendations seem to require practice owners to make major changes to the clinic layout that might not always be feasible or affordable, and more so, the regulatory authorities often do not strictly impose such strategies(11). On the contrary, administrative control and PPE are inexpensive to establish and easier to implement as compared to the former strategies(77) in an oral health care setting.

2.3.2 Infection prevention and control (IPC) documents

These infection prevention and exposure control measures for SARS-CoV-2 discussed above are important and had to be communicated to OHCPs promptly. The reason for this was the pressing question being asked by OHCPs: "How to provide safe dental care during the pandemic?" Therefore, enhanced IPC documents specifically for COVID-19 are essential as they provide a framework for safe and uniform quality of care that is backed by scientific evidence. Additionally, these documents are ideally a synthesis of the best available evidence provided concisely to guide professionals otherwise dealing with a plethora of overwhelming information.

Oral healthcare regulatory bodies across the world drafted IPC documents comprising of minimum requirements for their registrants to follow safe delivery of services. To Illustrate, the General Dental Council (GDC)[UK], a national level organization, and on the other hand, the individual State dental boards in the USA hold the authority to establish the standards of

practice. Similar to the USA, Canada that is divided into ten provinces and three territories(78), each province and territory in Canada has its regulatory authority for each health care profession (79). It is they who were responsible for setting the COVID-19-specific IPC documents for OHCPs registered with them. With this in mind, naturally, Canada had a minimum of 13 IPC documents for each health profession.

Since March 2020 there have been numerous guidelines, protocols, directives, and patient management pathways developed for OHCPs, by regulatory boards, associations, national or regional health authorities, and public health agencies in Canada. In the available literature, there are a handful of articles that review guidelines provided to the OHCPs worldwide(80),(81),(9),(82),(83),(84),(85),(86),(52),(87),(88). In the Canadian context, the IPC documents from the 13 regulatory bodies have been reviewed in the last two years to provide a summarised overview(11) or to answer a specific research question(89). Both studies state that the information reported is subject to change due to the ever-evolving nature of SARS-CoV-2 and relevant research findings, as well as constant changes in the prevalence of cases in each region. Therefore, to maintain the relevance of the IPC documents in the current context, they were frequently updated as and when new evidence emerged. Nevertheless, these reviews are important to facilitate a comparison between strategies recommended by different countries. Furthermore, comprehensive global and national reviews help policymakers to come up with alternative recommendations, bring forth problems in a policy, evaluate the communication to stakeholders, identify priorities for future updates, negotiate recommendations and help with complex decision-making contexts(90).

2.3.3 Importance of and evidence behind face-coverings in PPE

As mentioned in section 2.1.3 concerning transmission routes of SARS-CoV-2, the portals of entry are nasal mucosa, conjunctivae, and oral mucosa(91), making it essential to keep these covered and protected while being in high-risk environments. When PPE is used appropriately and in combination with other measures, an effective physical barrier is formed against the transmission of infections(92). To prevent any occupational exposure when performing AGPs during periods of a high prevalence of airborne infectious agents, the Occupational Safety and Health Administration (OSHA) of the USA, recommends protection for the eyes, nose, and mouth by using a respirator or mask and goggles, or a face shield alone, especially when there will be a splash or spray of any respiratory secretions or other body fluids(93). This recommendation is supported by the conclusion drawn after a study involving dentists

practicing in France, which states that dentists are not over-exposed to infectious pathogens in their workplace when adequate preventive measures are applied(94).

Considering the elevated risk of SARS-CoV-2 virus transmission in an oral healthcare setting through aerosols (< 5 μm), often when PPE for OHCPs is discussed in the literature, the focus has been on the combination of the type of respirator or mask and protective eye coverings used under different circumstances. The reason for these discussions is first, because of ambiguity over the use of certain types of respirators and masks(95). Although there is enough scientific evidence to report the filtration capacity of respirators(96), their usefulness over surgical masks in preventing transmission of aerosols in an oral healthcare setting has been questioned by a few studies(97). Furthermore, some authors tried to address the possibility of reusing or extending the use of respirators between patients provided a surgical mask is used over it and that is disposed of after each patient(98). In addition, CDC published guidance on double masking with a cloth mask over a routine surgical mask that can substantially reduce exposure to infectious aerosols(99).

Similarly, the use of equipment to protect the eyes of OHCPs from respiratory droplets and aerosols, during a respiratory infection like COVID-19, is considered a supplement to respirators and masks. Scientific publications communicated that eye protection such as face shields and goggles or glasses are just as important as masks, and their use is associated with fewer infection rates(12),(100),(91). However, there was a discrepancy in reports about the effectiveness of goggles over glasses and visors. For example, a report authored by Ottawa Public Health phrased that goggles are the 'most reliable eye protection', and face shields are 'preferred as they cover the maximum area of the face'(101). Contradictory and low-quality scientific evidence like these, do not provide clarity for OHCPs and may have influenced the policy makers while drafting recommendations to mitigate COVID-19 in an oral healthcare setting.

2.3.4 Face-covering measures as per the COVID-19-specific enhanced IPC document

Broadly stating the face-covering recommendations mentioned in the current literature, for example, FFP2 respirators in European countries(102), and N95 or KN95 respirators in North America and the rest of the world(103) were the minimum requirements when (i) giving care to confirmed or symptomatic/suspected COVID-19 patients; or (ii) providing high-risk aerosol-generating care to any patient(102),(103). On the other hand, a surgical/procedural mask was recommended to be worn by all OHCPs and staff for the entire duration of their shift with an

imperative to change them every 4 hours(91),(102). Lastly, the use of protective eye coverings, be it glasses or a full-coverage face shield, is recommended at all times for OHCPs(91).

With regards to the Canadian IPC documents for COVID-19, Mario et al(11) reviewed the IPC document from each province and territory that was the most recent between April to July 2020. The authors reported that all 13 documents recommended using N95 or higher quality respirators for AGPs. In addition, alternatives for N95 respirators were suggested as follows: (i) ASTM level 3 masks were suggested by 5 out of 13 documents; (ii) ASTM level 2 or 3 masks were suggested by 5 documents; while (iii) one document did not specify the level of a surgical mask that was allowed to be used; and (iv) two documents did not mention any alternatives. As for the eye covering, the recommendation by two documents was to use both glasses and a face shield, while four documents allowed the use of either or both. Six documents went on to recommend the use of either of the two glasses or a face shield and lastly, one document specified a face shield as the choice for AGPs.

2.4 Compliance of OHCPs with the face-covering recommendation

The previous section summarises the face-covering recommendation, across Canadian provinces and territories and explains the importance of these protective barriers in reducing the risk of exposure to SARS-CoV-2 in an oral healthcare setting. However, they are effective only when the OHCPs comply with the different face-covering recommendations. Therefore, this section will define compliance and use published literature to discuss the infection control behaviour of OHCPs in the past and during COVID-19.

2.4.1 Definition of compliance

In the context of understanding how health professionals and others follow guidelines, throughout the literature, the words “compliance” and “adherence” are used interchangeably. The term ‘guideline adherence’ was introduced in 1998 in the Medical Subject Heading (MeSH)(104). It is defined as the conformity in fulfilling or following official, recognized, or institutional requirements, guidelines, recommendations, protocols, pathways, or other standards(104). Another term commonly used in the literature is, ‘provider adherence’ and it is defined as the extent to which healthcare professionals follow evidence-based recommendations for patient treatment and care(105).

The organizations and regulatory bodies that draft the recommendations expect the practitioners to consistently adhere to those in their day-to-day practice. An obvious method to

make sure this is happening is for timely compliance evaluation studies among the target population.

2.4.2 Measuring compliance

Compliance is rarely binary because the behaviour, attitude, and knowledge of practitioners can cause them to deviate. To deal with this, compliance is generally expressed as a percentage that is calculated using the following formula, as recommended by WHO(106):

$$\boldsymbol{Compliance = \frac{Observed\ adherence}{Number\ of\ opportunities\ to\ adhere}\ x\ 100}$$

Methods used for measuring and reporting compliance varied considerable in the literature. Firstly, a difference in scoring strategy can be observed; on one hand, some studies used an ordinal scale ranging from one (never) to four (always)(107),(108),(109), while other studies used binary scoring of zero (never) and 1 (always) or a yes/no answer(110). Further, there were study designs that used the score for each aspect of IPC being evaluated and summed it to assign an overall score to the participant(111). Secondly, a difference in categorizing the participants based on their overall scores was observed across studies. A few articles assigned ordered levels such as low, moderate, and high compliance with arbitrary cut-offs for scores, or under two extreme categories of compliant and non-compliant(110),(112). Moreover, cut-off values for each of these categories varied across studies. For example, one study considered a score of four out of five or above as good compliance(111), while another study considered its participants compliant only if they adhered to the complete list of IPC recommendations(110). More importantly, in the current literature, the threshold for clinically relevant compliance in patient care has not yet been standardized(113). Lastly, majority of the studies recorded the HCPs self-reported behaviour using a questionnaire, subsequently using that information to evaluated the level of compliance of the respondent(107),(108),(109), (110).

2.4.3 Infection control behaviour of OHCPs

The usage of face-covering measures among OHCPs have been studied before. Among the studies that were conducted before the COVID-19 pandemic, a 2011 study of general dental practitioners from Lithuania reported that 75.1% of respondents used a mask and that 49.9% used protective eyewear or face-shield during routine dental care(114). A study of Russian OHCPs published in 2012, documented that 100% of the respondents used protective eyewear but an astonishingly low 2% used face masks, and 2.9% used side shields(115). On the other

hand, a survey of OHCPs from India published in 2010 reported that 92.6% and 46.6% of respondents used face masks and protective eyewear respectively(116). There were similar studies conducted in Jordan and Nigeria. Results from dentists in Jordan showed that 69.5% and 43.8% of participants reported always using masks and eyewear respectively(117). Less than fifty percent of Nigerian dentists engaged in a study always wore masks, and only 5.8% wore protective eyewear (118). To the best of my knowledge no study conducted in Canada reported the behaviour of OHCPs to basic PPE components during routine oral care.

Articles published after the onset of COVID-19 reported the behaviour of OHCPs towards enhanced IPC measures to mitigate the transmission of COVID-19. A study conducted by Madathil et al among Canadian dentists communicated that only 40% of the participants used N95 respirators or higher in August 2020, and this proportion increased to 60% by January 2021(13). Likewise, the proportion of participants using the combination of N95 respirator and visor for all in-person oral health care was extremely low at 9.3% but increased to 19.6% by the end of the follow-up period(13). On the contrary, the reported proportion of dentists using eyeglasses or goggles at all times was more than 90% throughout the study duration(13). Information from a study of OHCPs in the USA found that 59% of the participants who practiced AGPs at the time of the study reported using an N95 respirator for the procedure, and 12.9% reported using the highest level surgical masks(65). In contrast, a study conducted in April 2020 in France reported that only 8.8% of participating dentists, who showed COVID-19 symptoms, used FFP2 respirators and 62% of them used safety glasses(64). Interestingly, another study from France in September 2020, reported 94% of participants wearing FFP2 or FFP3 or N95 respirators during AGPs(94). Furthermore, survey results from two Palestinian districts showed that 77.70% masked and 79.7% used eye protection(119).

To summarise the findings, it is evident that before and during the pandemic the behaviour of the OHCPs towards IPC recommendations falls within a wide range. Some studies reported as low as 2% of participants using masks(115), while others reported 92.6% use of masks by their participants(116). In addition, studies conducted at different time points during the pandemic report an increase in the use of masks and protective eyewear. Although this information is about the proportion of OHCPs using protective equipment, it is not establishing data on compliance with the recommended and procedure-appropriate use of the protective equipment. Therefore, the next section reviews the evidence from studies reporting compliance of OHCPs to the pertinent IPC guidelines.

2.4.4 Compliance among OHCPs

Oral health care facilities began strict implementation of infection prevention and control practices in the 1980s when the Human Immunodeficiency Virus (HIV) was identified(120). These measures kept modifying over the years as new blood and air-borne pathogens were identified. Subsequently, adherence to relevant infection control practice guidelines among OHCPs have been studied widely. For example, an overall adherence of 88% among dental school students in New York to CDC and current teaching recommendations was reported(121). This study further went on to compare pre-operative (97.9%), intra-operative (43%), and post-operative (49%) compliance to respirators and masks specifically(121). Another example is 100% and 98% compliance with masks and eyewear, as recommended by the Public Health Services of the city of Frankfurt, for dentists practicing in Frankfurt(122). Lastly, a national-level study investigated the compliance of Canadian dentists to the IPC practices recommended by the Canadian Dental Association (CDA), the American Dental Association (ADA), and the CDC in 1995. In this study, 70.0% of dentists reported using a basic combination of masks, gloves, and eye protection at all times(123).

Importantly, very few research teams have assess compliance among OHCPs in the context of the COVID-19 pandemic. For example, we have identified only one study that explicitly states the guideline document to which compliance of OHCPs is being checked. This study reported results from a survey taken by dental hygienists in the USA in October 2020 and documented that 28.2% of participants followed the CDC interim guidelines for PPE patient care(68). Furthermore, compliance of Canadian OHCPs to the IPC guidelines is unknown and warranted given the potential impact of such information on implementation of future guidelines in Canada.

3. RATIONALE

SARS-CoV-2 is a highly contagious virus that has infected 80 million people in past 2 years to cause COVID-19(124) and brought the world to a standstill like never before(125). OHCPs are at a high risk of occupational exposure when performing AGPs, due to working in close proximity to the patient, and the contaminated surfaces in a dental operatory. The number of active cases of COVID-19 in populations across the world overwhelmed health systems. To reduce transmission rates of the virus, public health initiatives in Canada and many countries restricted dental services to emergency care during the initial phase of the pandemic(126).

The public health initiatives critical to oral health services in Canada were for one, the gradual re-opening of non-essential care in a phased manner, and two, the face-covering recommendations as per the enhanced IPC document that guided OHCPs in providing safe services(11). Both of these initiatives were influenced by numerous factors such as the daily number of cases in the provinces, the scientific evidence, patient characteristics, level of risk associated with the treatment procedure, and lastly, market availability of face-coverings. As a consequence of these factors being fast-changing and region-specific during the COVID-19 pandemic, the public health initiatives were region specific and dynamically evolving as the pandemic itself.

According to the Canadian healthcare system, regulatory bodies are at the provincial and territorial level, therefore, each province and territory have its own dental and dental hygiene regulatory body, mandated to strategize and issue enhanced IPC guidelines to mitigate transmission. Given the difference in how COVID-19 struck each Canadian province (see section 2.1.2) the timeframe of mitigation strategies varied, for example, parts of Canada that reported a few cases approached COVID-19 differently, and as the risk changed over time the approach may have changed. Secondly, the market availability of masks and respirators was also different in the initial phase, for instance in April 2020 AB was supplying masks to ON, QC, and British Columbia [BC](127).

In the current literature, two studies reviewed the enhanced IPC recommendations from all 13 provinces and territories of Canada(11),(89). However, these studies by Brondani et al and Singhal et al, compared and summarised the recommendations from only the initial phase of the pandemic (April - July 2020). Yet, the IPC recommendations were updated multiple times thereafter, highlighting the need to review the updated documents and analyse how often, when

and what was being updated to better understand the mitigation strategy followed over time by regulatory bodies across Canada.

Furthermore, unlike other countries such as Spain(128) and the USA(68), some Canadian provinces and territories applied different re-opening strategies and IPC recommendations for dental hygienists as compared to dentists. Knowing that Brondani et al and Singhal et al, focused on the IPC recommendations for dentists, there is an evident gap in the literature for a review comparing the re-opening strategy and face-covering recommendations between the two OHCPs i.e., dentists and dental hygienists. Therefore, a comprehensive review to document how Canadian provinces and territories mitigated the high risk of transmission in oral healthcare settings during the fast-changing COVID-19 pandemic is essential.

An important aspect of the IPC documents was the combination of face-covering measures as it forms a barrier that protects practitioners from the virus. Nonetheless, face-covering measures are only effective when the recommended combination is implemented correctly in daily practice. However, it is understandable that not all practitioners follow the recommendation completely. Some of the possible barriers and facilitators for compliance , especially during the COVID-19 pandemic are(129),(130),(131): (i) following the recommendations only in certain circumstances (e.g.: for a certain category of patients); (ii) adhering only partially (e.g. mask, gloves, gown, hood but no eye covering); (iii) volume of information (e.g.: length of guideline document too long and information is scattered); (iv) accessibility of information; (v) time needed to stay informed (e.g.: frequent updates to guideline but not enough time to pivot behaviour); (vi) motivation and lack of motivation (e.g.: comorbidities, follow a strict routine and find it difficult to deviate, fear of transmitting the virus to family members); (vii) believing guidelines are a hinderance in quality of care (e.g.: OHCPs complaining about the use of face shield along with loupes); (viii) lack of time and resources (e.g.: low supply of N95 respirator at the beginning of the pandemic, financial constraints due to rising prices of PPE); (ix) contradictory recommendations in guidelines; (x) malpractice liability; and (xi) patient preferences (e.g.: patients not comfortable with usage of rubber dam).

Measuring adherence to IPC recommendations is necessary and important as it provides insight into the extent to which OHCPs work safely, can be useful when setting up educational programs for OHCPs, and can help understand gaps for improvements in policy implementation(132). In the context of OHCPs practicing in the community in Canada, an IPC

compliance evaluation study was last conducted in 1995(123). The COVID-19 pandemic has provided us with a natural experimental setting to assess the compliance level of OHCPs, as there were new IPC recommendations they were expected to adhere to.

Moreover, studies performed during COVID-19 focus on the behaviour of OHCPs in general and only give an overview of the proportion of participants using face masks and eye protection (section 2.4.3). They did not compare the reported behaviour of the participants to the operational guidelines recommended by regulatory bodies. Furthermore, no study has compared the compliance rate of dentists and dental hygienists. Most importantly, the majority of the studies from over the world were cross-sectional, thus not capturing the changes in compliance while the COVID-19 scenario was changing. Lastly, there is a lack of research on the implementation of COVID-19 recommendations, and a way to measure implementation would be to calculate compliance with the recommendations. In a nutshell, there is a significant gap in the literature for a longitudinal study to evaluate the pattern of compliance among two OHCPs: dentists and dental hygienists, practicing in Canada. The current thesis project was designed to address these gaps in the literature and document the longitudinal patterns in how, when and what changed in terms of face-covering recommendations during the COVID-19 pandemic and evaluated the degree of their implementation by the OHCPs.

4. STUDY OBJECTIVES

This project reviewed the enhanced IPC documents, specific to COVID-19, shared by the provincial bodies regulating dentists and dental hygienists (DHs) practicing in Canada. The overall aim is to assess the compliance of OHCPs i.e., dentists and DHs practicing in Canada, to the enhanced IPC documents specific to COVID-19.

- To describe the different strategies for resuming non-essential oral healthcare services between provinces of Canada (Manuscript I).
- To document the changes in recommended face-covering combination over multiple waves of COVID-19 pandemic across different provincial regulatory bodies in Canada (Manuscript I)
- To compare the strategy of resuming non-essential oral healthcare services, and face-covering recommendations for dentists and dental hygienists practicing in Canada (Manuscript I).
- To estimate the rate of self-reported compliance to recommended face-covering combinations for AGPs among Canadian dentists and dental hygienists, during the COVID-19 pandemic (Manuscript II).

5. METHODOLOGY

For this project, data from three different sources were used: i) a comprehensive review of IPC guideline documents; ii) a longitudinal cohort study involving dentists practicing in Canada; and iii) a longitudinal cohort study involving dental hygienists practicing in Canada.

For clarity purposes, the methodology has been explained in three parts. In part one, the methodology applied to review the enhanced IPC guideline documents will be explained, and in part two the methodology followed by two cohort studies involving dentists and dental hygienists will be presented. Subsequently, part three of the methodology comprises explaining the methods and logic applied to derive the main outcome variable of this project i.e., compliance score.

5.1 Part 1- description of the methods to review the enhanced IPC documents

The primary research question of this thesis project is to evaluate the compliance of OHCPs in Canada to the fast-changing face-covering recommendations during the COVID-19 pandemic. To be able to answer this question, my first step was to investigate and capture data about the face-covering recommendations shared by the dental and dental hygienist regulatory bodies of provinces and territories across Canada. I will now describe the methods applied to gather and analyse that information:

5.1.1 Study design

My review of IPC guidelines was retrospective in that it was performed during the period September 2021 to March 2022 and covered guidelines published during the period March 2020 to January 2022. To perform the review, I implemented steps followed for a traditional, narrative literature review rather than those of scoping or systematic reviews. This decision was based on the methodological demands of a systematic or scoping review that could not be applied to the type of search required for this project. To clarify, firstly this project included reviewing documents that are not research reports and not peer-reviewed in the standardized manner of peer-review journals. Thus, the documents included in the review were different from the traditional inclusion of peer-reviewed articles in systematic and scoping reviews. Secondly, using the appraisal tool of clinical practice guidelines would be incorrect for our study as the selected documents for this project were not informed by a systematic review of evidence. Third, with the frequent updates in the recommendations and no universal reporting standard, a review of over 100 documents had to be performed which made it challenging to systematically compare them. Fourth, unlike a scoping review, the sources of these documents

are clearly defined as the regulatory bodies. Finally, the need to summarize and disseminate the research findings from this large volume of documents issued in a short period, made traditional literature review my choice of study design.

