

The Influence of the Changing External Environment and Demographics on Orthodontics

By

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Abstract

Purpose: To evaluate the factors that influence potential orthodontic patients' choice between an orthodontist, general dentist (GPs), and direct-to-consumer (DTC) providers for their treatment. To evaluate orthodontists' perceived impact from GPs and DTC providers providing orthodontic treatment and determine the adaptive changes they have made to the administration of their practices in the past ten years.

Methods: An electronic survey was administered to 330 individuals among the general population of adults in Canada. Questions were designed to determine the participants' demographic background, choice of orthodontic treatment provider, preferred mode of treatment, orthodontic issues they wished to address, and motivation for treatment. An electronic survey was also administered to 270 orthodontists in Canada and the United States. Questions were designed to determine the orthodontists' demographic background, practice profile, perceived impact from non-specialist orthodontic providers, and recent changes to the administration of their practices. For both surveys, Pearson's chi-squared tests were used to evaluate the factors influencing participants.

Results: When laypersons were asked their preference in provider type, 49.4% of participants selected an orthodontist, 19.2% would follow the recommendation of their general dentist, 18.9% selected a general dentist, and 12.5% selected DTC providers. When asked their preference in mode of orthodontic treatment, 45.4% selected clear braces, 34.1% selected clear aligners, 14.3% selected metal braces, and 6.1% indicated they currently have no interest in orthodontic treatment. When orthodontists were asked if they perceived an impact from GPs providing orthodontic care, 67.7% indicated yes, 19.3% indicated no, and 13.0% were unsure. When orthodontists were asked if they perceived an impact from DTC providers offering orthodontic care, 40.1% indicated yes,

33.1% indicated no, and 26.8% were unsure. When orthodontists were asked if they have perceived a reduction in the number of referrals received from GPS in the past ten year 61.1% indicated yes, 23.3% indicated no, and 15.6% were unsure. When orthodontists were asked if they feel the need to make their practice more competitive 74.0% indicated yes, and 26.0% indicated no.

Conclusions: Adults in Canada have a high preference for orthodontic treatment to be performed by orthodontists, and a subsequent lesser extent for GPs and DTC providers. Younger respondents were more likely to prefer metal braces, while older respondents were more likely to prefer clear braces. Preference for clear aligners is positively correlated to a larger community size. The perceived impact of GPs providing orthodontic care was greater than that of DTC providers. American orthodontists were significantly more likely than Canadian orthodontists to perceive an impact on their practice from DTC providers. Orthodontists have experienced a reduction in referrals from GPS and an increase in referred case difficulty. Orthodontists in Canada and those who are female have made significant changes to the administration of their practices in the last ten years.

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Introduction

Traditionally, orthodontic practices relied heavily on referrals from general practitioners (GPs) to acquire new patients. In the early 2000s, clear aligner therapy was popularized by Align Technology with their Invisalign system. GPs now had a tool to provide orthodontic services and keep their patients “in house”.¹ The rise in popularity of clear aligner therapy has had two significant effects on orthodontists: (1) an increased number of GPs are providing orthodontic treatment, and (2) direct to consumer (DTC) providers are enabling patients to treat themselves at home without direct supervision by an oral health care provider. Studies from the end of the 20th century reported that 18-20% of dentists provide comprehensive orthodontic treatment with 32-57% offering some form of limited treatment.^{2,3} The number of GPs who utilize clear aligner therapy has also increased in the past two decades.^{3,4} Current reports suggest an expected increase in the future.^{5,6} In the past decade, the thriving clear aligner sector has also spawned new orthodontic product companies that advertise directly to the consumer.^{1,7,8} Despite the data demonstrating a rise in general dental practitioners providing orthodontic services and the advent of DTC providers a significant number of patients still seek treatment from orthodontic specialists. To date, only two studies have examined the influence of patient factors on selection of an orthodontic treatment provider.^{9,10} These studies sought to determine the influence of various patient demographic factors on selection of an orthodontic treatment provider. Additionally, the perceived effects of general practitioner orthodontics and DTC providers on orthodontic specialists was examined. It is important for orthodontists and other dental professionals to know what factors affect patient preferences and the collective perceptions of colleagues regarding the evolving state of the orthodontic specialty profession.