5.1.2 Search Strategy

A robust search on the official website of Canadian provincial and territorial dental and dental hygiene regulatory bodies (Table 1) was conducted by myself (MK) and a peer Julie Farmer (JF) from the University of Toronto (i.e., we both, independently performed the same search). In the absence of the required information on certain provincial or territorial websites (NWT, YK, NU, and QC), a search was performed on relevant provincial or territorial government websites.

On the websites, we looked for the IPC documents in the dedicated section for COVID-19, or under communications, notices, or news for members. A challenge faced with websites of some provinces during this stage was not being able to access the out-of-date documents, as the webpage would be updated to display only the most updated versions of the IPC documents. To mitigate this challenge and make the search more comprehensive, the web archive server was used to look at the available historical snapshots of the websites from March 2020 onwards. This benefitted the study by identifying and collecting once current documents that were subsequently removed from websites.

5.1.3 Inclusion and exclusion criteria

The relevant documents were exported to Zotero(133), a citation manager, based on the following inclusion criteria: (1) the document referred to PPE use and/or IPC guidelines specific to the COVID-19 pandemic; (2) a date of issue and or implementation between 1st March 2020 and 15th November 2021 inclusive for dental regulators, and 1st March 2020 to 15th January 2022 inclusive for dental hygiene authorities; and (3) author of the document is a provincial regulatory body.

Subsequently, after merging the list of documents retrieved by the two independent searches performed by MK and JF, I first removed any duplicated documents. Then I excluded documents for professionals other than dentists and dental hygienists (such as denturists and dental assistants) and documents issued by non-regulatory authorities (such as the Canadian Dental Association (CDA) and, the Canadian Dental Hygienists Association (CDHA)).

Following these document exclusions, while examining the full text of included documents for data extraction, I applied the second series of the following exclusion criteria: (1) documents

containing only general information about COVID-19; (2) those discussing IPC guidelines issued before March 2020; (3) letters and/or messages to registrants; (4) guidelines for tele-dentistry, pharmacotherapy or remote care during COVID-19; and (5) guidelines for dental and dental hygiene schools or institution boards.

Table 1: Regulatory body/association distributing the IPC guideline documents in each province.

Name of Province	Dental regulatory body/association	Dental hygiene regulatory body/association
AB	Alberta dental association and college	College of registered dental hygienists of Alberta
BC	College of Dental Surgeons of British Columbia	College of dental hygienists of British Columbia
MB	Manitoba dental association	College of dental hygienists of Manitoba
NB	New Brunswick dental society	New Brunswick College of dental hygienists
NL	Newfoundland and Labrador dental association, Newfoundland and Labrador dental board	Newfoundland and Labrador College of dental hygienists
NS	Provincial Dental Board Nova Scotia	College of dental hygienists of Nova Scotia
ON	Royal college of dental surgeons Ontario	College of dental hygienists of Ontario
PE	Dental Association of Prince Edward Island	Dental Association of Prince Edward Island
QC	Ministère de la Santé et des Services sociaux (En: Ministry of Health and Social services)	
SK	College of dental surgeon of Saskatchewan	Saskatchewan dental hygienists' association
NT	Government of Northwest Territories	
NU	Dental Services - Department of Health, Government of Nunavut	
YK	Government of Yukon	

5.1.4 Data extraction

Given the focus of this project, to check for compliance with a combination of face-covering recommendations, information was extracted from the included IPC documents to best answer the research question. To enable quality control in this procedure, I developed a data extraction form and pilot tested it with five IPC documents from five different provinces.

This form was the updated on the findings from pilot testing to ensure maximal information retention. As a result, the final data extraction form included information for each included document, under five categories: 1) metadata i.e., informative labels; 2) guidelines on screening of patients and staff; 3) guideline on office set-up; 4) guideline on face-covering measures used; and 5) guideline on risk mitigating strategies. These broad categories enabled recording of the following information: title, date of document issue, name province, phase of re-opening, name of issuing organization(s), and category(ies) of oral health professional/s; temperature check and symptom assessment for the patient, oral health care provider and, staff; travel history of the patient; contact tracing; pre-treatment isolation; installation of barrier screens; reduced

waiting area seating; the combination of face-covering measures used for AGP and Non-AGP's; pre-procedural mouthwash use; air-flow assessment; use of HEPA filtration; use of extra oral suction; practicing 4-handed-dentistry; and, use of rubber dam.

The data extraction form was used to enter information into the specialized software, Claris FileMaker Pro (FileMaker, Inc., Santa Clara, CA 95054, USA), and subsequently exported for processing and analysing with the statistical software RStudio(134).

5.1.4.1 Description of the variables

A. Primary variables: This list of key variables that stored the descriptive characteristic information of each IPC document.

i. Name of issuing province/territory

This variable recorded the name of the province or territory housing the regulatory body that published the IPC document. This information was selected from a drop-down menu in the data collection form, which allowed only one province to be associated with an IPC document. It is one of the key variables as it was used subsequently to match the participants' data to the relevant guideline.

ii. Date of issue and in-effect date

The date of issue is defined as the date on which the IPC guideline document was distributed by the regulatory authorities to their registrants.

The "in-effect date" is defined as the date on which registrants were expected to implement the guidelines in their practice.

Although a majority of the documents considered the date of issue as the in-effect date, some of them were shared a few days before their date of coming into effect, which means the date of issue is different from the date of being in effect. This information was of crucial importance for the study, to know the exact operational periods of guidelines.

iii. Professions

IPC documents identified using our search strategy and inclusion/exclusion criteria could have been intended for a number of dental health care professionals beyond dentists and dental hygienists, such as denturists, dental assistants and dental technicians. In some provinces/territories, but not all, the regulatory authorities for different professions worked together to produce one document to ensure similar/same approaches across professions. However, for the purpose of this project, we focused only on documents for dentists and dental

hygienists. Nevertheless, I gathered information concerning which profession(s) each document was targeting.

iv. Combination of face-covering recommended for AGPs and Non-AGPs

All the IPC documents recommended combinations of minimum PPE to use for AGPs and Non-AGPs. As previously mentioned, the focus of this project is on face coverings, hence information was extracted on the type of respirator or mask used in combination with eye protection. Furthermore, several documents mentioned alternative combinations in case of non-availability of PPE components of the primary recommendation, therefore the alternative recommendation was also recorded. Having said this, during the early phase of the pandemic, health authorities recommended conservative but appropriate use of PPE to reduce demand on the supply chain as much as possible, when demand around the world was beyond supply. Consequently, the fact that primary and alternative recommendation data were collected ensured that compliance was measured in its entirety. This is one of the most essential variables for evaluating compliance.

B. Derived variables:

i. End-date

End-date is defined as the date on which a guideline document ceases to be operational because a new document or an updated or revised version of the existing document has been distributed by the issuing authorities.

If the documents for a province are arranged in chronological order, intuitively, the end-date for document 'A' would be either the latest date mentioned in document "A" as its in-effect period, or the date of issue of the subsequent document 'B'. Concerning the last document in my record, I considered 15th November 2021 as the end date for dental documents and 15th January 2022 the end date for dental hygienist documents. I chose these dates as they were well after the last response from our participants in the respective cohort studies.

ii. Operational period

The operational period is defined as the length of time for which an IPC guideline document is valid and in execution. This was calculated as the time starting from the in-effect date to the end-date of the document. In the absence of the in-effect date, the date of issue was considered at the starting date. It was one of the key variables when evaluating compliance.

5.1.5 Reporting and visualization of the findings

The findings from this review are communicated in the form of tables and graphs. I first tabulated the number of enhanced IPC guideline documents specific to COVID-19 issued by each provincial/territorial regulatory body, separately for dentists and dental hygienists and common to both professions. Then I used a plot to depict the differences in timelines of re-opening non-essential oral healthcare services across provinces and territories and differences across the two professions. Lastly, the same plot was used to demonstrate the frequency with which the guideline documents were being updated during the COVID-19 pandemic. Most importantly, I summarised the evolution of face covering combinations during the different levels of restrictions on oral healthcare services in a tabular format.

5.2 Part 2- methods followed for the dentist and dental hygienist cohort studies

The primary objective of this project is to evaluate the compliance of OHCPs in Canada with dental and dental hygienist regulatory authority face-covering recommendations during the COVID-19 pandemic. To answer the question, I first obtained and analysed data about the face-covering recommendations. The second requirement was to acquire data concerning the use of face-covering by the two relevant OHCPs in Canada during the COVID-19 pandemic. I will now describe the methods for two prospective cohort studies that gathered clinical activity data from dentists and dental hygienists in Canada during the relevant period.

5.2.1 Study design

Longitudinal studies are observational studies conducted over a period of time with several observations of the same subjects collected at different time points during the study(135). Information is collected in a prospective fashion, either through interviews or online questionnaires. This information allows researchers to detect changes or development of patterns and/or characteristics of subjects over time, at individual and/or group levels. The data for this project were derived from two longitudinal studies to estimate the incidence of COVID-19 among a cohort of dentists and another cohort of dental hygienists practicing in the community in Canada. Both studies used online questionnaires to collect data at regular intervals over a period of approximately one year. For this thesis project, I focused on the data gathered concerning details of in-person care, such as PPE use and IPC measures implemented, by the participants at each data collection point.

5.2.2 Study setting

The two longitudinal cohort studies were conducted online, using LimeSurvey (*Limesurvey GmbH. / LimeSurvey: An Open Source survey tool /LimeSurvey GmbH, Hamburg, Germany.*

URL http://www.limesurvey.org) questionnaires at each data collection point, thus allowing the recruitment of participants across Canada. The cohort of dentists had a total of 12 data collection points: baseline, and then onwards every four weeks. The study started in late July 2020 (the first response was on 29th July 2020) well after oral health services had resumed non-essential care, and just before the beginning of the second pandemic wave in Canada. The last data collection point was in November 2021 (the last response was on 4th November 2021) covering three waves of surges in COVID-19 infection rates in the general population during this time interval. In the second study, the cohort of dental hygienists had a total of seven data collection points: baseline, and six more collection points spaced at a median interval of 87 days. The study of dental hygienists was started in December 2020 (first response 9th December 2020) at the peak of the second COVID-19 wave and closed in January 2022 (last response 5th January 2022) during the peak of the fifth wave in Canada.

5.2.3 Study population

To be considered eligible for the studies, at baseline enrolment dentists and dental hygienists needed to: 1) sign a consent form; 2) hold a valid license to practice; 3) have never tested positive for COVID-19; and 4) not have stopped working before November 2019 for dentists and before December 2020 for dental hygienists.

5.2.4 Ethical approval

Both the study protocols to estimate the incidence rate of COVID-19 among dentists and dental hygienists practicing in Canada were approved by the Institutional Review Board (IRB) of McGill University Faculty of Medicine and Health Sciences. The IRB approval letters are included in Appendix I - 10.1.

5.2.5 Data collection

5.2.5.1 Recruitment of participants

Email invites were sent to dentists and dental hygienists listed on the email roster of dental associations or regulatory bodies from ten Canadian provinces i.e., AB, BC, MB, New Brunswick (NB), Newfoundland and Labrador (NL), Nova Scotia (NS), Prince Edward Island (PEI), ON, QC, and SK. The initial invitation message was followed by regular email reminders during the recruitment phase. Respondents who consented were checked for eligibility, and those who fit the eligibility criteria were invited to participate in the longitudinal phase of the study.

The participant recruitment for the dentist's cohort began in late July 2020 and ended in late August 2020. During this 702 consented to participate in the study, and 644 (91.74%) were eligible for the longitudinal phase of the study. Regarding the dental hygienists' cohort, the recruitment began in early December 2020 and ended in early January 2021. Out of the 958 dental hygienists who consented to participate, 876 (91.44%) were eligible for the longitudinal phase of the study.

5.2.5.2 Study instrument

An online questionnaire (Appendix I – 10.2) was created on LimeSurvey and was available in French and English. The same questionnaire was used for both cohorts after minor changes to suit the respective profession type. This helped maintain uniformity of data collection. The questions were adapted from the WHO Unity Study protocols for assessment of COVID-19 risk among health care workers(136).

To begin with, the recipients of the invitation were informed of the research goals, description of the study, confidentiality and benefits of participating. Following this, they were asked to sign a consent form. Participants who provided signed consent then had to respond to a detailed structured baseline questionnaire that collected information on: a) demographics (sex, age, gender, ethnicity) and comorbidities; b) in-person care provided in the previous two weeks (e.g., number of AGPs performed, use of N95 respirator, risk mitigating IPC strategies); and c) self-reported symptoms and infection status (e.g., respiratory symptoms related to COVID-19, whether the participant has tested positive for SARS-CoV-2, date, and type of test). At each data collection point, the same questionnaire minus the demographic and comorbidity section was used. Therefore, in the follow-up questionnaires, questions addressed activities (e.g., treatments provided) and events (e.g., COVID-19 infections) in the past two weeks.

5.2.5.3 Measurement and definition of variables

A. Primary variables: This section will discuss how the variables used for this thesis were collected through the questionnaire. As mentioned previously, the focus of this thesis was on PPE and IPC standards followed during in-person dental care episodes two weeks before each date of response. Data were collected on the following variables:

i. Province of primary practice

Primary practice is the term used for the location of the clinic in which most hours of work are performed by the practitioner during a week's work. For example, for a practitioner working in two provinces, the one at which they work most hours is taken as the primary site. The name

of the province in which the primary practice of the participant is located was the primary indicator to match participant responses to the relevant IPC document.

ii. In-person oral healthcare

At the beginning of the clinical activity section of each follow-up questionnaire, participants were asked if they provided any form of in-person oral healthcare (including consultations) during the two weeks prior to their last working day, or two weeks prior to testing positive for COVID-19, if they ever tested positive during the course of the study. The response options to this question had binary input of yes or no.

Those participants responses that reported not providing any form of in-person oral healthcare, were not asked any of the leading questions about their clinical activity in those two weeks. Therefore, these responses were considered 'not applicable' for compliance evaluation.

iii. Face-coverings

Self-reported use of face-covering was the main variable of interest for this project. Detailed information was collected about the use of five types of facial coverings: routine surgical mask; N-95 [or higher] respirator; eyeglasses or goggles; facial visor; and hood or complete head coverage. The participants had to report this information based on their use in the clinic during the two weeks prior to their last working day, or two weeks prior to testing positive for COVID-19, if they ever tested positive during the study. The online questionnaire was set up for participants such that responding to this question was mandatory (i.e., if they did not respond, they could not progress in the questionnaire) unless the participant reported that they were not providing any form of in-person care during those two weeks.

Figure 2: Illustration of a completed questionnaire that collected face-covering data.

54. Please specify the types of facial protection you used while providing in-person dental care, during this period *

Please choose the appropriate response for each item:

	For all procedures	For AGPs only	For non AGPs only	For none
Routine surgical mask			✓	
N-95 [or higher] mask		✓		
Eye glasses or goggles			✓	
Facial visor	✓			
Other form of hood or complete head coverage				✓

This information was collected through a table in the questionnaire (Figure 2). This table consisted of the different face-coverings as rows and different procedural circumstances as columns. There were four options of procedural circumstances i.e., for all procedures, for AGPs only, for non-AGPs only, and for none. For each of the face-coverings, the participant was allowed to select a single procedural circumstance for which they commonly used that face-covering. As an example, in Figure 2, considering the black tick marks as a response from a participant, we can say that this participant used routine surgical masks for non-AGP only, N95 [or higher] respirators for AGPs only, and lastly facial visor for all procedures.

iv. Other face-coverings

This variable recorded open-text responses from the participants. These responses were used in addition to the data collected from responses to the table in Figure 2. Responses to this "other face-coverings" variable were reviewed to overcome any measurement errors from difficulties in understanding how to respond to the table in Figure 2, and also to record a complete response from the participants.

For example, a response from a participant reading, *"level III mask for all patients"*. For the purpose of this study, it was considered that the category of routine surgical mask comprises of masks of ASTM level 1, 2 and 3. Therefore for such responses, it was considered that the participant uses routine surgical masks for all procedures.

Other examples, *"KN-95 because impossible to get N-95 and do a fit test"*, and *"KN95 mask for aerosol generating procedure."* Responses such as this, that specified the use of KN95, P100, N99, or respirators of various other kinds were considered as using N95 [or higher] respirator for either all procedures or the specified procedure/s in the comment, if any.

Lastly, we noticed many responses from participants about using double masks, such as *"face shield in addition to N95 plus level 3 surgical mask over top"*. In this case, it was recorded that the participants used both routine surgical mask and N95 [or higher] respirator for either all procedures or the specified procedure/s specified in the comment, if any. In addition to that, face shield and any full coverage eye protection was considered equivalent to the visor, while all partial coverage eye protections were considered equivalent to glasses/goggles.

Subsequently, the additional information from these responses was added to the variable that was recording responses to the table in Figure 2 i.e., the Face-coverings variable discussed in the previous paragraph.

v. IPC procedures

Information on enhanced IPC procedures, recommended especially for COVID-19, was collected from the third data collection point onwards for the cohort of dentists and from the beginning of the study for the cohort of dental hygienists. This information was collected via a set of 12 sub-questions under the main question about IPC procedures. Out of the 12 sub-questions, ten required a binary input of yes/no, and these questions concerned; (i) Separate entrance and exit doorways; (ii) Pre-appointment screening for COVID-19 symptoms; (iii) Screening staff for COVID-19 symptoms; (iv) Temperature check of patients before appointment; (v) Temperature check of staff members at least once a day; (vi) Preprocedural mouth rinse use; (vii) Use of special air filtration or purification units; (viii) Use of extra-oral aerosol suction devices; (ix) installation of physical barriers/plexiglass; and (x) contact tracing. The remaining two sub-questions were formatted to collect detailed information, firstly about the frequency of disinfecting surfaces and secondly, concerning encouraging patients to wear masks or face coverings. The question concerning surface disinfection had the following response options; (i) After every patient; (ii) > once per day but not after every patient; (iii) Once a day only; and (iv) Never. The question concerning patient face cover use had the following response options: (i) At all times; (ii) Only in the waiting area; and (iii) Only in areas close to where dental care is provided.

vi. Vaccination against COVID-19 status

International data shows that vaccinated individuals are less motivated to comply with standards recommended for reduced transmission rate, due to their perception of lower risk of infection and/or serious consequences of infection(137). Therefore, information on vaccination status, type of vaccine, number of doses received, and dates of the first and second dose of vaccine were collected for all participants, and these data were used to examine any change in compliance pattern after vaccination.

B. Derived variables: This section provides detailed information about variables derived by transforming primary data gathered in the studies. The list of derived variables is as follows:

i. Date of response (Index date)

The date of response to the questionnaire was defined as the date assigned for each data collection time point for each participant throughout the study duration. It is mentioned under derived variables as it depended on the completion status of the questionnaire, and the infection status of the participant at that data collection time point. To illustrate, the submission date was considered as the date of response when the questionnaire was completed. Secondly, when the

questionnaire was not completed, the recorded date of last entry by LimeSurvey was considered as the date of response. Lastly, the date of the positive COVID-19 test result was considered the date of response for participants who reported testing positive between the two consecutive data collection time points.

ii. Two-week practice interval

To begin by restating the study design, at each data collection time point the participants had to respond to all questions about their in-person care clinical activities performed in the previous two-weeks (. For example, if the last working day or date of positive COVID-19 test was 15th July 2021, then the response was based on what the participant implemented in their clinic from 1st July to 15th July 2021.

This is a key variable as it records the time period for which the main exposure variable i.e., Face-coverings was implemented by the participants.

iii. Combination of face-covering used for AGP and Non-AGP

This variable is a derived version of the main exposure variable (i.e., Face-coverings) of this project. The primary exposure variable provided data concerning the use of each type of face-covering. Inversely, this derived variable was formatted to provide information about the combination of face-coverings used for specific procedure types.

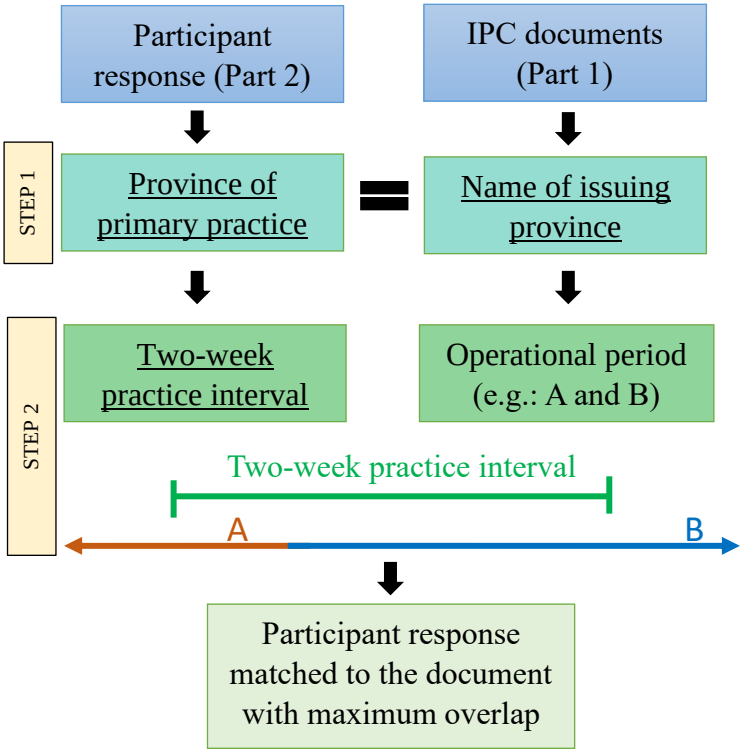
To illustrate with an example, firstly, recall that the data from the primary exposure variable is interpreted as: N95 [or higher] mask used for AGPs only; surgical masks for non-AGPs only; visors for all procedures; glasses or goggles for non-AGPs only. Based on this information, the interpretation of the derived variable was that the participant used a combination of N95 [or higher] mask + visor for AGPs, and a combination of surgical mask + glasses/goggles + visor during non-AGPs. To further clarify, as evident from the above example the face-covering reported to be used for all procedures was considered in the combination of AGPs as well as non-AGPs.

This derived variable is flexible to take up any combination of face-covering reported to be used by the participant. For example, supplementary Table 2 and 3 in APPENDIX III – Supplementary Material Manuscript - II list all the combinations derived for AGPs based on the responses from the participating dentists and dental hygienists.

Transforming the primary variable to this derived version was an essential step in evaluating the compliance of the participants. The reason was often the guideline recommendations are

on combinations of face-coverings to be used for a particular type of dental procedure. Therefore, it was easier to have the information reported by the participants, 'Face-coverings', be in the same format as the guideline recommendation.

Figure 3: Flow chart of applied logic to match participant response to relevant IPC guideline document.



5.3 Part 3- compliance scoring logic

The next step to answer the primary research question was to decide on the compliance scoring logic, now that I had the required data on face-coverings from enhanced IPC guidelines (Part 1), and the self-reported information from the dentists and dental hygienists' cohorts (Part 2). This section will focus on how the participants were evaluated and scored based on their reported use of face-covering for AGPs.

5.3.1 Working definition of compliance

Although I have already provided a general definition of compliance in the literature review (see section 2.4.1), I'm going to redefine it in the context of this thesis project. The working definition of compliance adopted for this project is defined as, the degree of agreement between dentists and dental hygienists' self-reported face-covering use, and the provincial regulatory authority's face-covering recommendation for AGPs, in-effect during the period of data collection (two-week prior to the index date).

In addition, this thesis project will report compliance during AGPs only. The reason being it is during AGPs that the potential risk of transmission is highest in an oral healthcare setting (see section 2.2.2).

5.3.2 Logic to match a participant's response to the relevant IPC guideline document

The IPC guideline documents were provincial/territorial-level regulations and fast-changing during the COVID-19 pandemic. Hence, to ensure participants were being evaluated for their compliance with respect to the correct and in-effect recommendations, a two-step approach was used as explained below (Figure 3).

i. Step 1 – Match provinces:

The IPC guideline documents were issued by provincial/territorial regulatory bodies and were applicable only to the registrants practicing under that jurisdiction. Therefore, as an example, a dentist whose Province of primary practice was reported as SK was expected to comply with the recommendations laid out by the dental regulatory body of SK ('Name of issuing province'). This was the first filter applied to the list of IPC documents when matching them to the participant responses.

ii. Step 2 – Maximum time period overlap

The second and final filter applied to arrive at the most relevant IPC guideline document was of maximum overlap in time periods. At each data collection time point the participants responded to the questions regarding Face-coverings based on what they practiced at their clinics during the two-weeks prior to their index date (last working day or date of a positive test for COVID-19). This two-week period was derived and stored in the variable Two-week practice interval. Secondly, all the IPC guideline documents included in the study had an Operational period (e.g.: Guideline documents A and B in Figure 3).

To illustrate with an example from Figure 3, the operational period of guideline document 'B' in comparison to that of document 'A' has more overlap with the two-week practice interval. Therefore, the participants' self-reported face-covering combination was evaluated for agreement with face-covering recommendations as mentioned in guideline document 'B'.

5.3.3 Quality consideration when evaluating compliance

Using only a quantitative evaluation of compliance would not provide a wholesome analysis. Therefore, this study incorporated a qualitative assessment of the participants' reported combination of face-covering when evaluating their level of compliance.

The use of an N95 respirator was considered superior to routine surgical masks due to its reported particulate filtration capacity of up to 95% of aerosols of size less than 0.3μm, correct peripheral seal, and ability to prevent contaminated aerosol inhalation bidirectionally(96), (95). Secondly, a visor was considered superior to glasses or goggles because it provided better coverage and protected not just the eyes from contaminated aerosols but provided an additional physical barrier over the nose and mouth. Therefore, in a situation when the guideline document recommended using a routine surgical mask, and the participant reported using N95 [or higher] respirator, the participant was considered to be compliant and scored based on the explanation in the following paragraph.

5.3.4 Assigning a compliance score

The derived Combination of face-covering used for AGP and Non-AGP for each participant data collection time point was scored based on their agreement with the Combination of face-covering recommended for AGPs and Non-AGPs as per the relevant enhanced IPC guideline document.

The formula used to score responses from participants was as follows:

$$\textbf{\textit{Compliance score}}\ (\textbf{\textit{CS}}) = \frac{\textbf{\textit{No. of components followed by the participants}}}{\textbf{\textit{Total no. of components in the recommended combination}}}$$

To explain, if a guideline document recommended the combination of N95 + glasses + visor as the minimum requirement for AGPs, while the participant used N95 + surgical mask + glasses. This means that the participant followed two out of the three components recommended (underlined above), therefore getting a score of $^2/_3 = 0.67$. On the other hand, if the guideline-recommended surgical mask + glasses while the participant reported using N95 + glasses + visor, a full score of $^2/_2 = 1$ was assigned. The full list of combinations used by participants, corresponding recommendations and the scores assigned is provided in supplementary Table 1 under APPENDIX III – Supplementary Material Manuscript - II

Compliance score was considered as an ordinal variable in this study, ranging from zero to one, with zero being the least possible score and one being the maximum.

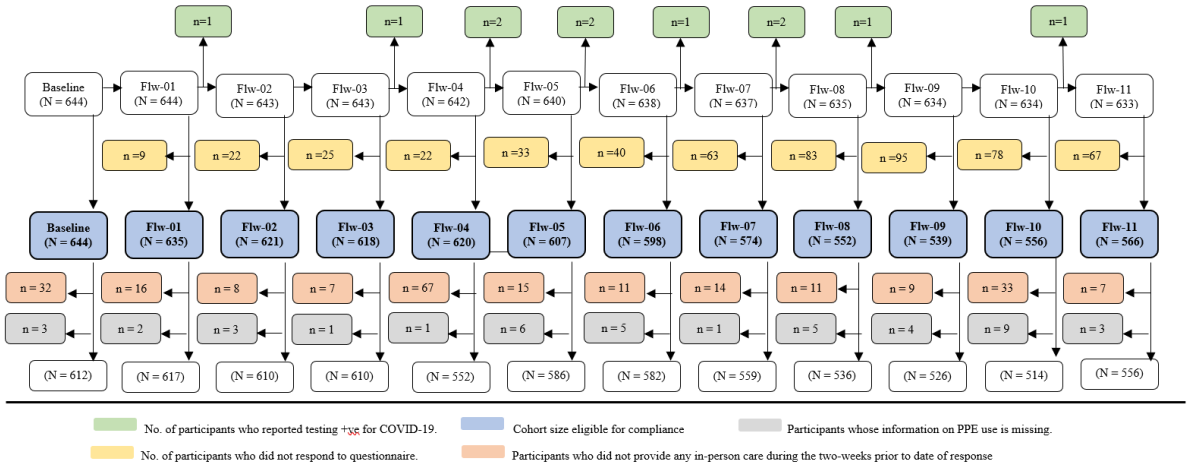
5.3.5 Categories of compliance

The continuous numeric variable, compliance score, was transformed into a categorical variable for purposes of visualization of change in the pattern of compliance over time of the participants. Three broad categories were assigned, (i) full compliance (CS = 1), (ii) partial compliance (0 < CS < 1), and (iii) zero compliance (CS = 0).

5.3.6 Lost to follow-up

Even after applying rigorous methods and providing an incentive to reduce loss to follow-up, some participants did not return to respond to the questionnaire at some data collection time point (follow-up – flw). The number of missing responses is documented in Figure 5 and Figure 4 for the dental hygienist and dentists' cohorts respectively.

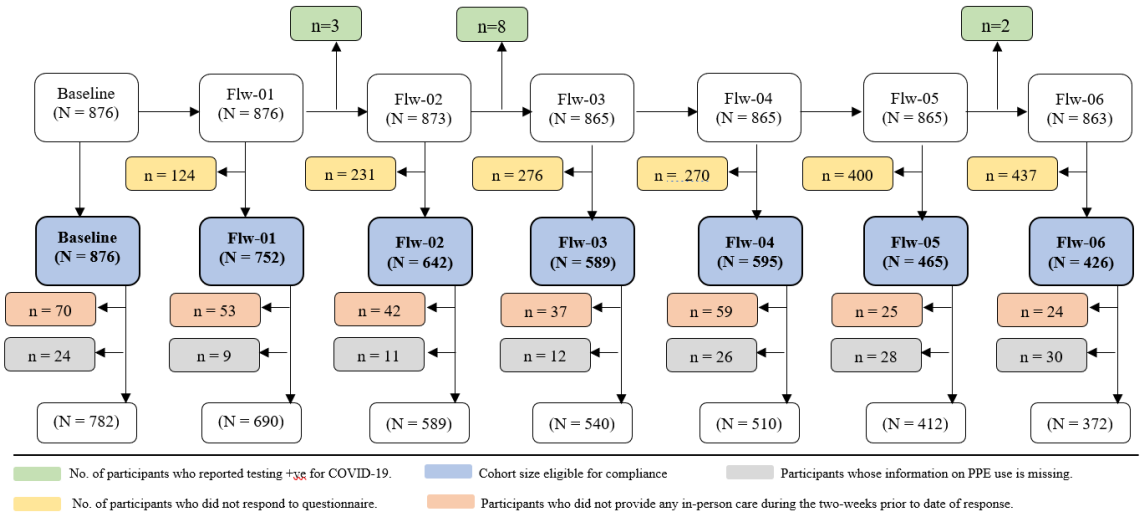
Figure 4: Flowchart depicting participant count at each data collection time point - DENTISTS



5.3.7 Participants 'not applicable' for evaluation of compliance

Responses from all those participants who responded to the questionnaire were matched to the relevant enhanced IPC guideline document based on the logic discussed in the previous section 5.3.2. Consequently, the responses were assessed to evaluate their compliance. However, if the response from a participant reported, not having provided any In-person oral healthcare (including consultations) to their patients during the two-week practice interval, then that response was considered as 'not applicable' for the compliance evaluation. The reason for considering those responses as 'not applicable' is because the participants were not asked any of the leading questions about their clinical activity, unlike the situation where the participants are asked but they do not respond.

Figure 5: Flowchart depicting participant count at each data collection time point - DENTAL HYGIENISTS



5.3.8 Missing information

Participants who had an affirmative response to providing in-person oral healthcare during the two-week practice interval were asked questions to capture details of the face-covering used

during their clinical activity. However, there were a few participants who did not respond to those questions and therefore, are considered as having missing information.

5.3.9 Reporting and visualization of compliance rate

Compliance rate was defined as the proportion of participants, out of those who provided in-person care, in each category of compliance at different data collection time points among both dentists' and dental hygienists' cohorts. For example, the formula for rate of full compliance used for this thesis project is as follows:

$$\textit{Rate of 'full' compliance} = \frac{\textit{No. of participants eith compliance score of 1 at a data collection time point}}{\textit{Size of cohort at that data collection time point}}$$

It is essential to justify the number of participants included in the denominator for reproducibility of research findings, and appropriate interpretation of the reported results. For the calculation of proportions in this thesis project, the sum of participants who were lost to follow-up, and 'not applicable' for compliance evaluation were not included in the denominator.

The proportion of participants who were fully, partially, and zero compliant was plotted as points along with their 95% confidence interval (95% CI) range that was computed using Goodman's rule for simultaneous CI calculations for multinomial proportions(138). These points for each data collection time point were plotted against the time period of the study to depict changes in compliance over time.

6. RESULTS

The findings from this thesis project have been communicated in the form of two research manuscripts, that have been submitted as independent research contributions to different peer-reviewed journals; therefore, some concepts and definitions may be a repetition of different sections of the thesis.

The title of the first Manuscript is "*Personal protective equipment during COVID-19: A natural history of dental and dental hygiene regulatory guidance in Canada*". The motivation for this narrative review was to summarize and document the evolution of the enhanced IPC guidelines shared by ten provinces and three territories in Canada during the COVID-19 pandemic.

The review focused on the change in face-covering recommendations across different phases of restricted oral healthcare services in Canada, by province and territories, as well as for two groups of OHCPs i.e., dentists and dental hygienists. The findings of this review provided one side of the information to answer the overall research question of estimating the compliance of OHCPs to the face-covering recommendations during the COVID-19 pandemic.

6.1 MANUSCRIPT I

Personal protective equipment during COVID-19: A natural history of dental and dental hygiene regulatory guidance in Canada.

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Conflict of Interest: None to declare

Data availability statement: The list of documents included in the review are available for use via a public repository on GitHub [Link].

Abbreviations:

IPC	Infection Prevention and Control
IPCG	Infection Prevention and Control Guideline
OHCP	Oral Healthcare Practitioner
AGP	Aerosol Generating Procedure
DH	Dental Hygienist

Keywords: Infection control, Personal protective equipment, COVID-19, Evidence-based dentistry

ABSTRACT

Background: At the beginning and during the pandemic, in the absence of strong evidence to the contrary, the perception of elevated risk of transmission of COVID-19 in oral healthcare settings resulted in Canadian oral healthcare professional regulatory authorities distributing enhanced infection prevention and control guideline (IPCG) documents for oral healthcare practitioners (OHCPs). The evidence upon which these documents were formulated was fast-changing due to the evolving nature of COVID-19. Therefore, the aim of this review is to document when and what in the IPCG documents for dentists and dental hygienists (DHs) in Canada was evolving during the COVID-19 pandemic and when.

Methods: A search was performed for documents shared from March 2020 to January 2022 on the websites of relevant regulatory authorities in ten provinces and three territories in Canada. A narrative review of the identified IPCG documents for dentists (n=78) and DHs (n=57) was performed.

Results: Overall findings from more than 100 IPCG documents distributed over a period of 22 months revealed that the documents were updated and revised frequently. It was observed that the frequency of these updates differed between jurisdictions, and the two professionals within the same jurisdiction. A unified approach was observed by a few, whereas the majority had separate IPCG documents for the two professionals. Moreover, different combination of face-coverings was recommended for dentists and DHs within a jurisdiction during the same time.

Conclusion: It may had been necessary to have different strategies across jurisdictions, and between professionals in the same province. The findings of this project bring forth an opportunity for future research work to understand the perception of the two professionals to the rapid changes of IPCGs, and how that affected their compliance to the recommendations. Ultimately providing policy-makers with information needed to better strategize development and communication of guidelines.

INTRODUCTION

Cross-infection in oral healthcare settings through air droplets, blood and saliva, was a major public concern[1] that was contained by introducing routine infection prevention and control guidelines (IPCG) in 1980s[2]. These concerns were elevated during the COVID-19 pandemic[3], when several articles discussed the high risk of exposure to SARS-CoV-2 in dental settings[4,5], due to the proximity of oral healthcare practitioners (OHCPs) and patients during treatment, and the everyday use of aerosol-generating procedures (AGPs) in dental care[6,7]. As a result, public health authorities and dental professional regulatory authorities across the globe issued enhanced IPCGs specific to COVID-19[8], and the World Health Organization (WHO) advised delaying routine oral health care services[9].

In principle, all clinical practice guidelines, including the enhanced IPCGs for OHCPs, are expected to be evidence-based. It has been observed that, during the COVID-19 pandemic, the quality of research was often poor[10,11,12], leading to the production of weak evidence to support interventions[13]. Unfortunately, policy makers were relying on this sub-optimal evidence to meet the demand and expectations of drafting IPCGs. Furthermore, during the pandemic these IPCGs became 'living' documents that were updated often in order to incorporate the fast-changing evidence and risk associated with COVID-19.

An important aspect of these COVID-19-related IPCGs particularly was the combination of face-coverings recommended for AGP procedures. Face-coverings such as masks, respirators, glasses or goggles and face-shields form a protective barrier against the virus' transmission through oral, nasal and ocular mucosae. The published literature discusses how the rational selection of face-coverings depends on the local epidemiology of COVID-19, patient characteristics, level of risk associated with the treatment procedure, market availability of said equipment and, most importantly, scientific evidence[14]. As a consequence, the recommended face-covering combination changed over time.

In addition to the face-covering recommendations for health care providers, including OHCPs, in response to the WHO directive, a majority of countries took radical measures to restrict oral healthcare service to emergency care only[15], while a few allowed emergency and urgent care under enhanced IPCG standards specific to COVID-19[16,17]. In the Canadian context, health services, including oral healthcare, fall under provincial and territorial jurisdiction, hence 13

regulatory bodies with different mitigation strategies were observed. Oral healthcare services in Canada underwent phases of complete and partial shutdown, then restricted services before re-opening to non-essential care. In the meantime, there were significant differences in the daily COVID-19 incidence rates across Canadian jurisdictions[18], which also influenced the timeline of these phases of closure, partial and complete re-opening of dental clinics and the recommendations included in the IPCGs.

The enhanced IPCG documents circulated by Canadian dental regulatory authorities on resuming non-essential oral care have been previously reviewed by Brondani et al[19] and Singhal et al[20]. However, since then these documents have been updated and substituted multiple times. With these updates, the face covering recommendations also changed across different phases of dental care reopening in the country. Furthermore, previous reviews did not include guidelines specific to dental hygienists. A comprehensive review of all IPCG documents across different reopening phases, from all regulatory bodies for OHCPs in Canada is needed to better inform future policies.

To address this need, aim of this manuscript is to retrospectively review all the enhanced IPC documents, along with their revised, and updated versions which were circulated by Canadian provincial regulatory bodies for dentists and dental hygienists from March 2020 up until January 2022. In doing so, we aim to document how, when and what was communicated through these guidelines with special focus on recommendations regarding face covering during AGPs.

METHODOLOGY

To review the COVID-19 specific enhanced IPCGs recommended by Canadian dental and dental hygiene authorities, the methods for a narrative review were followed. Documents published by provincial dental and dental hygiene regulatory authorities in Canada from March 2020 until January 2022 were considered in this review.

Sources of information:

During the COVID-19 pandemic the IPCGs were published by the authorities on their respective websites. This practice facilitated the provision of timely updates to the target audience. Therefore, authors MK and JF performed a robust search on the official website of each provincial dental and dental hygienist regulatory body in Canada. In the absence of IPC documents on the relevant territorial regulatory (Nunavut [NU], Northwest Territories [NWT],

and Yukon [YK]) websites, the authors searched the territorial government websites for pertinent information. In addition, the web archive server was used to look for historical snapshots of all the websites we searched. Supplementary Table 1 in APPENDIX II – Supplementary Material Manuscript – I lists the organizations that shared the IPC documents, along with the links to their website.

Eligibility criteria:

Our criteria to decide on the inclusion of documents were: (1) mention of PPE use and/or enhanced IPCGs specific to COVID-19; (2) Date of issue and or effective from between March 2020 and November 2021 inclusive, for dental regulators and March 2020 to January 2022 inclusive, for dental hygiene authorities. Once we had identified relevant documents using these inclusion criteria, the following exclusion criteria were applied to these documents as we examined their full text for data extraction: (1) guidelines for tele-dentistry, pharmacotherapy or remote care during COVID-19; (2) guidelines for dental and dental hygiene schools or other institutions; (3) documents prepared by organizations with no regulatory authority, such as the Canadian Dental Association (CDA) or Canadian Dental Hygienists Association (CDHA); (4) documents containing only general information about COVID-19; and (5) letters and/or messages to registrants. The full texts of all included documents were imported to a citation manager and duplicates were removed.

Data extraction:

A data extraction form was developed a priori and fine-tuned after pilot testing with five documents from different provinces. The finalized data extraction form was used by author MK to record information under five broad categories: (1) metadata (title, date of issue, name of province, phase of re-opening, name of issuing organization(s), and category of oral health professional(s), version number); (2) guidance for screening patients and staff (temperature check, symptom assessment, travel history, contact tracing, pre-treatment isolation); (3) office set-up (installation of barrier screens; reduced seating, separate entry and exit, air-flow assessment); (4) PPE recommendation (combination of PPE used for AGP and Non-AGP's, fit tested respirators, donning and doffing of PPE); and 5) risk mitigating strategies (pre-procedural mouthwash, use of HEPA filtration, extra oral suction, four-handed-dentistry and, rubber dam).