Literature Review

As a part of the literature review, patient demographic information and the relative importance of different demographic factors will be discussed. In order to provide a comprehensive background of the changing external environment surrounding orthodontic practices several categories will be explored. The literature pertaining to the business of orthodontics will be expounded. The history and current state of general practitioner orthodontics and teleorthodontics will be illuminated. After following the trends observed, this literature review will culminate in an explanation of do-it-yourself (DIY) orthodontics.

Patient Demographics

Prevalence of Malocclusions

The prevalence of malocclusion in adults is equal to or greater than that observed in children.¹¹ Several authors have reported that approximately two-thirds the US adult population have some type of malocclusion.^{12,13} Malocclusions have a range of consequences including physical, social, economic, and psychological.¹⁴ These concerns can affect quality of life through the detriment of function, appearance, and inter-personal relationships.¹⁵

Patient Demographic Factors Influence on Treatment

The literature contains several studies examining patient values in orthodontics.¹⁶⁻¹⁸ It has been suggested that patient values such as oral function and aesthetics might encourage people to seek orthodontic services.^{19,20} An interesting continuation of this line of thinking is considering how demographic information such as age, ethnicity, gender, family status, education, employment, and income affect a patient's perception and predisposition for seeking orthodontic treatment.

Age. Children and adolescents have always been a core segment of the orthodontic population. Prior to the 1960's adult orthodontic treatment was uncommon and at times discouraged.²¹ After the mid-1970's it became more common as society became more conscious of health and aesthetics.²¹ Traditionally, referring to adult orthodontic treatment implied a patient in their 20's or early 30's. The notion of adult treatment has been progressively changing to include middle-aged and senior adult patients.^{22,23} The principal reasons for this change are an aging population, an increased ability for the profession to treat older patients' concerns, the populations' augmented desire to maintain their teeth, and the patients' desire to improve their function and aesthetics.²⁴ Adult patients typically differ from children and adolescents by having an increased prevalence of periodontal problems.^{25,26} Adult patients also have a more resilient psychological profile than children and adolescents indicating they are less vulnerable to the unpleasant psychological effects of malocclusions and treatment.²⁷ One can surmise, that patients of different ages will have diverse perceptions of their need and potential benefit from orthodontic treatment.^{11,28,29} Such differences may affect their choice for modality of treatment. It is also within the realm of possibility that a parent may choose a different provider of orthodontic care for themselves and their child. It is generally accepted that in most scenarios parents make decisions for their offspring with the child's best interests in mind.³⁰ One can speculate on whether this logic applies to adult patients own self-interest when choosing from different orthodontic treatment providers.

Race. Racial and ethnic disparities exist in self-reported orthodontic visits among Black and Hispanic children.³¹ They reported fewer orthodontic visits compared to White children of a similar population size. The authors found that even after adjusting for socio-economic disparities, both minority groups were less likely to report an orthodontic visit. Furthermore, multiple studies

have suggested a disparity of prevalence of malocclusions across racial groups.^{32–36} One such study reported that Black children have a greater incidence of severe malocclusion than White children.³⁷ Studies have reported that there was a disparity between White and non-White groups in the number of orthodontic visits.^{31,38,39} Manski and coauthors estimated that roughly 3.5% of the White population had an orthodontic visit, while only 2% percent of the non-White population reported a visit.³⁸ The white group was homogenous; however, the non-White group was composed of multiple ethnic groups, with different cultures and values.

Gender. Gender is a demographic profile that is of interest in determining patients' desire for, and choice for mode of orthodontic treatment due to the divergences within the literature. However, two studies have found that gender has no significant effect on the desire for orthodontic treatment.^{40,41} These authors found that self-perceived facial aesthetics relating to factors such as anterior crowding were the main driving factors prompting patients to seek treatment, rather than gender. Alternatively, some authors have reported that woman are more conscientious about aesthetics and less satisfied with their dental appearance than men.^{42–44} A study of a Taiwanese population found that women were more likely to be concerned about the negative aesthetic impact of orthodontic treatment but also valued the appealing outcomes of treatment.⁴⁵

Family Status. The available literature linking marital or family status to orthodontic preferences is scarce. A study investigating the psychosocial reward of orthodontic treatment in adults determined that there was no difference in self-confidence or psychological impact post treatment between married and unmarried individuals across various education levels.⁴⁶ A report of Taiwanese patients found a significant influence of marital status on desire for treatment among women, with unmarried individuals having a greater interest in orthodontic treatment.⁴⁵