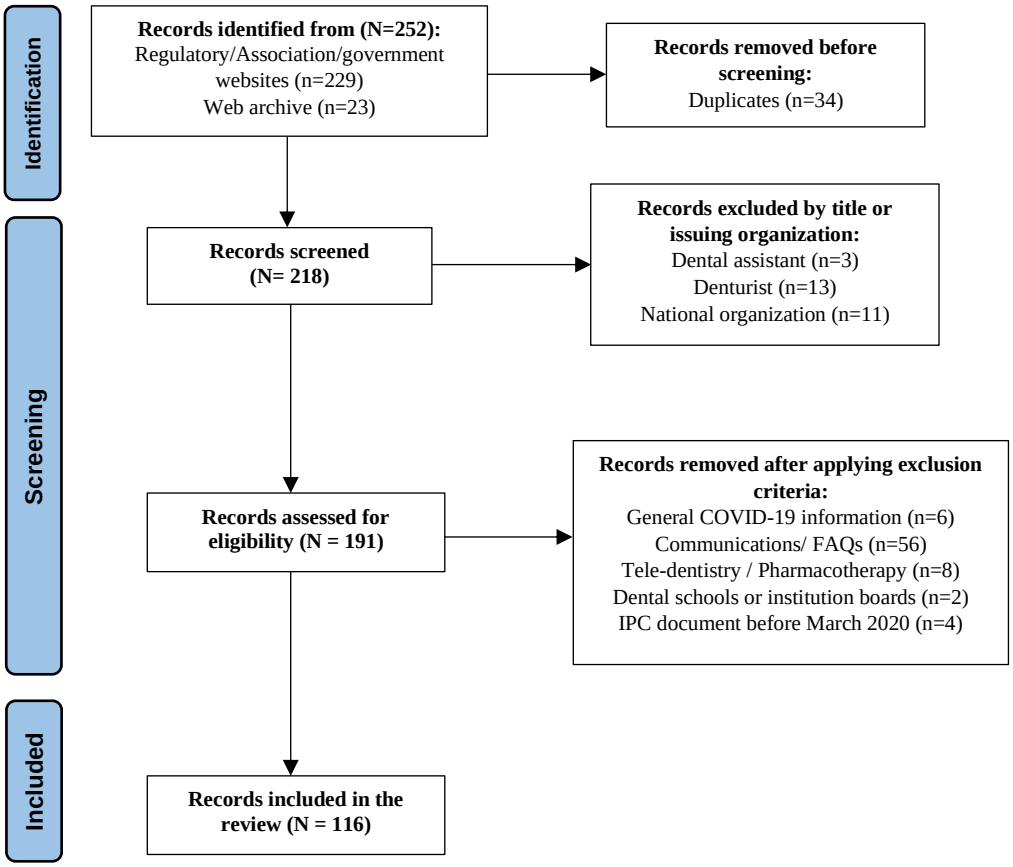
With the aim of reproducibility and to aid future work in policy research and drafting, the Zotero library of enhanced IPCGs included in this study have been made available to public on GitHub [link].

RESULTS

Search results:

Regulatory dental, and dental hygiene bodies from all the ten provinces and government authorities from the three territories in Canada shared enhanced IPCGs with their registrants during the COVID-19 pandemic. The web-based search, yielded a total of 252 documents. Upon removal of duplicates (n=34), documents for oral health professionals other than dentists and dental hygienists, and documents shared by any organization other than the targeted ones, 191 unique documents remained. Of these, 75 documents fit the exclusion criteria, leaving 116 documents to review and from which to extract data (Figure 1)[21].

Figure 1: PRISMA flowchart



Distribution of included literature:

Among the documents included, Quebec [QC] was the first to share IPCGs on 22nd March 2020 for dentists, and Saskatchewan [SK] was the first to share for dental hygienists (DHs) on 4th

May 2020. Table 1 provides a summary of the distribution of the included documents by province and applicable profession. Of the 116 documents included in the study, 59 were solely for dentists, 38 were for DHs and 19 were common to the two professions. Details such as document title, issuing organizing/s, province, date of effect, date of dissemination and applied to which profession were collected from all the included documents and can be found as supplementary material in the GitHub repository as a .csv file. Overall, the province of Nova Scotia (NS) shared the highest number of documents (n=21, 18.1%), followed by Alberta (AB) and Ontario (ON) at a considerable difference (n=14, 12.1%), closely after which came SK (n=13, 11.2%) and Manitoba (MB; n=12, 10.3%). Six out of 13 (AB, British Columbia [BC], Prince Edward Island [PEI], QC, NWT, and YK) provinces or territories shared IPCGs that were common to both dentists and DHs. However, the remaining seven provinces or territories shared separate recommendations for each profession. Of the six that shared common recommendations, four provinces (AB, BC, PEI, and QC) shared at least one document specifically for dentists. The remaining two territories (NWT and YK) shared common documents throughout the specified period.

NS (n=13, 22%), ON (n=10, 16.9%) and SK (n=8, 13.6%) are the three provinces with the highest number of documents for dentists. On the contrary, NS (n=8, 21.1%) followed by MB and New Brunswick (NB; n=6, 15.85%) were the three provinces with highest number of recommendations for the DHs.

Table 1: Distribution of the included documents by province and by applicable profession

	Dentists (N=59) n(%)	**Dental Hygienists (N=38) n(%)**	**Both (N=19) n(%)**	**Overall (N=116) n(%)**
Province				
Alberta (AB)	7 (11.9)	5 (13.2)	2 (10.5)	14 (12.1)
British Columbia (BC)	1 (1.7)	1 (2.6)	3 (15.8)	5 (4.3)
Manitoba (MB)	6 (10.2)	6 (15.8)	0 (0)	12 (10.3)
New Brunswick (NB)	2 (3.4)	6 (15.8)	0 (0)	8 (6.9)
Newfoundland and Labrador (NL)	6 (10.2)	3 (7.9)	0 (0)	9 (7.8)
Nova Scotia (NS)	13 (22.0)	8 (21.1)	0 (0)	21 (18.1)
Nunavut (NU)	1 (1.7)	0 (0)	0 (0)	1 (0.9)
Ontario (ON)	10 (16.9)	4 (10.5)	0 (0)	14 (12.1)
Prince Edward Island (PEI)	1 (1.7)	0 (0)	1 (5.3)	2 (1.7)
Quebec (QC)	4 (6.8)	0 (0)	7 (36.8)	11 (9.5)
Saskatchewan (SK)	8 (13.6)	5 (13.2)	0 (0)	13 (11.2)
Northwest Territories (NWT)	0 (0)	0 (0)	3 (15.8)	3 (2.6)

	Dentists (N=59) n(%)	Dental Hygienists (N=38) n(%)	Both (N=19) n(%)	Overall (N=116) n(%)
Yukon (YK)	0 (0)	0 (0)	3 (15.8)	3 (2.6)

Phases of restrictions in oral healthcare services in Canada:

Restrictions on oral health services in Canada during the COVID-19 pandemic were lifted over time. Due to the heterogenicity across jurisdictions in lifting restrictions, we have grouped them into four broad phases based on the services allowed during that time period (Figure 2).

The four phases are as follows:

I. Suspension of dental care: For the duration of this phase OHPs were not allowed to deliver any kind of in-person care, in other words, offices were to remain closed. Five out of 13 provinces (AB, NB, NS, ON, and PEI) suspended services for DHs. ON was the first to suspend services on 15th March 2020, and PEI was the last to lift it on 11th June 2020. Moreover, PEI was the only province to suspend services for dentists (17th March 2020 to 21st May 2020), except there were two centralized clinics that were handling dental emergencies referred to by the general dentists.

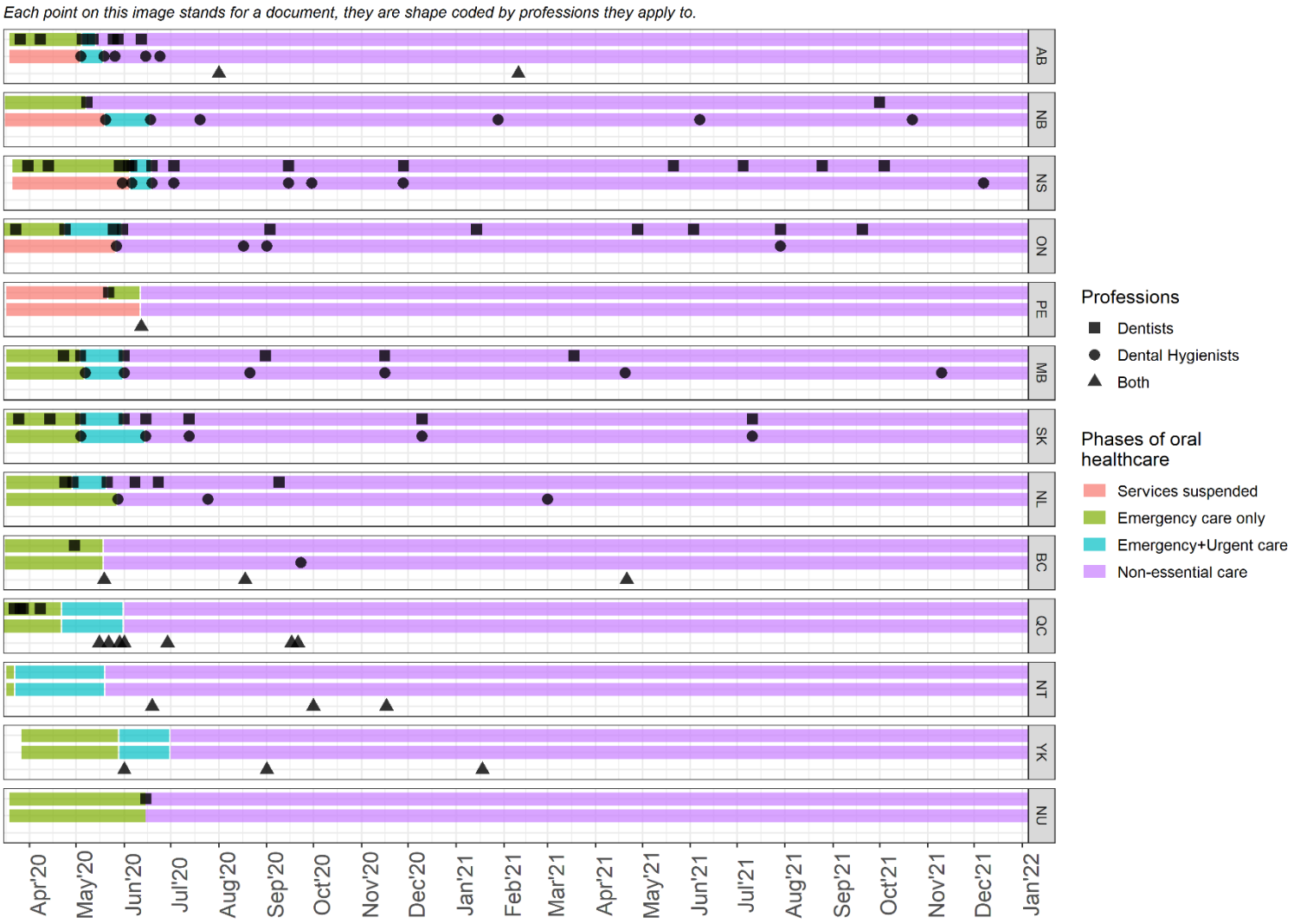
II. Emergency care only: During the course of this phase (15th March 2020 to 15th June 2020), OHPs were recommended to manage only emergency cases in-person. A majority of jurisdictions considered emergency situations to be oro-facial trauma, significant infection, prolonged bleeding and pain that cannot be managed by other means. Starting on 15th March 2020 for dentists in ON and DHs in QC, and the last to end in NU on 15th June 2020. What stands out from Figure 2 is that the provinces that had suspended care, did not have an emergency phase, instead directly permitted urgent care (AB, NB, NS and ON).

III. Emergency and urgent care: Permitting urgent care in addition to emergency care was an intermediate stage applied by 10 out of 13 jurisdictions, started with NWT as early as 23rd March 2020. Some examples of what was considered as urgent care are denture or appliance adjustment, crown/bridge cementation, dental trauma, pericoronitis and dental treatment prior to critical medical procedures. This phase was not implemented in some provinces, for example: (i) for dentists in NB; (ii) for DHs in ON; and (iii) for both professions in BC, PEI and NU.

IV. Non-essential care: The onset of this phase marked the provision of routine or non-urgent procedures. Examples included cosmetic dentistry, orthodontic treatment and restoring asymptomatic carious lesions. Figure 2 assists in visual comparison of when different

provinces allowed resumption of non-essential oral healthcare. To illustrate, dentists practicing in NB (8th May 2020) and AB (14th May 2020) were the first groups to re-open practice, while OHPs in YK (1st July 2020) were the last to resume full services.

Figure 2: Frequency of distributing IPCG, by province, profession and phase of re-opening of oral healthcare in Canada.



Lastly, 5 out of 13 jurisdictions (BC, QC, NWT, YK, and NU) had similar reopening strategies for dentists and DHs.

Frequency of issuing and updating guideline documents:

The count of documents includes the primary document plus the updated or revised versions, therefore summing to 116. The primary IPC recommendations are the ones released at the time of transitioning between phases. For example, the IPCG shared by ON for dentists at the end of the emergency plus urgent care phase (25th May 2020)[22] was updated seven times until the end of this study period. There was an immediate update (31st May 2020), which was followed

by updates every three months. On the contrary, dentists in NB received only one update over the time of study.

Furthermore, using AB as an example, from March 2020 to July 2020 the recommendations for both professions were separately documented, but from August 2020 onwards, a common document[23] was shared that was updated only once in mid-February 2021[24]. This is in contrast to SK, where separate documents where shared on the same date for both the professions, throughout the study period.

When comparing between professions, documents for DHs were first shared only at the start of emergency plus urgent care or non-essential care phase, in other words, none of the jurisdictions issued IPCGs for DHs during the emergency phase. On the other hand, practicing dentists during the emergency phase in a few provinces received repeated updates in short time spans (QC, AB, NS).

Change in face-covering recommendations:

Table 2 and Table 3 display the minimum face-covering combinations recommended for use during AGPs for dentists and DHs respectively, through different phases of re-opening. This permits comparison of recommendations by provinces during the different phases. Six out of 13 jurisdictions (BC, ON, QC, YK, NU and NL) categorised their recommendations based on the SARS-CoV-2 infection status of the patient determined by a screening questionnaire. Whereas, three out of 13 jurisdictions (NL, SK, and NT) classified their recommendations based on the possibility of using a dental dam for the procedures. And five provinces (NB, AB, MB, PEI and NS) classified them as a primary and an alternative combination of face-covering for AGPs. These alternate options were for instances when certain components of the primary combination were not available due to short supplies of some PPEs. Furthermore, as shown in Table 3, SK categorised AGPs performed by DHs (ultrasonic instrumentation, air polishing, selective prophylaxis, and using air-water syringe in combination) as high- and low-risk procedures.

Only a few jurisdictions updated their face-covering recommendations after the re-opening phase. The rest are marked as ‘no further changes’ in Table 2 and 3. In other words, new IPCGs may have been circulated or updated or revised but the face-covering recommendation was not changing. In addition, ‘AGPs not allowed for these patients’, was indicated in QC and NL for patients suspected or confirmed of COVID-19 infection during the screening stage. Nevertheless, both these provinces had designated clinics equipped to provide care for high-risk patients.

Another observation is that face-covering recommendations were changing over time to become flexible. Among the jurisdictions that had an emergency phase for dentists, very few (2 out of 12) allowed the flexibility to use either goggles or visors while performing AGPs. Whereas, in the next phase of emergency and urgent care most of the jurisdictions (6 out of 10) recommended either visors or goggles. Similarly, the mask recommendation became flexible over time, with most of the jurisdictions in the emergency phase (7 out of 12) strictly specified N95 respirators or superior for AGPs during the emergency phase, as compared to the non-essential services phase when majority of the jurisdictions (11 out of 13) allowed the use of surgical masks for AGPs.

DISCUSSION

In 2003 a group of experts raised concerns about the way Canada handled the SARS epidemic. They commented on the lack of resources, unplanned chain of command and an ill-equipped public health system[25]. This led to the formation of the Public Health Agency of Canada (PHAC)[26]. Apart from its fundamental role to respond to public health threats[27], PHAC drafted a national guideline titled, 'Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Healthcare Settings'[28]. With the most recent update in 2017, it provided a framework for provincial and territorial policy-makers in Canada to draft the COVID-19 specific enhanced IPC guidelines.

In the current manuscript we have summarised the evolution of face-covering recommendations provided as part of the enhanced IPCGs, and compared the strategy of re-opening oral healthcare across provinces in Canada. The overall aim was to have a document that reviews strategies for mitigating COVID-19 in oral healthcare settings in Canada. Our results revealed the similarities and differences in re-opening strategies and face-covering recommendations between dentist and DH regulators, between Canadian jurisdictions over time. It is important to note, however that our review was not aimed at and does not make any comment on the success or not of these strategies.

Table 2: Minimum face cover requirement for AGPs by phase of oral health care services in Canada, during COVID-19 pandemic – DENTISTS

Name of Province	Patient or Procedure criteria	Emergency care only				Emergency + Urgent care/ all essential service				Resume non-essential services				Any changes after re-opening				Any changes after re-opening			
		surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor
British Columbia $	suspected/confirmed COVID-19			AND		This phase was skipped						OR				OR		No furtherchanges			
	negative COVID-19	level 3		AND																	
Ontario	suspected/confirmed COVID-19 (applied only from phase 3 and 5)							AND				AND									
	negative COVID-19			AND						level 2or3		OR				AND				OR	
Quebec $	suspected/confirmed COVID-19	AGPs not allowed for these patients												No further changes							
	negative COVID-19							AND													
Yukon $	suspected/confirmed COVID-19	Missing information						OR		No further changes											
	negative COVID-19					level 2or3		OR													
Nunavut	suspected/confirmed COVID-19	Missing information				This phase was skipped						AND									
	negative COVID-19									level 2or3											
Newfoundland and Labrador	suspected/confirmed COVID-19 | Non essential- without dental dam	AGPs not allowed for these patients										AND		level 2or3		AND		No further changes			
	negative COVID-19 | Non essential- with dental dam			AND				AND		level 3		AND		level 2or3							
Saskatchewan	Without dental dam (phase 2 onwards)											OR		level 2or3							
	With dental dam			OR				OR		level 2or3				level 2or3		OR		level 2or3			
Northwest Territories $	Without dental dam	Missing information										OR		No further changes							
	With dental dam									level 2or3											
New Brunswick	primary	Missing information				This phase was skipped						AND									
	alternative									level 3		AND									
Alberta	primary																				
	alternative			OR				OR		level 3											
Manitoba	primary																				
	alternative			AND				OR		level 3											
Prince Edward Islands	primary	Service suspended						OR		No furtherchanges											
	alternative					level 3		OR													
Nova Scotia	primary							OR													
	alternative			AND																	

$ - Common guideline documents for dentists and dental hygienists

Surgmsk – Surgical Mask (levels based on ASTM International standards)

N95 – respirators with filtration capacity greater 95%

Goggles – partial coverage eye protection like glasses and goggles

Visor – Full coverage eye protection like face-shield

Table 3: Minimum face cover requirement for AGPs by phase of oral health care services in Canada, COVID-19 pandemic – DENTAL HYGIENISTS

Name of Province	Patient or Procedure criteria	Emergency care only				Emergency + Urgent care/ all essential service				Resume non-essential services				Any changes after re-opening				Any changes after re-opening			
		surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor	surgmsk	N95	goggles	visor
British Columbia $	suspected/confirmed COVID-19			AND		This phase was skipped						OR				OR		No furtherchanges			
	negative COVID-19	level 3		AND																	
Ontario	primary	Service suspended										OR		No further changes							
	alternative																				
Quebec $	suspected/confirmed COVID-19	AGPs not allowed for these patients																			
	negative COVID-19							AND													
Yukon $	suspected/confirmed COVID-19	Missing information						OR		No further changes											
	negative COVID-19					level 2or3		OR													
Nunavut	suspected/confirmed COVID-19	Missing information																			
	negative COVID-19																				
Newfoundland and Labrador	primary					No further changes															
	alternative	Level 3																			
Saskatchewan	High risk AGP	AGPs not allowed																No further changes			
	Low risk AGP													level 2or3							
Northwest Territories $	Without dental dam	Missing information										OR		No further changes							
	With dental dam									level 2or3											
New Brunswick	primary	Service suspended				AGPs not allowed						AND				AND		No further changes			
	alternative													level 2or3		AND					
Alberta	primary	Service suspended						OR						No further changes							
	alternative									level 3											
Manitoba	primary	AGPs not allowed																			
	alternative									level 3											
Prince Edward Islands	primary	Service suspended				AGPs not allowed						OR									
	alternative									level 3		OR									
Nova Scotia	primary	Service suspended						OR				OR									
	alternative									level 2or3											

$ - Common guideline documents for dentists and dental hygienists

Surgmsk – Surgical Mask (levels based on ASTM International standards)

N95 – respirators with filtration capacity greater 95%

Goggles – partial coverage eye protection like glasses and goggles

Visor – Full coverage eye protection like face-shield

While it is easy to focus on the details of the differences between jurisdictions and over time, it is also important to note that among the 116 guidelines from 13 different jurisdictions, there was homogeneity in restricting non-essential oral health services in March and April 2020 in accordance with the WHO recommendations[9] and similar to other countries[29]. Another commonality was that each regulatory body paced their strategy to resuming non-essential services. One of the many reasons for this approach could be the local status of the COVID-19 outbreak as well as the availability (or not) of scientific evidence. Moreover, in March 2020 survey responses from OHCPs worldwide reported that 87% of the participants were afraid of being infected by a patient or co-worker. Ninety two percent of the respondents in this survey were afraid of carrying the infection from their practice setting to their family[30]. Similarly, another study on OHPs from NS reported that 73.5% of dentists and 89% of DHs strongly believed that returning to work would increase their risk of infection[31]. The fear and anxiety associated with returning to work depended on the local number of daily cases, knowledge and awareness of transmission and scientific evidence.

There was an evident difference between the re-opening strategy and face-covering recommendations for dentists and DHs across certain jurisdictions (AB, NB, NS, ON, PEI, MB, SK, NL). This was unlike other countries such as, Spain[32] and the US[33] where the enhanced IPCGs for dentists and DHs were the same. The concept of different strategies could have been established because of the nature of work done by DHs, which includes mostly elective and high-risk procedures. Secondly, the provinces with different strategies have separate bodies regulating dentists and DHs, unlike NWT, NU, and YK which have a single regulatory body for OHPs and indeed other health professionals. These different IPCGs for the two professions on the one hand could be respecting the differences in the nature of their work, but also could cause confusion for DHs working in dental clinics where they are expected to implement the IPC strategy suggested by their dentist practice owner.

The frequency of updating guidelines could have been perceived by dentists and DHs as helpful or confusing by practitioners who had to make relevant changes to their practice regularly. The regulatory bodies had to quickly adapt to the dynamics of the pandemic and base their decisions on rapidly updated evidence. However, the clarity of recommendations is a key component to ensure compliance to them and to fulfil the ultimate aim of reducing transmissions in dental clinics. Studies conducted by our research group on Canadian cohorts reported incidence rates among dentists[34] and DHs[35] to be lower than those of the general population. These

observations could be reflective of the effectiveness of the enhanced IPCGs recommended by dental and dental hygiene regulatory bodies in Canada, or it could simply be that as well-trained health professionals, dentists and dental hygienists in Canada were observing general public health recommendations for the public better than many in the general population so were at lower risk of being infected while living in the community.

Having made these observations concerning the findings of our review, it is important to recognize the project's limitations. One limitation was in the incompleteness of the COVID-19 specific enhanced IPCG database. The retrospective nature of this study limited us in retrieving the guidelines from the initial days of the pandemic for NU, NWT, YK, and NB. This has been reported as 'missing information' in Table 2 and 3. Furthermore, to avoid introducing bias, we did not reach out to any of the organizations who drafted and circulated the guidelines. Moreover, we did not reach out to the dentists or the dental hygienists who received the guideline documents. Finally, it is important to note that while we have compared the issuance of IPCGs, in this report, we have not compared the effects in terms of behaviours of dentist and DHs or outcomes such as infections rates. Nevertheless, the strengths of this study lie in its longitudinal nature. In the span of two years, no review article has reported the changes over time in face-covering recommendations. In addition, comparing the guidelines between two OHPs has also not been done to the best of our knowledge.

CONCLUSION:

This review documents the differences and similarities in timeline of resuming oral healthcare for dentists and DHs between jurisdictions in Canada, particularly the varied IPCG approaches in mitigating the risk of transmission during the different phases of the pandemic. The observations from this study should encourage policy-makers from different jurisdictions to share their experiences and learning from the process of drafting the enhanced IPCGs during COVID-19 pandemic. As well as, inform future research projects to understand how the OHCPs who implemented these guidelines perceived them. Furthermore, investigate the barriers and challenges faces by OHCPs in adhering to these fast-changing recommendations, including issues with supply chain, lack of training during dental schools, and shortage of resources for staff. Lastly, evaluation of compliance to the fast-changing guidelines will help understand more about the communication and implementation of these IPCG documents.

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Preface of Manuscript II

As described previously, to answer the overall aim of compliance of OHCPs i.e., dentists and dental hygienist, practicing in the community in Canada, to the enhanced face-covering recommendations during COVID-19 pandemic, we need two sides of information. One, the official face-covering recommendations during COVID-19 and two, information about use of face-covering by dentists and dental hygienist in Canada.

Clearly, manuscript I from the previous section discussed and documented the fast-changing face-covering recommendation for dentists and dental hygienist across different phases of oral healthcare services in Canada. The following section comprises of manuscript II that firstly, communicates the second side of the required information i.e., self-reported use of face-coverings combinations over time by dentists and dental hygienists in Canada during COVID-19 pandemic. Secondly, it brings together these findings and those from manuscript I to answer the primary research question of rate of compliance of dentists and dental hygienist in Canada.

6.2 MANUSCRIPT II

Compliance to face-covering recommendations among Canadian dentists and hygienist, during COVID-19.

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Data availability statement: Data used for this article will be made available on request for collaborative research.

Abbreviations:

IPC	Infection Prevention and Control
OHCP	Oral Healthcare Practitioner
PPE	Personal protective equipment
AGP	Aerosol Generating Procedure
DH	Dental Hygienists

ABSTRACT

Background: During the COVID-19 pandemic, among a range of enhanced infection prevention and control (IPC) recommendations, dental and dental hygiene regulators focused on the type and combination of face-coverings oral healthcare professionals (OHCPs) should use under different circumstances. With the ever-evolving evidence, there were frequent updates to the IPCs making compliance difficult.

Aim: To investigate the compliance of dentists and dental hygienists (DHs) in Canada to the face-covering recommendations of their regulatory bodies during the COVID-19 pandemic.

Methods: IPC guidelines published by Canadian dental and dental hygiene regulatory authorities during the period March 2020 to January 2022 were collected and reviewed for face-covering recommendations. Face-covering behaviour data from two prospective cohort studies on dentists (n=644), and DHs (n=876) practicing in Canada over the period July 2020 to January 2022 were used. A face-covering compliance score was generated for the self-reported combination of mask and eye protection used during dental care and its agreement with the relevant IPC guideline applicable on the dates of participant responses.

Results: Only 37.5% of dentists and 66.7% of DHs, were fully compliant to the recommendations at all the data collection time points during the study period. The percentage of fully complaint dentists at the data collection point fluctuated during the course of the study. An initial increase from 67.3% at baseline to 84% at follow-up three, then a decrease to 59.2% at follow-up nine. On the other hand, the compliance rate for DHs did not change significantly across follow-up visits.

Conclusion: The patterns of compliance with IPC guidelines among dentists and DHs in Canada during summer 2020 to autumn 2021 were different in the two professions. There is a need for further research to explore the barriers and challenges in implementation of the face-covering recommendations from the perspective of both practitioners and regulatory authorities to enable the most efficient and effective use of IPC guidelines at all times.

INTRODUCTION:

Numerous studies discuss the high risk of spread of infection during routine oral healthcare procedures[1,2]. These studies list exposure to blood and/or saliva and/or contaminated water from the unit, along with needle injury and splatter of droplets or aerosols as the potential routes of transmission of infectious agents during oral health care procedures[3,4]. Consequently, routine infection prevention and control (IPC) guidelines are published for oral and other healthcare practitioners (OHCPs). Needless to say, those OHCPs that do not adhere to guidelines, are increasing their patients', their staff, their own and their families' risk of infection with diseases such as tuberculosis, hepatitis B, C, and D, HIV, and SARS-CoV-2[5].

The term 'guideline adherence', is a Medical Subject heading (MeSH) coined in 1998 and is defined as, "the conformity in fulfilling or following official, recognized, or institutional requirements, guidelines, recommendations, protocols, pathways, or other standards"[6]. In the literature, the term compliance is often used interchangeably with guideline adherence.

Evaluating compliance of OHCPs to IPC recommendations is important as it provides information about: (i) the extent to which OHCPs follow IPC guidelines; (ii) gaps in guideline dissemination, comprehensibility and implementation; and (iii) the potential development of relevant continuing education programs. Previous studies have reported compliance to IPC recommendations among OHCPs primarily using data from cross-sectional surveys[7-12]. Results from these surveys from across the globe have demonstrated a gap between established guidelines and actual practice in oral healthcare settings. A few studies have also reported improvement in compliance after three or ten years as compared to baseline[13-16]. However, these studies did not follow up with the same cohort of participants who responded at baseline.

An IPC document is commonly applicable for extended periods, with changes and updates only occurring with a relatively slow evolution of their scientific evidence base. For example, the Centers for Disease Control and Prevention's (CDC) IPC guidelines for dental health-care settings published in 1993[17] were only updated after 10 years[18]. This makes it easier for practitioners to adhere to them as they would have received relevant training at dental school and/or through continuing education, and it becomes a habitual part of their workflow. However, during periods of rapid change such as the current pandemic, the situation is very different. IPC documents specific to the COVID-19 pandemic have frequently been updated to maintain relevance in the ever-changing COVID-19 scenario. For example, the IPC recommendations shared by the CDC towards the end of March 2020 were updated on 13th

April 2020[19], 19th June 2020[20] and on 15th July 2020[21], and more revisions have followed. The reasons for these rapid and multiple updates are many. In the early phase of the pandemic, scientific evidence on transmissibility and preventive measure needed against SARS-CoV-2 infection was limited to past experience with severe acute respiratory syndrome (SARS) from 2003[22]. Since then, an exponential surge in research occurred, providing a plethora of new and often week or preliminary scientific evidence[23]. However, many regulatory authorities and government agencies had to make recommendations to their communities, even though they did not have strong evidence to support their guidelines[24,25]. Consequently, just like many other health professionals and other groups during the COVID-19 pandemic, OHCPs are expected to stay updated with the changing guidelines and adapt their workflow frequently which in turn could have affected their level of compliance.

The dentists practicing in Canada were assessed for compliance with IPC recommendations previously in 1995. This cross-sectional study conducted by McCarthy et al found that 70% of participants reported they routinely use the combination of basic barriers i.e., gloves, mask and eye protection[26]. To the best of our knowledge, since the study by McCarthy et al, there is no comprehensive study on the compliance of OHCPs in Canada with recommended IPC guidelines. This lack of investigating compliance continued during the current pandemic, with studies focusing only on the behaviour of OHCPs in using personal protective equipment (PPE). For example, in Canada, our group reported that only 40% of the participating dentists used N95 respirators or higher in August 2020, and this proportion increased to 60% by January 2021[27].

In summary, the COVID-19 pandemic, its high risk of transmission in an oral healthcare setting, and the new COVID-19 specific enhanced IPC recommendations that have been updated frequently make it an important time to evaluate the compliance of OHCPs in Canada to the relevant IPC recommendations. Furthermore, a compliance study like ours is needed to assess the degree to which OHCPs function safely during an infectious pandemic. Furthermore, our study aimed to provide an evaluation of guideline implementation by scoring the compliance to the core components of the guideline, i.e., face-coverings during aerosol-generating procedures (AGPs) [28]. Therefore, this study aimed to estimate the rate of compliance to face-covering recommendations among dentists and dental hygienists (DHs) practicing in Canadian communities during the COVID-19 pandemic.

METHODOLOGY:

To estimate compliance, there are three requirements. Firstly, data on face-covering use in the clinics by dentists and DHs; secondly, information on the face-coverings that they are expected to adhere to according to IPC recommendations; and finally, information enabling the matching of dates and provincial jurisdiction for face-covering use and the relevant guidelines.

The first requirement was met by using data from prospective cohort studies on dentists[27] and DHs[29] in Canada. Both these studies recruited participants using the email roster of dental and dental hygiene licensing bodies or associations from ten Canadian provinces i.e., Alberta (AB), British Columbia (BC), Manitoba (MB), New Brunswick (NB), Newfoundland and Labrador (NL), Nova Scotia (NS), Prince Edward islands (PE), Ontario (ON), Quebec (QC), and Saskatchewan (SK). The methods for the two studies have been reported elsewhere in detail[27,29]. Briefly, the participant recruitment for dentists began in late July 2020, well after oral health services had resumed non-essential care, and just before the beginning of the second wave in Canada. In regards to the DHs', the recruitment was started in December 2020, at the peak of the second COVID-19 wave. Respondents who consented to participate during the recruitment phase were invited for the longitudinal phase of the study if they (i) held a valid license to practice at baseline; (ii) had never tested positive for COVID-19; and (iii) had not retired from practice before November 2019.

The final eligible cohort of dentists underwent a total of 12 data collection points including baseline data collection and 11 follow-up collections at a median interval of 41 days. Data collection for this study closed in November 2021. The DH study had a total of seven data collection points, including baseline and six more collection points spaced at a median interval of 87 days, closing in January 2022.

At each data collection time point, participants responded to an online questionnaire (Supplementary material) on LimeSurvey (*Limesurvey GmbH. / LimeSurvey: An Open Source survey tool /LimeSurvey GmbH, Hamburg, Germany. URL http://www.limesurvey.org*), that was available in French and English. The same questionnaire was used for both cohorts after minor changes to suit the respective profession type. We collected information on a) demographics (sex, age, gender, ethnicity, province) and comorbidities; b) in-person clinical activity provided in the previous two weeks (e.g., number of AGPs performed, face-coverings used for AGPs and Non-AGPs, as well as risk mitigating IPC strategies); c) self-reported symptoms and infection status (e.g., respiratory symptoms related to COVID-19, whether the

participant has tested positive for SARS-CoV-2, date, and type of test); and d) vaccination (e.g., type of vaccine, date of first dose and second dose). These projects were approved by the Institutional Review Board of McGill University Faculty of Medicine and Health Sciences [A06-M49-20A (20-06-018)].

The second requirement, as mentioned previously, to estimate compliance of OHCPs is the IPC recommendations. Our team has previously conducted a comprehensive review of all the IPC guideline documents, published by 13 dental and dental hygiene regulatory bodies in Canada between March 2020 and January 2022. The detailed methods of this review are reported elsewhere [Manuscript I]. Briefly, the type and combination of face-coverings, recommended for AGPs and Non-AGPs, in each of the IPC documents were extracted.

Finally, the third requirement was met through matching dates of face-covering self-reports from the two cohort studies, with dates of relevant regulatory body IPC guidelines to ensure we were matching behaviour and guideline compliance for the same periods of time, as well as the same province.

Calculation of compliance score (CS):

Reviewing the literature revealed a range of approaches to assessing, scoring and reporting compliance[30,31,8]. Since there is no standardized way to measure compliance, we used a working definition for compliance. We defined it as the degree of agreement between the reported behaviour of the participants and the minimum face-coverings recommended by the IPC guideline document. For the purpose of this study, 'Surgical mask' is considered as a broad category comprising masks with ASTM rating levels of 1, 2 and 3. Furthermore, N95 corresponds to respirators with filtration capacity equal to or greater than 95%. The category of 'Glass' includes glasses, goggles and any other partial coverage protective eyewear. The category of 'Visor' consists of face-shields, visors and any other full facial coverage protective gear.

The focus of measurement for this project was on self-reported face-covering use while providing in-person care during a period corresponding to two-weeks before the date of response to follow-up questionnaire. For each participant who reported any in-person dental care provision during this period, we derived the combination of face-covering used for AGPs and Non-AGPs (e.g., N95 + Glass + Visors). These combinations were then compared to the minimum recommendation as per the COVID-19 specific enhanced IPC document.

The criteria used to identify the enhanced IPC document pertinent to the response from the participant was as follows: (i) the document of the provincial regulatory body in which the practitioner identified their primary practice (i.e., for the few practitioners working on more than one province, we asked them to identify their primary work site and this location was used to match with the relevant provincial guideline); and (ii) the document operational period that has the maximum overlap with the two-week interval during which the self-reported face-covering was used by the participant.

Subsequently, a CS for each participant for each data collection point was calculated by comparing how many out-of-the total number of face-coverings recommended by the IPC guideline the participant reported to be using. For example, if an IPC document specified N95 + Glass + Visor as the minimum requirement for AGPs, while the participant reported using N95 + Surgical_mask + Glass, the participant is fulfilling two out of the three requirements, therefore getting a score of $^2/_3 = 0.67$ (Table 1). On the other hand, if the guideline recommended Surgical_mask + Glass while the participant used N95 + Glass + Visor, a full score of $^2/_2 = 1$ was given, with the reason being that quality of face-covering used was superior to that recommended. N95 respirators were considered superior to surgical mask due to better efficacy in filtering aerosols[32,33], and visor was considered superior to glass because it provided better coverage[34]. The resulting compliance score, thus ranged between 0 and 1 and encoded quantity and quality of compliance to the recommendations. The scores assigned to each unique combination of face-covering use and recommendation patterns is provided in supplementary material Table 1.

Table 1: Examples of compliance scoring

Recommended Face-covering / **Reported use by Participant**	N95 + Glass + Visor	N95 + Visor	Surgical_mask + Glass
N95 + Glass + Visor	$^3/_3 = 1$	$^2/_2 = 1$	$^2/_2 = 1$
Surgical_mask + Glass	$^1/_3 = 0.33$	$^0/_2 = 0$	$^2/_2 = 1$
N95+Surgical_mask+Glass	$^2/_3 = 0.67$	$^1/_2 = 0.5$	$^2/_2 = 1$

The proportion of participants and corresponding 95% confidence intervals (CI)[35] were estimated as three broad categories of fully compliant (CS=1), partially compliant (CS: >0 &

< 1), and zero compliance (CS=0). Participants who reported of not providing any in-person care or any AGPs at a data collection point were not included in this estimation.

RESULTS:

Out of the 702 dentists who responded to email invitation, 644 dentists aged between 24 and 79 years (median, 48 years) were eligible for the study. Likewise, 958 DHs consented to participate, out of which 876 aged between 21 and 92 years (median, 42 years) were considered eligible. Among the cohort of dentists 56.4% identified as female, whereas 97.8% of DHs identified as females. In addition, 90.8% of the participating dentists were general dental practitioners, and 92.7% from the DHs were practicing in a dental clinic alongside a dentist (Table 2). The median follow-up time for a participant in the cohort of dentists was 424 days, and in the DHs was 318 days. The follow-up time for a participant is measured from the day of recruitment until the participant tests positive for COVID-19 or the participant drops out of the study or the study ends, whichever comes first.

Table 2: Demographic and professional characteristics of the participants.

	Dental Hygienists (N=876) n (%)	**Dentists (N=644) n (%)**
Age [years]		
Median [Min, Max]	42.0 [21.0, 92.0]	48.0 [24.0, 79.0]
Sex		
Female	857 (97.8)	363 (56.4)
Male	19 (2.2)	281 (43.6)
Ethnicity		
White (Caucasian)	754 (86.1)	481 (74.7)
Asian	85 (9.7)	127 (19.7)
Aboriginal	6 (0.7)	1 (0.2)
Black	6 (0.7)	1 (0.2)
Latin American	6 (0.7)	10 (1.6)
Mixed	11 (1.3)	10 (1.6)
Others	8 (0.9)	14 (2.2)
Province of primary practice		
Alberta	222 (25.3)	27 (4.2)
British Columbia	230 (26.3)	109 (16.9)
Manitoba	81 (9.2)	26 (4.0)
New Brunswick	12 (1.4)	0 (0.0)
Newfoundland and Labrador	11 (1.3)	2 (0.3)

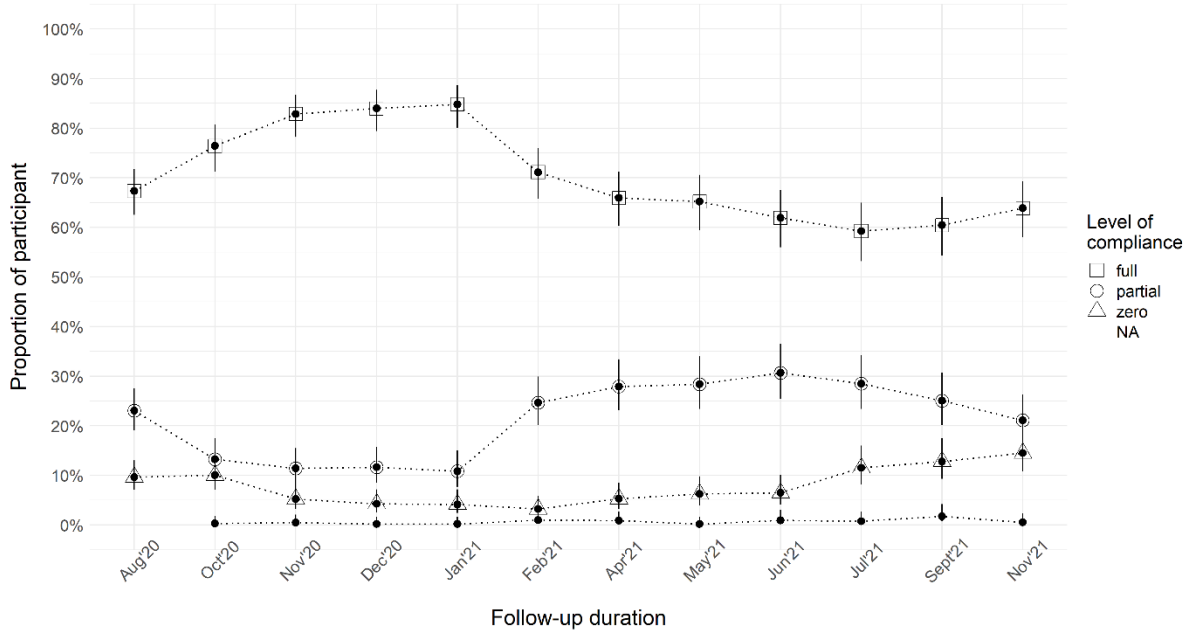
	Dental Hygienists (N=876) n (%)	Dentists (N=644) n (%)
Nova Scotia	26 (3.0)	34 (5.3)
Ontario	210 (24.05)	241 (37.4)
Prince Edward Island	0 (0.0)	11 (1.7)
Quebec	84 (9.6)	164 (25.5)
Saskatchewan	0 (0.0)	29 (4.5)
Yukon	0 (0.0)	1 (0.2)
Community serviced		
Metropolitan	213 (24.3)	147 (22.8)
Urban	314 (35.8)	220 (34.2)
Suburban	230 (26.3)	167 (25.9)
Rural	115 (13.1)	103 (16.0)
Remote	4 (0.5)	5 (0.8)
Missing	0 (0.0)	2 (0.3)
No. of offices [per week]		
1	686 (78.3)	537 (83.4)
2	150 (17.1)	83 (12.9)
3	30 (3.4)	13 (2.0)
>3	10 (1.1)	10 (1.6)
Missing	0 (0.0)	1 (0.2)
Type of profession		
General Dentist	-	585 (90.8)
Specialist	-	59 (9.2)
Clinical Dental Hygienist*	812 (92.7)	-
Independent Dental Hygienist**	25 (2.9)	-
Others	39 (4.5)	-
Follow-up time (days)		
Median [25%, 75%]	318 [208, 355]	424 [418, 431]
Mean ±SD	261.1 ±123	403.2 ±78.5

*Working alongside a dentist.
**Working independently or alongside other dental hygienists.