Location. There is a paucity of research examining how patient geographic location affects choice of orthodontic treatment provider. Elgin performed a study investigating the factors affecting patient selection of an orthodontic practice and found that location was a consistently important influence.⁴⁷ A more recent study corroborated this finding that convenience of location is important to patients.⁴⁸ The aforementioned studies examined the importance of orthodontic practice location when the choice of orthodontic treatment provider was limited to specialists. Only one study to date has examined the influence of patient geographic data on preference for provider of orthodontic treatment.⁹ They examined whether their survey respondents were from a small town, town/small city, large city, or metropolitan area. Olsen et al., found that geographic factors were significantly associated with preference for an orthodontic treatment provider.⁹ Based on the aforementioned literature, further research is needed to examine the association between orthodontist location and the preference for an orthodontic treatment provider.

Education. There is a paucity of evidence to explain how patient education levels relates to their perception of orthodontic problems.⁴⁹ Authors who have studied the subject have previously focused on patient education resources, a variable they can control.^{49,50} A study of orthodontic patient treatment decisions found that it was advantageous to have patient education materials at a high school education level to improve accessibility of information.⁴⁹ It has been suggested that patient education is associated with perception of orthodontic treatment. A study of Pakistani patients suggested that patients with a higher education experienced significantly less anxiety about orthodontic treatments than patients with lesser education.⁵⁰

Several authors have studied the demographic of patient education level relating to orthodontic treatment choices.^{38,51} The likelihood of a dental visit for orthodontic purposes is less for patients with a low education level.³⁸ It has been suggested that families with fathers who have

completed a higher education level (e.g., greater than secondary school) place more value on orthodontic treatment.⁵¹ Patient education level can also affect the value they place on the various benefits of orthodontic treatment. Adult patients/parents with higher education levels placed greater value in both good oral function and dental aesthetics.⁵² This study also found that adult patients/parents with higher education levels relied most on their general dental practitioner for information about orthodontic treatment.⁵²

Employment. One team of researchers have published two studies examining the association between oral health and employment status.^{53,54} Both articles reported that unemployed subjects exhibited greater levels of missing teeth, decayed teeth, and periodontal problems than employed ones.^{53,54} A cross-sectional study described a significant association between workplace-related factors such as employment status and self-reported oral health.⁵⁵ Facial attractiveness has been shown to affect social interactions and employment situations.^{56,57} It has also been shown that dental rehabilitation has a positive impact on quality of life and employment of patients.⁵⁸ While it should be no surprise, research has shown that employed persons are significantly more likely to present for an orthodontic visit for themselves or their child.³⁸

Differentiation among employment status of individuals has also been examined. Temporary employment versus full employment has attracted attention in recent years due to the considerable changes in the labour market over the past two decades.⁵⁹ There have been increasing levels of unstable employment in both the public and private sectors of developed countries in recent decades.⁶⁰ The number of temporary employees continues to rise in developed countries.⁶¹ Unstable or temporary employment has significant adverse effects on health.⁶²

A change in employment status will reduce the likelihood of presenting for elective dental services.⁶² The secondary effect of psychologic stress may explain the association between

unstable employment and reduced oral health status. The association between work-related stress associated with unstable employment and the development of psychological disorders is well documented.^{63,64} Stress from unstable employment and psychological disorders can influence health behaviours such as reduced tooth brushing and heavier smoking.⁶⁵ An increase in stress levels is associated with a poorer biologic condition of the oral cavity.⁶⁶ Increased stress levels associated with employment also has the effect of reducing salivary flow which can increase the risk of periodontal disease.⁶⁷ A study of a Japanese adult population reported that a change in employment status from regularly employed to temporary employment was associated with increased rates of tooth loss.⁵⁹ In a study of treatment outcomes, it was determined that a parent's employment status was not a significant indicator of orthodontic treatment outcomes.⁶⁸ According to recent findings, the use of employment status as an indicator of socioeconomic status has serious limitations and may explain the lack of results in the literature.⁶⁸

Income. Household income seems to be the most obvious barrier to orthodontic treatment. Children from low-income families and those without private health insurance are less likely to report an orthodontic visit in the United States.³¹ Children from low-income families are significantly more likely to enter adulthood with malocclusions that harm quality of life.⁶⁹ Research has been conducted on the need for orthodontic treatment among socioeconomic groups. A study by Tickle et al reported that the need and desire for orthodontic treatment was higher among deprived socio-economic groups.⁷⁰ Family income may also have an effect on patient's preference for orthodontic treatment. A study of patient and parent preferences for orthodontic practices reported that high-income families were attracted to office characteristics such as excellence of the orthodontist, personalized attention, and convenience.⁴⁸ The same study also noted that parents with lower income, divorced parents, and parents with more children were

concerned about affordability and preferred an office offering payment plans.⁴⁸ Patients and families also experience financial loss related to absence from work to attend appointments. A survey⁷¹ of patients found that 77% of children attending orthodontic appointments were accompanied by one or both parents resulting in a financial loss in 18% of these cases due to absence from work.