As shown in Figure 1, the proportion of dentists who were evaluated to have full compliance to face-covering recommendations for AGPs changed over time. A great increase was seen in proportion from 67.3% (95% CI, 62.5% to 71.8%) in summer and fall of 2020, to a peak of 84.8% (95% CI, 80.1% to 88.6%) in winter 2021. However, this gradually decreased to a low of 59.2% (95% CI, 53.2% to 65.0%) in summer 2021. On the contrary, Figure 2 depicts the

almost steady rate of full compliance among the participating DHs, with the peak at 90.4% (95% CI, 86.9% to 93.1%) in January 2021 and the lowest at 75.4% (95% CI, 68.9% to 80.9%) in December 2021.

Figure 1: Change in compliance of participating dentists over time.



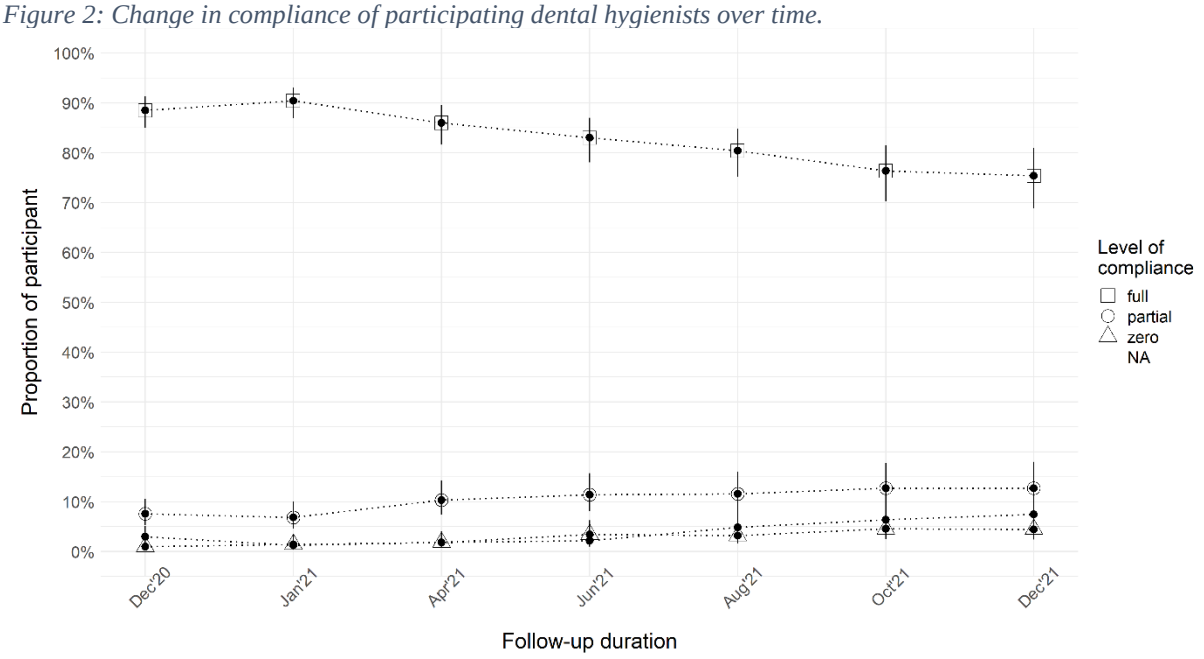
Moreover, 234 dentists (36.5%, 95% CI of 23.6% to 51.7%), and 574 DHs (66.7%, 95% CI of 57.7% to 74.7%) were fully compliant to the face-cover recommendations during the course of their entire follow-up. Furthermore, approximately 68.6% of the dentists, and 82.9% of DHs were perfectly compliant (CS=1) a majority of the times they responded during the study.

The combination of face-coverings most commonly used by participants changed through the study duration (Table 2 and Table 3 – supplementary material). At baseline (Jul -Aug.'20), a little over one-third of the participants of both the cohorts (35.8% dentists, 38.1% DHs) reported to use a combination of Surgical_mask + Glass + Visor for AGPs. Interestingly, only 15.4% of dentists used an N95 + Glass + visor. Nonetheless, this proportion increased to 26.5% by follow-up five (Feb. – Mar.'21), making it the most commonly used combination among the participants of the study at that time. By the end of the study (Nov.'21), the proportion using the combination with N95 had dropped to 17.9%, while a combination of surgical mask + glass was reported to be used by 26.8% of dentist participants.

For the DHs, the combination of surgical mask + Glass + Visor remained the most commonly used combination throughout the study duration. This face-covering combination was reported by 38.1% at baseline (Dec.'20 – Jan.'22), 41.7% at follow-up three (May-Jun.'21) and 39.3%

as the end of the study (Dec.'21 – Jan.'22). Furthermore, the proportion of participants using N95 + Glass + Visor decreased with time from 18.2% at baseline to 15.6% at follow-up three and 13.7% as the end of the study.

Figure 2: Change in compliance of participating dental hygienists over time.



DISCUSSION:

OHCPs are at a high risk of cross-infection[1,2] therefore, IPC forms an important part of the practice, even more so during the COVID-19 pandemic when it was reported that SARS-CoV-2 can be transmitted from person-to-person by contaminated aerosols generated during routine treatment procedures[36]. To our knowledge this is the first study conducted to assess the compliance of dentists and DHs, practicing in the Canadian community during the COVID-19 pandemic, with the face-covering recommendations for AGPS as per the IPC guideline documents that are drafted to reduce the risk of transmission of SARS-CoV-2 in oral healthcare settings.

We studied the compliance score of the participants at each data collection time point and observed that dentists were less compliant as compared to DHs. Furthermore, the proportion of fully compliant dentists wavered during the study period. Although full compliance by all the participants is the expected ideal situation, it is understandable that not all practitioners follow recommendations completely. There are numerous personal (fear of carrying the virus home[37,38], suffering with comorbidities, difficult to deviate from a strict workflow, not believing in scientific evidence that supports), professional (claustrophobic under a well fitted respirator[39], inability to wear loupes in the right position due to the respirator reaching the

bridge of the nose[40], excessive volume of information, ambiguity in general public health recommendations[41], malpractice liability), and circumstantial situations (limited staff at the clinic, financial constraints, supply problems associated with N95 respirators) that are reason enough for possible deviations, and sometimes "over compliance" with recommendations that can occur with practitioners deciding to take more protective measures than the guidelines propose.

A compliance study on dentists practicing in Taiwan published that in 1999 only 16.5% of the participants had good compliance with wearing a combination of basic protective barriers (gloves, mask, face shield, head cap), and this increased to 30.9% in 2010[15]. Similarly, a study from Beijing reported an overall low rate of implementation of a combination of basic PPE (gloves and mask) and protection against splatter (eye protection, gowns and high-volume suction) by dentists at 4.86% in 2000 and 44.86% in 2010[14]. Likewise, the study by McCarthy et al on Canadian dentists in 1995, communicated low compliance with combinations of IPC measures[42]. These previously conducted studies on changes in IPC compliance over time among OHCPs were cross-sectional studies carried out over a gap of several years in separate samples rather than the same cohort, therefore making it difficult to compare those results to those of our project.

The strength of this study is in the longitudinal design that allowed repeated reporting at intervals over an extended time period of above a year for both cohorts. Furthermore, the design of this study allowed repeated assessment of compliance of the same cohort of participants, unlike a longitudinal panel survey in which a different cohort of participants is evaluated at each data collection time. Another action taken was to evaluate compliance with the minimum recommendations for AGP in the pertinent guideline document, as a result of this we noticed responses that were evaluated to be over-compliant. These responses were not reported separately and have been considered under the category of fully compliant. Lastly, participants reported face-coverings they used in the immediate past i.e., two weeks prior to the date of responding to the questionnaire, therefore reducing recall bias. Reporting behaviour over a two-week period, one month apart may not capture all relevant information, but it is a good proxy of it.

Like every study, this one has some limitations. Self-reported use of face-covering through an online questionnaire may have led to an over-estimation of compliance due to the introduction of social desirability bias. However, the fact that we did not directly ask about their compliance,

and instead derived their combination of face-coverings used for AGPs could have reduced the impact of the social desirability bias. The gold standard for evaluating compliance is direct observation of the participants, however that was not possible due to the nature of COVID-19, and the public health measures of physical distancing in place[43]. Furthermore, the online questionnaire allowed for the study to be conducted across ten provinces in Canada at the same time. Moreover, in-person observation methods require well-trained observers increasing the cost of the study. Also, it is important to acknowledge that the cohorts comprised a convenience sample of dentists and DHs who volunteered to participate in the study on receiving the email invitations. This approach can introduce an important selection bias, which may have affected our results compared to compliance in the general dentist and DH populations in Canada. Though we encountered an evidently low response rate, the distribution of the participants is similar to the national data on Canadian dentists and DHs. The low response rate may be attributed to the fact that the dentists and DHs were pre-occupied with re-configuring their practices, so as to be sustainable during the pandemic. Lastly, 5.9% and 47.03% was the proportion of dentists and DHs lost to follow-up during the study, respectively. Assuming the participants lost to follow-up were the ones less compliant by nature and the ones who continued more compliant, our results may have overestimated the true compliance rate at later follow-ups.

A few unexpected reports of face-covering combinations, for example, only Glass or only Visor used while performing AGPs during the COVID-19 pandemic, suggested measurement error that could have been introduced due to the use of a non-validated questionnaire. However, there is no standardized questionnaire to record this information, and the sum of these reported combinations is too few to have an impact on our findings. Participants who reported not providing any form of in-person care were considered as ‘not applicable’ for compliance evaluation and therefore have not been considered in the denominator when calculating these proportions. On the contrary there were participants who reported providing in-person care but did not respond to the question about face-coverings, this is considered as missing information and has been reported in supplementary material Table 1 and Table 2. Overall, 0.6% and 3.5% of responses from dentists and dental hygienists respectively, were missing information on behaviour of usage of face-coverings.

CONCLUSION:

Our findings report that 36.5% of dentists and 66.7% of DHs in our sample were fully compliant to the COVID-19 face-covering recommendations throughout the study period. Moreover, among the responses from dentists that were evaluated for compliance, the proportion of fully compliant responses wavered during the study durations with a gradual increase from baseline to January 2021, to a sudden drop in February 2021. These results highlight the importance of future work to explore the variables that caused the considerable change in compliance over time. On the contrary, the responses from DHs had an almost fixed rate of compliance. Therefore, further studies can compare the behaviour, knowledge and attitude of the two professional groups to explore the reasons for DHs being more compliant than dentists.

Without a doubt, the OHCP regulatory bodies across Canada, drafted and distributed IPC guideline documents in a timely manner, however, the question is how, when, and who is evaluating their implementation in private and public clinics? Overall results highlight the importance of having an implementation strategy that can help over-come the above discussed preventable reasons for deviating from the recommendations every time a new IPC guideline is drafted.

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7. DISCUSSION

The results and findings of my work have been individually discussed in detail at the end of each manuscript, therefore there might be repetition of points in this section. This section of my thesis will be restating the rationale, providing a broad overview of the results, addressing consistency of findings with other similar studies in the literature, lastly acknowledging the strengths and limitations of this work.

7.1 Rationale

Earlier on in the COVID-19 pandemic it was well established that oral healthcare settings are at a high risk of cross-infection. This statement was supported by evidence demonstrating that contaminated aerosols generated during routine oral healthcare procedures(7) settle in the operatory and can infect the staff, practitioner and/or the next patient(38). Based on this evidence, oral health regulatory bodies around the world circulated COVID-19 specific enhanced IPC guidelines to mitigate this risk of transmission. Although these guidelines from several countries including Canada have been reviewed, there is no documentation about the changes made to these guidelines to accommodate the evolving nature of the pandemic.

Similar to the studies reviewing the IPC guidelines in other parts of the world, studies by Brondani et al(11) and Singhal et al(89) focused on the IPC guideline documents from provinces and territories in Canada. These review differences in IPC recommendation for dentists across the 13 jurisdictions of Canada during the first wave of COVID-19. Our work builds on those reviews by documenting the differences between jurisdictions in changes made to IPC guidelines over time and incorporates those used for both dentists and dental hygienists in Canada.

Beyond investigating these differences and changes in IPC guidelines, it is also important to consider to what extent practitioners are compliant. To evaluate compliance, in addition to reviewing the IPC guideline documents circulated by regulatory bodies during the pandemic, we also collected primary data from separate cohorts of dentists and dental hygienists in which they self-reported their face-covering behaviours over time for the same periods as the IPC documents we reviewed. This provided us with an ideal setting to evaluate dentists' and dental hygienists' compliance. This is a significant contribution to the literature concerning IPC guidelines and behaviours during the COVID-19 pandemic but is also the first study evaluating compliance of OHCPs in Canada since 1995(139), and this study involved only the dentists.

Therefore, in this thesis project on compliance of dentists and dental hygienists to enhanced face-covering combinations during COVID-19, first, I conducted a review of the primary, updated, and revised enhanced IPC guideline documents issued by provincial dental and dental hygiene regulatory bodies of Canada, from March 2020 to January 2022. Second, I used data from two longitudinal cohort studies involving dentists and dental hygienist practicing in Canada, to evaluated their compliance to the recommended face-covering combination as per the enhanced IPC document.

7.2 Essential findings

7.2.1 Review of the enhanced IPC guideline documents

In this review, a comparison of the strategies mitigating the risk of transmission of SARS-CoV-2 in oral healthcare settings across jurisdictions in Canada was performed. Overall, there was an evident consistency in line with WHO recommendations(126) and other nations(140) in restriction or suspension of services during March and April 2020. However, the time duration of the emergency restriction and suspension phase was different between jurisdictions and between dentists and DHs. Also, the majority of the jurisdictions implemented an intermediate stage permitting partial services but, again, its initiation date and its duration differed for dentists as compared to DHs in the same jurisdiction. This phased re-opening approach could have been perceived as helpful in gradually adapting to the unprecedented and rapidly-changing COVID-19 pandemic. It could also be helpful in assisting practitioners overcoming the fear and anxiety of becoming infected or bringing the infection home to their families(141),(142). On the contrary, restrictions in dental service provision during the phases reduced the revenue generation(143) and could have led to a financial burden on some practitioners.

Furthermore, when it came to making necessary modifications to their practices on a frequent basis, dentists and DHs may have found the frequency of updating guidelines to be confusing rather than helpful. The potential benefits of regularly updated IPC documents could be from the perspective that regulatory authorities were quick to adapt to the dynamic situation of the pandemic and the fast-changing evidence and quick to inform their registrants. However, these well-informed IPCG changes could be counteracted by confusion created by repeated changes, potential lack of clarity and differences across professions and across jurisdictions.

Our work's last contribution to the literature was in our summarizing the change in combinations of face-covering recommendations for AGPs during different phases of the

COVID-19 pandemic. Although, previous studies have documented the most recent recommendations at the time of their publication, none have reported the changes over waves of the pandemic. Furthermore, the reported disparity in face-covering combinations for the two professions i.e., dentists and DHs from a few jurisdictions, may reflect differences in the nature of their work, but they may also cause confusion for DHs working in dental clinics, where they are expected to adhere to the IPC strategy recommended by their dentist practise owner. This lack of unified approach by some of the jurisdictions in Canada, was unlike what was observed in other countries such as Spain(128) and the USA(68).

7.2.2 Assessment of self-reported compliance to the face-covering recommendations

In the second part of the work for this thesis, I calculated and reported the change in self-reported compliance to the face-covering recommendations for dentists and DHs in Canada during the COVID-19 pandemic. Our study showed a considerable fall in proportion of fully compliant dentists over time (85% to 59%), while for DHs, the compliance remained almost the same throughout (85% to 75%). The difference in compliance between the two professions was greatest during the winter of 2021, with the proportion of fully compliant DHs (66.7%) being more than that of dentists (37.5%) through the entire study duration. A more elaborate exploration of this difference is warranted. However, estimating differences in compliance rate is out of scope of this thesis project, hence not pursued.

A study conducted from 1994 to 1995 by McCarthy et al is the most recent evaluation of change in compliance of dentists to IPC guideline over time in Canada. This study documented an increase in compliance from 1994to 1995, for example, 91.6% participants always used gloves in 1994 as compared to 93.5% in 1995(108). A similar study was conducted in Beijing by Su et al, comparing compliance with the recommendation by American Dental association (ADA) among different cohorts of dentists in 2000 to 2010. They reported similar findings, with an increase from 93.1% to 97.7% of participants always using masks(144). A cross-sectional study conducted in late 2020 on dental hygienists practicing in the USA reported 28.2% of the participants did not follow the CDC IPC guidelines(68). It is challenging to compare the findings from these earlier cross-sectional studies, involving surveys at different time points to report on changes in compliance over time to those from our study. To date no study has reported change in compliance of the same cohort of participants, over multiple follow-ups, and also compared the compliance of dentists and dental hygienists.

7.3 Methodological considerations

7.3.1 Strengths

The key strength of this project is in its prospective longitudinal design, allowing repeated measurements of the face-covering and therefore, repeated assessment of the compliance score for the same two cohorts of participants during the study duration. This is unlike other compliance evaluations(139),(110),(145) that are cross-sectional studies reporting results on the basis of one-time observations. In addition, the design has an advantage over panel surveys, such as the compliance study on dentists in Beijing(144) that evaluated different cohort of participants. Majority of the time, stakeholders who developed the guidelines included alternates recommendations. Consequently, another step taken to mitigate the effect of any external factors was to evaluate the participants on the basis of the minimal face-covering standard outlined in the relevant IPC document. Another methodological strength on our work was that, the participants were required to record the face coverings they had worn within the previous two weeks, or in the near past, this approach helped overcome recall bias. In contrast, the recording behaviour of participants only over two weeks, one month apart did not capture the entirety of information, but can be considered a good proxy measure.

7.3.2 Limitations

One of the drawbacks was missing data, both from the relevant websites for the IPC guideline documents and from the individual participants in the dentists and DHs cohorts. The web-search was independently performed by two authors (MK and JF) therefore, reducing any chance of missing some IPC documents. Time periods for which we could not retrieve the IPC documents have been reported as missing information in manuscript I. Nevertheless, there might be more documents that we are unaware of and could not find because of our retrospective search strategy. As a future step, we plan on reaching out to the regulatory bodies to present the information and findings of our project. In return this will verify our search and they might assist us in completing the dossier.

Another limitation is that the cohorts were made up of a convenience sample of dentists and DHs who agreed to take part in the study after receiving email invitations. This might have introduced selection bias by recruiting people who choose to take part in the study. Nevertheless, the participant distribution matched that of the national data on dentists and DHs in Canada(13). Furthermore, an observed low rate of response can be attributed to the practice owner's preoccupation on reconfiguring their practices to be in accordance with guidelines during the pandemic, financial stress due to low revenue generation, and additional

responsibilities due to lesser staff. Moreover, the small sample size limited the scope to a descriptive study, restricting us from comparing compliance of OHCPs between province or evaluating association of compliance with specific characteristics of participants. Nevertheless, to the best of our knowledge, no study has evaluated compliance repeatedly over a year on a cohort of dentists and DHs of this size. To be able to estimate the proportion of fully compliant dentists from a population of approximately 21,000 with a 95% CI and 5% margin of error, the estimated sample size needed in 378. On the other hand, an estimated sample size of 383 DHs is needed to evaluate the proportion of fully compliant DHs with 95% CI and 5% margin of error. Our study has a sufficient sample of 644 dentists and 876 DHs.

On top of this ample bias limitation, our data are likely subject to social desirability bias. Given the importance of infection control procedures during the pandemic, particularly those used by health professionals, self-reported use of PPE through an online questionnaire may have resulted in an overestimation of compliance. Direct observation of the participants is the gold standard for assessing compliance; however, given the nature of COVID-19 and the then in place social distancing public health measures, this was not feasible. Additionally, the expense of the study would have been extremely high due to the need for qualified observers when using this in-person observational approach. Nevertheless, the online survey system permitted us to recruit participants from ten Canadian provinces, increasing the generalizability of the study. Lastly, the lack of a standardised instrument to measure compliance, introduced error while participants were reporting the face-covering combinations. For example, some of the strange responses of using only Glass or only visor for AGPs during the pandemic. However, the number of such responses that were evidently due to misunderstanding of the measurement instrument were small and not likely to have affected the findings.

Finally, 5.9% of dentists and 47.03% of DHs were lost to follow-up during the study, respectively. Assuming that the participants who were lost to follow-up were less compliant by nature and those who continued to be more compliant, our results may have overestimated the true compliance rate. However, the finding from the same cohort study that the COVID-19 infection rates were lower among dentists(13) and DHs(14) support our finding of moderately high compliance rate.

8. CONCLUSION

The following conclusions can be drawn from the results presented in the two manuscripts included in this thesis:

- Majority of the jurisdictions in Canada had different guideline documents for dentists and DHs, and the face-covering recommendations also differed for the two professions.
- The combination of face-coverings recommended for AGPs became flexible and accommodating of alternatives over time; and
- The temporal trend of compliance for dentists depicts considerable change, with a gradual increase over Fall 2020 and a sudden drop in Winter 2021, as compared to the almost constant trend for DHs.
- Compliance among DHs was consistently higher than among dentists.

The implications of this thesis project can be best explained using the example of the life cycle of every policy. This life cycle has three distinct phases in the following order, policy development, policy implementation and policy review(146). It is during the first phase of policy development that technical and circumstantial issues are addressed. Our study is important as it compares IPC guideline documents from within a nation but different jurisdictions. This documented review can be the first step towards bringing policy makers and stakeholders from all jurisdictions of Canada, to discuss the challenges and barriers faced during policy development and dissemination during the COVID-19 pandemic. Even so, considering the possibility of a unified approach during future endemic situations. We also highlighted the frequent updates and revisions of the guideline documents to bring in the aspect of the communication strategy followed by the policy makers. As communication plays an important role in facilitating successful implementation of a policy, the drastic difference in number of updates and revisions between jurisdictions should be another point of discussion for the policy makers nationwide. Furthermore, the findings raise an important question about the perception of the OHCPs towards the fast-changing and updating of IPC guideline documents during COVID-19. Therefore, opening possibilities of future work on knowledge translation from both the policy makers and those who are implementing the policy in their daily work(147). This knowledge translation between the two is intended to be a feedback mechanism.

Moving on to the second phase of a policy, i.e., policy implementation. There is a fine line between development and implementation, as policy development stage should include

considerations for how a policy will be implemented. Recommendations need to be clear to ensure the practitioners can interpret and implement them consistently. Therefore, the findings of rate of compliance of dentists and DHs reported in our study are important as it gives an insight into implementation of the IPC guideline documents shared during the COVID-19 pandemic. Our findings are indirect feedback for the policy makers who want to ensure their policy is being implemented in practice. Most importantly, the results stimulate the need to investigate the challenges, barriers and facilitators encountered by OHCPs in implementing the recommendations, moreover, explore variables that could have affected the compliance rate of the participants positively as well as negatively. Followed by which leverage the knowledge of barriers and facilitators to identify strategies that can influence the implementation of IPC guideline documents.

In conclusion, this thesis project, to an extent is a longitudinal policy review of pan-Canadian oral healthcare system during COVID-19 pandemic. That brings forth the policy development and policy implementation findings that can be beneficial for future policy makers.

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10. APPENDIX I - Dentists and Dental Hygienists cohort studies

10.1 IRB Approval Letter

McGill

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June 5, 2020

Dr. Sreenath Madathil
Dentistry
Faculty of Dentistry
2001 McGill College
Montreal, Quebec H3A 1G1

RE: IRB Review Number: A06-M49-20A (20-06-018)

COVID-19 incidence rates among Canadian dentists as they return to work: a cohort study

Dear Dr. Madathil,

Thank you for submitting the above-referenced study for an ethics review.

As this study involves no more than minimal risk, and in accordance with Articles 2.9 and 6.12 of the 2nd Edition of the Canadian Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans (TCPS 2 2018) and U.S. Title 45 CFR 46, Section 110 (b), paragraph (1), we are pleased to inform you that approval for the study, French questionnaire, French recruitment email and English and French consent forms (IRB dated May 2020) was provided by an expedited/delegated review on 05-Jun-2020, valid until **04-Jun-2021**. The study proposal will be presented for corroborative approval at the next meeting of the Committee.

Prior to initiating the study, please add the following contact information on the French and English consent forms: **For any questions regarding your rights as a research participant, please contact the Faculty of Medicine Ethics Officer at ilde.lepore@mcgill.ca . Si vous avez des questions concernant vos droits en tant que participant à cette recherche, veuillez contacter l'Agente en éthique de la Faculté de Médecine ilde.lepore@mcgill.ca .**

The Faculty of Medicine Institutional Review Board (IRB) is a registered University IRB working under the published guidelines of the Tri-Council Policy Statement 2, in compliance with the Plan d'action ministériel en éthique de la recherche et en intégrité scientifique (MSSS, 1998), and the Food and Drugs Act (17 June 2001); and acts in accordance with the U.S. Code of Federal Regulations that govern research on human subjects (**FWA 00004545**). The IRB working procedures are consistent with internationally accepted principles of good clinical practice.

The Principal Investigator is required to immediately notify the Institutional Review Board Office, via amendment or progress report, of:

- Any significant changes to the research project and the reason for that change, including an indication of ethical implications (if any);
- Serious Adverse Effects experienced by participants and the action taken to address those effects;
- Any other unforeseen events or unanticipated developments that merit notification;
- The inability of the Principal Investigator to continue in her/his role, or any other change in research personnel involved in the project;
- A delay of more than 12 months in the commencement of the research project, and;
- Termination or closure of the research project.

The Principal Investigator is required to submit an annual progress report (continuing review application) on the anniversary of the date of the initial approval (or see the date of expiration).

The Faculty of Medicine IRB may conduct an audit of the research project at any time.

If the research project involves multiple study sites, the Principal Investigator is required to report all IRB approvals and approved study documents to the appropriate Research Ethics Office (REO) or delegated authority for the participating study sites. Appropriate authorization from each study site must be obtained before the study recruitment and/or testing can begin at that site. Research funds linked to this research project may be withheld and/or the study data may be revoked if the Principal Investigator fails to comply with this requirement. A copy of the study site authorization should be submitted the IRB Office.

It is the Principal Investigator's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval and which documents have been approved.

The McGill IRB wishes you and your colleagues every success in your research.

Sincerely,

Roberta M. Palmour

Roberta Palmour, PhD
Chair
Institutional Review Board

cc: Dr. S. Baillet, Associate Dean, Research
A06-M49-20A (20-06-018)

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10 November 2020

Dr. Sreenath Madathil
Faculty of Dentistry
2001, av. McGill-College, Room 533
Montreal QC H3A 1G1

RE: IRB Study Number A06-M49-20A / 20-06-018
COVID-19 incidence rates among Canadian dentists as they return to work: a cohort study

Dear Dr. Madathil,

On 09 November 2020, at a meeting of the Institutional Review Board, the following amendment received a full Board review and approval:

- Amendment Notification dated 05 November 2020
- Updated English and French Baseline and Follow-Up Questionnaires, version 28 October 2020
- English and French Instruction Sheet for Saliva Collection
- English and French Termination email for self-reported positive COVID-19 participants
- English and French Termination email for participants who tested positive for COVID-19 in the saliva test
- Updated English and French Consent Form, version November 2020.

Please ensure that the research consent form is clearly identified as such in the consent title, as well as identify the Principal Investigator, credentials and institutional affiliation at the beginning of the consent form.

Regarding the questionnaire, section 3, the Committee recommends collecting only the first three digits of the postal code to provide participants with added privacy protection.

The Investigator is reminded of the requirement to report all McGill IRB approved study documents to the Research Ethics Offices (REOs) of participating study sites, if applicable. Please contact the individual REOs for instructions on how to proceed. Research funds may be withheld and/or the study's data may be revoked if there is a failure to comply with this requirement.

Kind regards,

Roberta M. Palmour

Roberta Palmour, PhD
Chair
Institutional Review Board

Cc: A06-M49-20A / 20-06-018

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21 September 2021

Dr. Sreenath Madathil
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RE: **IRB Study Number A06-M49-20A / 20-06-018**
COVID-19 incidence rates among Canadian dentists as they return to work: a cohort study

Dear Dr. Madathil,

On 21 September 2021, the following forms received a delegated / expedited review and approval:

- Amendment Notification dated 14 September 2021
- English and French Follow-Up Questionnaires for Canadian Dentists, version 01 September 2021
- English and French Consent to be contacted for future research projects, version September 2021 – ***the investigators might want to have participants identify their name on the re-contact consent form.***

Investigators are reminded of the requirement to report all McGill IRB approved study documents to the Research Ethics Offices (REOs) of participating study sites, if applicable. Please contact the individual REOs for instructions on how to proceed. Research funds may be withheld and/or the study's data may be revoked if there is a failure to comply with this requirement.

Regards,

Roberta M. Palmour

Roberta Palmour, PhD
Chair
Institutional Review Board

Cc: A06-M49-21A / 20-06-018

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June 14, 2022

Dr. Sreenath Arekunnath Madathil
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RE: IRB Study Number A06-M49-20A (20-06-018)
COVID-19 incidence rates among Canadian dentists as they return to work: a cohort study

Dear Dr. Madathil,

Thank you for submitting a Continuing Review Form to renew the above-referenced study's ethics oversight for one more year.

The study progress was reviewed and Full Board re-approval was provided on June 13, 2022. The ethics certification renewal is valid to **June 12, 2023**. The status of your renewal submission including documents can be accessed on eRAP. https://infoed.is.mcgill.ca

Investigators are reminded of the requirement to report all McGill IRB approved study documents to the Research Ethics Offices (REOs) of participating study sites, if applicable. Please contact the individual REOs for instructions on how to proceed. Research funds may be withheld and / or the study's data may be revoked for failing to comply with this requirement.

Should any modification or unanticipated development occur prior to the next review, please notify the IRB promptly. Regulation does not permit the implementation of study modifications prior to IRB review and approval.

Regards,

Roberta M. Palmour, PhD
Chair
Institutional Review Board

cc: A06-M49-20A (20-06-018)

10.2 Questionnaire

COVID-19 incidence rates among Canadian dentists: a cohort study

Follow-up Questionnaires (Updated 01/09/2021)

Sections 7 to 9 are added to the standard follow-up questionnaire (section 1 to 6).

Questions with an asterisk (*) are mandatory.
Questions with a hash (#) will only be asked to participants who consent to provide saliva sample.

Contents

Section 1: COVID-19 Vaccine

The following questions are about vaccination against COVID-19

1. Have you been vaccinated against COVID-19?
(*Answer 'Yes' if you have received at least one dose of the COVID-19 vaccine.*
Note: Certain types of vaccines require more than one dose to protect against COVID-19. You would have been informed at the time of vaccination if you needed a second dose.)

- Yes
- No

2. How many doses of the COVID-19 vaccine have you received so far?
Choose one of the following answers

- One dose
- Two doses
- More than two doses

3. When did you receive your first dose of the COVID-19 vaccine? _____

4. When did you receive your second dose of the COVID-19 vaccine?_____

5. Which vaccine did you receive? *(Choose one of the following answers)*
Was it:

- Pfizer and BioNTech mRNA vaccine
- Moderna mRNA vaccine
- AstraZeneca Oxford vaccine
- Don't know
- Other:

Section 2: COVID-19 Tests and symptoms

6. **Have you tested positive for COVID-19 since November 2019? ***

Please choose **only one** of the following:

- Yes
- No

7. **If yes, how many times and when? ***

Please enter a number: ☐

8. **Since November 2019 did any of your co-workers, at the office(s) where you provided care, test positive for COVID-19? ***

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

9. **If yes, please choose the description(s) that best fits the position of the staff member(s) who had a positive test for COVID-19: ***

Please choose **all** that apply:

- Dentist (If yes, how many dentists? _____)
- Dental hygienist (If yes, how many hygienists? _____)
- Dental assistant (If yes, how many assistants? _____)
- Receptionist (If yes, how many receptionists? _____)
- Other (If yes, how many others? _____)

10. **Have you been tested for COVID-19, other than this project since the last follow-up survey?**
    - Yes
    - No

11. **Please specify the type of test:**
    - Nasopharyngeal swab sample and PCR based test
    - Nasopharyngeal swab sample and antigen test
    - Saliva sample (Other than the test performed in this project) and PCR based Test
    - Saliva sample (Other than the test performed in this project) and antigen Test
    - Serum sample (Blood) and antibody testing
    - Other:_____

12. **Date of testing:**_____

13. **Were you tested positive for SARS-COV2 or COVID-19 in this test?**

- Yes
- No
- Inconclusive
- Still waiting for the results

14. If yes, date of testing: *

Answer must be less or equal to 'today'

Please enter a date: ☐

15. Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19, in last 28 days? *

Please choose **only one** of the following:

- Yes
- No

16. Date of first symptom onset:

Only answer this question if the following conditions are met:

Answer was 'Yes' at question 15 (Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19?)

Answer must be less or equal to 'today'

Please enter a date: ☐

17. Fever (≥38 °C) or history of fever *

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

18. Date of onset of fever:

Only answer this question if the following conditions are met:

Answer was ' Yes' at question 17 (Fever (≥38 °C) or history of fever)

Answer must be less or equal to 'today'

Please enter a date: ☐

19. Sore throat *

Only answer this question if the following conditions are met:

Answer was 'Yes' at question 15 (Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19?)

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

20. Date of onset of sore throat:

Only answer this question if the following conditions are met:
Answer was ' Yes' at question 19 (Sore throat)

Answer must be less or equal to 'today'

Please enter a date: [ ]

21. Cough *

Only answer this question if the following conditions are met:
Answer was 'Yes' at question 15 (Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19?)

Choose one of the following answers
Please choose **only one** of the following:

- Yes
- No
- Unknown

22. Date of onset of cough:

Only answer this question if the following conditions are met:

Answer was ' Yes' at question 21 (Cough)
Answer must be less or equal to 'today'

Please enter a date: [ ]

23. Runny nose *

Only answer this question if the following conditions are met:
Answer was 'Yes' at question 15 (Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19?)
Choose one of the following answers
Please choose **only one** of the following:

- Yes
- No
- Unknown

24. Date of onset of runny nose:

Only answer this question if the following conditions are met:

Answer was ' Yes' at question 23 (Runny nose)

Answer must be less or equal to 'today'

Please enter a date: ☐

25. Shortness of breath *

Only answer this question if the following conditions are met:

Answer was 'Yes' at question 15 (Have you experienced any respiratory symptoms (e.g., sore throat, cough, running nose, shortness of breath) of COVID-19?)

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

26. Date of onset of shortness of breath:

Only answer this question if the following conditions are met:

Answer was ' Yes' at question 25 (Shortness of breath)

Answer must be less or equal to 'today'

Please enter a date: ☐

27. Other symptoms *

Please choose the appropriate response for each item:

	Yes	No	Unknown
Chills			
Vomiting			
Nausea			
Diarrhoea			
Headache			
Rash			
Conjunctivitis			
Muscle aches			
Joint aches			
Nosebleed			
Fatigue			
General malaise			
Loss of appetite			
Loss of smell /altered sense of smell			
Loss of taste / altered sense of taste			

28. Any other symptoms *

Choose one of the following answers

Please choose **only one** of the following:

- Yes (Please specify below)
- No
- Unknown

Make a comment on your choice here:

29. Have you stopped working/practicing (even temporarily), in the past 28 days? *

Please choose **only one** of the following:

- Yes
- No

30. Please specify your last date of working/practicing: *

Answer must be less or equal to 'today'

Please enter a date:

Section 3: Activities

These questions are about your clinical activities in the 2 weeks prior to your last working day, or of 2 weeks prior to your COVID-19 positive test; depending on the answer to questions in the previous section.

31. During this period, did you spend most of your time at home? *

Please choose **only one** of the following:

- Yes
- No

32. During this period, how many times did you leave your home?

Choose one of the following answers

Please choose **only one** of the following:

- Never
- Once
- Twice
- 3 to 5 times
- 6 to 10 times
- More than 10 times

33. Please choose the outdoor activities you engaged in during this period:
(Choose all that applies)

- Shopping (Including shopping for groceries)
- Physical activity in groups (e.g., Gym, sports, dancing)
- Wellness or lifestyle services (e.g., Spa, Hair or Nail Saloons)
- Accompanying family members to events or appointments
- Visiting family or friends in residence or long-term care facilities
- Other:_____

34. During this period did you provide any form of in-person dental care (including consultations)? *
Please choose **only one** of the following:

- Yes
- No

Section 4: In-person dental care episodes

This section refers to the in-person care you provided during the 2 weeks prior to your last working day, or of 2 weeks prior to your COVID-19 positive test; depending on the answer to questions in the previous section.

35.

35. During this period how many patients did you provide some form of in-person dental care per day on average? *
Your answer must be at least 1
Only an integer value may be entered in this field.

Please write your answer here: _____
Please enter an average number.

36. During this period how many patients per day required an aerosol-generating procedure? *
Only an integer value may be entered in this field.

Please write your answer here: _____
Please enter an average number. If none, enter "0".

37. During this period did you provide any in-person dental care for COVID-19 positive patients? *
Please choose **only one** of the following:

- Yes
- No

38. If yes, for how many COVID-19 positive patients? *
Your answer must be at least 1
Only an integer value may be entered in this field.

Please write your answer here: _____

39. During this period did any of the patients you cared for, have any symptoms that made you suspect they are infected with COVID-19? *
Please choose **only one** of the following:

- Yes
- No

40. If yes, how many patients? *
Your answer must be at least 1
Only an integer value may be entered in this field.
Please write your answer here: _____

41. Please specify the types of in-person dental care you provided during this period
Check all that apply
Please choose **all** that apply:

- Advice and education only
- Tooth extraction
- Radiographs
- Examination and evaluation
- Scaling with hand instruments
- Scaling with ultrasonic scaler
- Abscess drainage
- Mineralized tissue removal with handpiece
- Adjustment of prosthesis or orthodontic appliance
- Pulp removal
- Provision of a prescription for a painkiller
- Provision of a prescription for an antibiotic
- Provision of a prescription for another medication
- Other: _____

42. Please specify the types of facial protection you used while providing in-person dental care, during this period *

Please choose the appropriate response for each item:

	For all procedures	For AGPs only	For non AGPs only	For none
Routine surgical mask				
N-95 [or higher] mask				
Eye glasses or goggles				
Facial visor				
Other form of hood or complete head coverage				

43. Did you use any other form of facial covering during the provision of in-person care during this period?*

Choose one of the following answers

Please choose **only one** of the following:

- No
- Yes (Please specify below)
- Make a comment on your choice here:_____

44. From the list below, please choose the Infection Prevention and Control (IPC) procedures and amenities in-place at the clinic you provided care during this period*

(Choose all that applies)

- Separate entrance and exit doorways
- Screening or interviewing patients before appointment for COVID-19 related symptoms
- Screening or interviewing staff members for COVID-19 related symptoms
- Checking the temperature of the patients using a thermometer before the appointment
- Checking the temperature of the staff members at least once a day using a thermometer
- Insisting or encouraging patients to wear masks or face covering
    - At all times
    - Only in the waiting area
    - Only in areas close to where dental care is provided
- Disinfecting of surfaces frequently touched by patients (e.g., doorknobs, switches)
    - After every patient
    - More than once per day but not after every patient
    - Once a day only
    - Never
- Preprocedural mouthwash rinse
- Installation of special air filtering or purification unit

- Use of extra oral aerosol suction device during procedures
- Installation of physical barriers in areas of frequent staff-patient interaction (e.g., plexiglass frames)
- Plan in place for contact tracing in case of an outbreak at your clinic
- Other:_____

Section 5: Co-workers

The questions on this page are referring to the period of 2 weeks prior to your last working day, or of 2 weeks prior to your COVID-19 positive test; depending on the answer to questions in the COVID-19 test and symptoms section.

45. During this period how many members of staff (including dentists, receptionists, dental hygienists, dental assistants and others) **were working with you in the same clinic where you worked most of the time?** *

Your answer must be at least 0

Only an integer value may be entered in this field.

Please write your answer here: _____

Please enter "0" if none.

46. During this period did any of your co-workers, at the office you provided care, have a

positive test for COVID-19? *

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

47. Please choose the description(s) that best fit the position of the staff member(s) who had a positive test for COVID-19: *

Please choose **all** that apply:

- Dentist
- Dental hygienist
- Dental assistant
- Receptionist

- Other:

48. During this period did any of your co-workers, at the office you provided care, have any symptom which made you suspect that they have COVID-19? *

Choose one of the following answers

Please choose **only one** of the following:

- Yes
- No
- Unknown

49. Please choose the description(s) that best fit the position of the staff member(s) who had symptoms similar to COVID-19: *

Check all that apply

Please choose **all** that apply:

- Dentist
- Dental hygienist
- Dental assistant
- Receptionist
- Other: _____

Section 6: COVID-19 Anxiety

50.Please rate the extent to which each statement applies to you over the last two weeks.*

	Not at all (0)	Rarely, less than a day or two (1)	Several days (2)	More than 7 days (3)	Nearly every day (4)
• I have avoided using public transport because of the fear of contracting coronavirus (COVID-19)					
• I have checked myself for symptoms of coronavirus (COVID-19)					
• I have avoided going out to public places (shops, parks) because of the fear of contracting coronavirus (COVID-19)					
• I have been concerned about not having adhered strictly to social distancing guidelines for coronavirus (COVID-19)					
• I have avoided touching things in public spaces because of the fear of contracting coronavirus (COVID-19).					
• I have read about news relating to coronavirus (COVID-19) at the cost of engaging in work.					
• I have checked my family members and loved one for the signs of coronavirus (COVID-19).					
• I have been paying close attention to others displaying possible symptoms of coronavirus (COVID-19).					
• I have imagined what could happen to my family members if they contracted coronavirus (COVID-19).					
• I am afraid of getting COVID-19 from a patient or a co-worker					
• I am anxious when providing treatment to patients with flu like symptoms					

• I fear that the PPE I am using may not be sufficient to protect me against COVID-19				

51.Over the last 2 weeks, how often have you been bothered by the following problems?*

	Not at all (0)	Several days (1)	More than half the days (2)	Nearly every day (3)
Feeling nervous, anxious or on edge				
Not being able to stop or control worrying				
Worrying too much about different things				
Trouble relaxing				
Being so restless that it is hard to sit still				
Becoming easily annoyed or irritable				
Feeling afraid as if something awful might happen				

Section 7: Economic impact of COVID-19

Context:

The following set of questions are concerning the economic impact that the COVID-19 pandemic might have had on your practice and the anxiety you might have had due to any such economic impact during this period. Understanding that the situation may have been changing dynamically, we have divided the pandemic times into four periods as follows:

- Strict lockdown period (March to April 2020)
- Return to work period (May to July 2020)
- Chronic period (August to December 2020)
- Vaccination period (January 2021 to present)

Please refer to the above time periods in the pandemic while answering questions 53 to 56

52. Which of the following options regarding type of dentist applies to you? *
(Please choose all that apply)

- General dentist
- Specialist
- Practice-owner
- Associate dentist
- Employed with corporate dental practice
- Working in a hospital or dental school
- Other_____

53. Which practice-related factors have led to increased anxiety for you during the COVID-19 pandemic?*
(Please choose all that apply)

- Reduced revenue collection
- Ability to offer limited dental treatments
- Reduced number of patients
- Increased costs involved in practice
- Fear of losing your job
- Being redeployed to frontline healthcare services
- Laying off dental office staff
- Other_____

54. Compared to before the pandemic, what was the change in your practice income during the following time periods of the COVID-19 pandemic?*

'Your practice income' refers to the income generated through services provided in your dental practice(s).

	Very much decreased	Somewhat decreased	No change	Somewhat increased	Very much increased
Strict lockdown period *(Mar to Apr 2020)*					
Return to work period *(May to Jul 2020)*					
Chronic period (Aug to Dec 2020)					
Vaccination period (Jan 2021 to present)					

55. Compared to before the pandemic, what was the change in your practice costs during the following time periods of the COVID-19 pandemic? *

Practice costs refers to the expenses involved in running the practice. These include the salaries paid to dental office staff.

	Very much decreased	Somewhat decreased	No change	Somewhat increased	Very much increased
Strict lockdown period *(Mar to Apr 2020)*					
Return to work period *(May to Jul 2020)*					
Chronic period (Aug to Dec 2020)					
Vaccination period (Jan 2021 to present)					

56. Compared to before the pandemic, what was the change in your practice net revenue generation during the following time periods of the COVID-19 pandemic? *

Net revenue is defined as "for you" only. It is income left over after practice expenses and business taxes and includes salary, commission, bonus and/or dividends and any payments made to a retirement plan on the dentist's behalf.

	Very much decreased	Somewhat decreased	No change	Somewhat increased	Very much increased
Strict lockdown period *(Mar to Apr 2020)*					
Return to work period *(May to Jul 2020)*					
Chronic period (Aug to Dec 2020)					
Vaccination period (Jan 2021 to present)					

57. Compared to before the pandemic, what was the effect of the above economic aspects of your practice on <u>your levels of anxiety</u> during the following time periods of the COVID-19 pandemic? *

	Very much decreased	Somewhat decreased	No change	Somewhat increased	Very much increased
Strict lockdown period					

(Mar to Apr 2020)					
Return to work period *(May to Jul 2020)*					
Chronic period (Aug to Dec 2020)					
Vaccination period (Jan 2021 to present)					

58. Which factors have helped you to manage your anxiety during the COVID-19 pandemic? *
(Please choose all that apply)

- Decided to retire earlier than previously planned
- Followed guidance from the provincial dental regulatory authority
- Submitted claims to dental insurance companies
- Received COVID-19 vaccination for yourself, family and dental office staff
- Enrolled in wellness initiative programs
- Financial support schemes from the government
- Other_____

59. What are the policy changes from dental regulatory authorities you would like to see in order to assist you to manage your anxiety during the COVID-19 pandemic?

Please write your answer here:

Section 8: Overall impact of COVID-19

60. Some provinces are moving towards mandating proof of vaccination for obtaining certain services (e.g., gyms, bars, festivals). What is your perspective on such a policy for dental visits and/or for your staff?

61. **How were your regulatory body's COVID-19 guidelines communicated to you? What are your thoughts on these communications?**

62. **What is your perspective on your regulatory body's COVID-19 guidelines?**

63. **What was your experience navigating information (e.g., guidelines, scientific reports and journals) that were available to you in providing dental care during different stages of the pandemic?**

64. **How are you managing patients with known or suspected COVID-19?**

65. **As researchers, we are interested in learning as much as we can about the COVID-19 experience for Canadian Dentists. Given your experiences, can you describe questions that warrant further exploration?**

66. **Please provide any observations you have concerning the dental care provision during the COVID-19 pandemic:**

Section 9: Participant satisfaction

We would like to evaluate how you feel about this research study, for future research purposes.

67. Please select one answer that best represents how you feel about the online survey part of this research study*

	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
a. This research study met my expectations.					
b. I was comfortable with the research procedure.					
c. I was comfortable working with the research team.					
d. The informed consent form was easy to understand.					
e. Based on my experience with this research study, I would participate in a similar study in the future.					

68. How disruptive was participating in this research study on your daily routine?*

- Completely disruptive
- Very disruptive
- Moderately disruptive
- Not very disruptive
- Not at all disruptive

69. Please select one answer that best represents how you feel regarding the saliva collection

	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
a. It was easy to follow the instructions of the saliva sample collection					
b. I feel confident that I followed the sample collection procedure as instructed.					
c. I felt comfortable collecting my own saliva sample.					
d. The package delivery and shipping procedures were well-instructed					

e. Using the prepaid self-addressed envelopes and FedEx was easy					
f. I would be comfortable participating in another study using the same saliva sample collection and shipping procedure					
g. The courier strategy of saliva samples will be essential to facilitate the diagnosis and prognosis of oral and systemic diseases					
h. The saliva collection procedure was not time consuming					
i. I was concerned about shipping my saliva samples via FedEx					

70. If you chose 5 or 4 for the question 68.i. above, please choose the reasons for your concern (select all that apply) #*

- Disease transmission
- Inappropriate handling and use
- Sample loss
- Other: _____

11. APPENDIX II – Supplementary Material Manuscript – I

Table 1: Regulatory authorities from all Canadian jurisdictions that published enhanced IPCGs

Name of Province	Dental regulatory body / association	Website URL	Dental hygiene regulatory body / association	Website URL
AB	Alberta dental association and college	https://www.dentalhealthalberta.ca/home/covid-19-info/	College of registered dental hygienists of Alberta	https://www.crdha.ca/protecting-the-public/covid-19-information
BC	College of dental surgeons of British Columbia	https://www.cdsbc.org/about-cdsbc/news/covid-19/covid-19-for-registrants	College of dental hygienists of British Columbia	https://www.cdhbc.com/News-Events/COVID-19.aspx
MB	Manitoba dental association	https://www.manitobadentist.ca/covid-19	College of dental hygienists of Manitoba	https://cdhm.info/news/covid-19/
NB	New Brunswick dental society	Not able to access*	New Brunswick college of dental hygienists	https://www.nbcdh.ca/legislation-and-resources/standards-of-practice/
NL	Newfoundland and Labrador dental association, Newfoundland and Labrador dental board	https://nlda.net/covid-19/	Newfoundland and Labrador college of dental hygienists	https://www.nlcdh.com/documents
NS	Provincial Dental Board Nova Scotia	http://pdbns.ca/covid19	College of dental hygienists of Nova Scotia	https://www.cdhns.ca/index.php/public/information-and-announcements
ON	Royal college of dental surgeons Ontario	https://www.rcdso.org/en-ca/rcdso-members/2019-novel-coronavirus/covid-19--managing-infection-risks-during-in-person-care	College of dental hygienists of Ontario	https://www.cdho.org/my-cdho/practice-advice/covid-19
PE	Dental Association of Prince Edward Island	https://www.dapei.ca/new-page-5	Dental association of Prince Edward Island	https://www.dapei.ca/new-page-5
QC	Ministère de la Santé et des Services sociaux (En: Ministry of Health and Social services)	https://www.msss.gouv.qc.ca/professionnels/covid-19/directives-cliniques-aux-professionnels-et-au-reseau/procedures-buccodentaires/	Ministère de la Santé et des Services sociaux (En: Ministry of Health and Social services)	https://www.msss.gouv.qc.ca/professionnels/covid-19/directives-cliniques-aux-professionnels-et-au-reseau/procedures-buccodentaires/
SK	College of dental surgeon of Saskatchewan	https://saskdentists.com/alerts	Saskatchewan dental hygienists' association	https://sdha.ca/covid-19-update/
NT	Government of Northwest Territories	https://www.gov.nt.ca/en/newsroom?search_api_views_fulltext=oral	Government of Northwest Territories	https://www.gov.nt.ca/en/newsroom?search_api_views_fulltext=oral
YK	Government of Yukon	https://yukon.ca/en/health-and-wellness/covid-19-information/health-professionals-covid-19	Government of Yukon	https://yukon.ca/en/health-and-wellness/covid-19-information/health-professionals-covid-19
NU	Government of Nunavut	https://gov.nu.ca/news?page=49	Government of Nunavut	https://gov.nu.ca/news?page=49

12. APPENDIX III – Supplementary Material Manuscript - II

Table1: Compliance score for all combinations

Recommended Face-covering / **Reported use by Participant**	N95 + Glass	N95 + Visor	Surgical_mask + Glass	Surgical_mask + Visor	N95 + Glass + Visor	Surgical_mask + Glass + Visor
Surgical_mask + N95 + Glass + Visor	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{3}/_{3}$	$^{3}/_{3}$
Surgical_mask + N95 + Visor	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{3}$	$^{2}/_{3}$
Surgical_mask + N95 + Glass	$^{2}/_{2}$	$^{1}/_{2}$	$^{2}/_{2}$	$^{1}/_{2}$	$^{2}/_{3}$	$^{2}/_{3}$
N95 + Glass + Visor	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{3}/_{3}$	$^{3}/_{3}$
Surgical_mask + Glass + Visor	$^{1}/_{2}$	$^{1}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{3}$	$^{3}/_{3}$
N95 + Visor	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{3}$	$^{2}/_{3}$
N95 + Glass	$^{2}/_{2}$	$^{1}/_{2}$	$^{2}/_{2}$	$^{1}/_{2}$	$^{2}/_{3}$	$^{2}/_{3}$
Surgical_mask + Visor	$^{1}/_{2}$	$^{1}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{1}/_{3}$	$^{2}/_{3}$
Surgical_mask + Glass	$^{1}/_{2}$	$^{0}/_{2}$	$^{2}/_{2}$	$^{1}/_{2}$	$^{1}/_{3}$	$^{2}/_{3}$
Glass + Visor	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{2}/_{3}$	$^{2}/_{3}$
N95	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$
Surgical_mask	$^{0}/_{2}$	$^{0}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{0}/_{3}$	$^{1}/_{3}$
Visor	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{3}$	$^{1}/_{3}$
Glass	$^{1}/_{2}$	$^{0}/_{2}$	$^{1}/_{2}$	$^{0}/_{2}$	$^{1}/_{3}$	$^{1}/_{2}$
MaxiAir CAPR PAPR	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{2}/_{2}$	$^{3}/_{3}$	$^{3}/_{3}$

None	$^{0}/_{2}$	$^{0}/_{2}$	$^{0}/_{2}$	$^{0}/_{2}$	$^{0}/_{3}$	$^{0}/_{3}$

Table 2: Proportion of Dentists who reported the combination of face-covering used during AGPs.

	flw00 (N=612) n (%)	**flw01 (N=619) n (%)**	**flw02 (N=613) n (%)**	**flw03 (N=611) n (%)**	**flw04 (N=553) n (%)**	**flw05 (N=592) n (%)**	**flw06 (N=587) n (%)**	**flw07 (N=560) n (%)**	**flw08 (N=541) n (%)**	**flw09 (N=530) n (%)**	**flw10 (N=523) n (%)**	**flw11 (N=559) n (%)**
Face-cover combination for AGPs by Dentists												
Surgical_mask + Glass + Visor	219 (35.8)	235 (38.0)	202 (33.0)	180 (29.5)	145 (26.2)	139 (23.5)	165 (28.1)	164 (29.3)	162 (29.9)	139 (26.2)	134 (25.6)	138 (24.7)
Surgical_mask + Glass	126 (20.6)	134 (21.6)	101 (16.5)	91 (14.9)	65 (11.8)	63 (10.6)	75 (12.8)	74 (13.2)	81 (15.0)	115 (21.7)	128 (24.5)	150 (26.8)
Surgical_mask + N95 + Glass + Visor	100 (16.3)	87 (14.1)	109 (17.8)	114 (18.7)	115 (20.8)	127 (21.5)	129 (22.0)	122 (21.8)	108 (20.0)	98 (18.)	84 (16.1)	77 (13.8)
N95 + Glass + Visor	94 (15.4)	88 (14.2)	103 (16.8)	126 (20.6)	133 (24.1)	157 (26.5)	126 (21.5)	115 (20.5)	106 (19.6)	100 (18.9)	93 (17.8)	100 (17.9)
Surgical_mask + N95 + Glass	20 (3.3)	23 (3.7)	20 (3.3)	28 (4.6)	29 (5.2)	31 (5.3)	29 (4.9)	24 (4.3)	22 (4.1)	20 (3.8)	18 (3.4)	26 (4.7)
N95 + Glass	18 (2.9)	19 (3.1)	32 (5.2)	32 (5.2)	35 (6.3)	35 (6.0)	31 (5.3)	27 (4.8)	31 (5.7)	27 (5.1)	33 (6.3)	39 (7.0)
Surgical_mask + Visor	17 (2.8)	16 (2.6)	16 (2.6)	10 (1.6)	9 (1.6)	11 (1.9)	10 (1.7)	13 (2.3)	12 (2.2)	9 (1.7)	11 (2.1)	9 (1.6)
Surgical_mask + N95 + Visor	5 (0.8)	3 (0.5)	5 (0.8)	5 (0.8)	1 (0.2)	4 (0.7)	2 (0.3)	2 (0.4)	2 (0.4)	2 (0.4)	2 (0.4)	2 (0.4)
N95 + Visor	7 (1.1)	6 (1.0)	15 (2.4)	13 (2.1)	14 (2.5)	15 (2.6)	8 (1.4)	11 (2.0)	7 (1.3)	9 (1.7)	5 (1.0)	7 (1.3)
MAXAIR CAPR-PAPR	2 (0.3)	3 (0.5)	2 (0.3)	2 (0.3)	3 (0.5)	3 (0.5)	3 (0.5)	5 (0.9)	4 (0.7)	3 (0.6)	5 (1.0)	4 (0.7)
Glass + Visor	1 (0.2)	0 (0)	3 (0.5)	4 (0.7)	0 (0)	1 (0.2)	2 (0.3)	0 (0)	1 (0.2)	0 (0)	0 (0)	0 (0)
Surgical_mask	1 (0.2)	0 (0)	0 (0)	1 (0.2)	1 (0.2)	0 (0)	1 (0.2)	1 (0.2)	0 (0)	3 (0.6)	0 (0)	2 (0.4)
Visor	1 (0.2)	0 (0)	1 (0.2)	3 (0.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N95	0 (0)	2 (0.3)	0 (0)	0 (0)	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.2)	1 (0.2)	1 (0.2)
Glass	0 (0)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
None	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.2)	1 (0.2)	0 (0)	0 (0)	0 (0)	1 (0.2)
Missing	0 (0.0)	2 (0.3)	3 (0.5)	1 (0.2)	1 (0.2)	6 (1.0)	5 (0.9)	1 (0.2)	5 (0.9)	4 (0.8)	9 (1.7)	3 (0.5)

Surgical_mask – Surgical Mask (ASTM level 1,2 and 3)
N95 – respirators with filtration capacity > 95%
Glass – glasses / goggles / partial coverage eye protection
Visor – face-shield / visor / full coverage eye protection

Table 3: Proportion of Dental Hygienists who reported the combination of face-covering used during AGPs.

	flw0 (N=806) n (%)	**flw1 (N=699) n (%)**	**flw2 (N=600) n (%)**	**flw3 (N=552) n (%)**	**flw4 (N=536) n (%)**	**flw5 (N=440) n (%)**	**flw6 (N=402) n (%)**
Face-cover combination for AGPs by dental Hygienists							
Surgical_mask + Glass + Visor	307 (38.1)	285 (40.8)	264 (44.0)	230 (41.7)	226 (42.2)	188 (42.7)	158 (39.3)
Surgical_mask + N95 + Glass + Visor	186 (23.1)	164 (23.5)	129 (21.5)	104 (18.8)	92 (17.2)	55 (12.5)	55 (13.7)
N95 + Glass + Visor	147 (18.2)	129 (18.5)	94 (15.7)	86 (15.6)	67 (12.5)	59 (13.4)	55 (13.7)
Surgical_mask + Glass	44 (5.5)	36 (5.2)	41 (6.8)	59 (10.7)	74 (13.8)	64 (14.5)	68 (16.9)
Surgical_mask + Visor	26 (3.2)	17 (2.4)	21 (3.5)	21 (3.8)	18 (3.4)	13 (3.0)	8 (2.0)
N95 + Visor	26 (3.2)	16 (2.3)	9 (1.5)	10 (1.8)	4 (0.7)	5 (1.1)	5 (1.2)
Surgical_mask + N95 + Glass	15 (1.9)	14 (2.0)	17 (2.8)	16 (2.9)	13 (2.4)	13 (3.0)	11 (2.7)
Surgical_mask + N95 + Visor	10 (1.2)	11 (1.6)	2 (0.3)	3 (0.5)	2 (0.4)	2 (0.5)	2 (0.5)
N95 + Glass	10 (1.2)	6 (0.9)	4 (0.7)	1 (0.2)	8 (1.5)	7 (1.6)	8 (2.0)
Glass + Visor	2 (0.2)	3 (0.4)	3 (0.5)	3 (0.5)	2 (0.4)	0 (0)	0 (0)
MAXAIR CAPR-PAPR	2 (0.2)	2 (0.3)	0 (0)	1 (0.2)	1 (0.2)	0 (0)	0 (0)
N95	1 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.2)	0 (0)
Glass	1 (0.1)	4 (0.6)	1 (0.2)	2 (0.4)	0 (0)	0 (0)	0 (0)
Surgical_mask	0 (0)	0 (0)	2 (0.3)	1 (0.2)	2 (0.4)	3 (0.7)	1 (0.2)
Surgical_mask + N95	0 (0)	0 (0)	0 (0)	1 (0.2)	0 (0)	1 (0.2)	0 (0)
Visor	0 (0)	0 (0)	0 (0)	1 (0.2)	0 (0)	0 (0)	0 (0)
None	5 (0.6)	3 (0.4)	2 (0.3)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)
Missing	24 (3.0)	9 (1.3)	11 (1.8)	12 (2.2)	26 (4.9)	28 (6.4)	30 (7.5)

Surgical_mask – Surgical Mask (ASTM level 1,2 and 3)
N95 – respirators with filtration capacity > 95%
Glass – glasses / goggles / partial coverage eye protection
Visor – face-shield / visor / full coverage eye protection