Weighting Demographic Categories

Patient demographic factors related to socioeconomic status can have a significant impact on oral health. Patient employment status has been linked with poor oral health^{53,54,59} and less motivation for dental treatment.^{38,62} Patients with a higher level of education have an increased interest in their oral health.^{38,50–52} Individuals with a lower income are less likely to utilize orthodontic services^{31,69} despite some research showing greater need.⁷⁰ The previously discussed literature only examines patient interest and need for orthodontic treatment based on demographic factors. In the process of this review, only one study has been identified weighing demographic factors in relation to orthodontic treatment outcomes.⁶⁸ The authors measured patient demographic factors as well as pre- and post-treatment Index of Treatment Complexity, Outcome, and Need (ICON)⁷² scores in an attempt to describe the role of socioeconomic status on orthodontic treatment outcomes.⁶⁸ Patient demographics such as income and occupation were found to be correlated to treatment outcomes, while education and employment status were not.⁶⁸ Therefore, some demographic characteristics traditionally exert more importance than others.

The Changing External Environment and Profession's Response

The setting in which orthodontic practices exist has changed dramatically over the preceding decades. Orthodontic practices have always functioned as small businesses in North America and had near absolute influence on the provision of orthodontic care. In recent years, more GPs have begun offering limited and full orthodontic treatment. Clear aligner companies have also spawned and begun offering orthodontic care. A depiction of modifications to the environment surrounding orthodontic practices will be described and interpreted.

Business in Orthodontics

Orthodontic Practices Function as Small Businesses

The healthcare industry, dentistry, and orthodontics are continuously changing. Orthodontic practices are small businesses. In order to function and thrive they must be competitive. The market influences the nature of competition, specifically the environment and industry operates therein.⁷³ As the market evolves, business owners form strategies to adapt. One would expect competitive market forces to affect the business aspect of orthodontic practices. A business strategy is formulated by assessing external opportunities and threats as well as internal strengths and weaknesses. Businesses that specifically create strategies usually perform better than their counterparts.⁷³ The business of orthodontics is changing as GPs still refer orthodontic patients, however that source of new patients has been steadily declining.⁷⁴ Orthodontists need to know patient values in order to appeal to them.

Marketing

In modern society, most businesses compete for consumers. Dental health care providers also participate in this convention. Marketing is a key instrument employed to acquire consumers.

The goal of marketing is to present products or services to potential customers to increase their desirability. This also applies to orthodontics since it is often an elective service.⁷³

Traditionally, the main way to gain patients is through referrals from general dentists and existing patients.⁷⁵ In recent decades, GPs have increased the number of patients they provide with orthodontic services and DTC providers have begun marketing directly to patients.^{1,2} More contemporary methods of acquiring new orthodontic patients are advertising and visibility through community involvement.⁷⁵ A study published in 2005 indicated that at that time, 50% of all orthodontic patient referrals came from GPs and 30% came from patients.⁷⁶

Internal marketing involves integrating with existing patients to influence them to refer relatives and friends. Multiple factors can be manipulated to serve as internal marketing, including: office design, inner décor, positivity of staff-patient interactions, inter alia.⁷⁷ External marketing is directed outward towards potential patients. The elements that can be influenced externally to attract new patients include: advertising, sponsorships, community involvement and any other means to positively increase your practice's visibility to the public.⁷⁷ In North America generally, dentists, physicians, lawyers, and other professionals are not prohibited from advertising, but many practitioners feel that advertising commercializes and demeans their professional services.⁷⁸ The source of this feeling possibly arises from the high ethical standards health care professionals are held to in practice.⁷⁸

Advertising can be used to provide useful information to patients and provide education on the services available to them. It can also stimulate interest in new technologies and stimulate the demand for such innovative services.⁷⁷ Edwards et al conducted a study to determine how consumers of orthodontic services perceive the treatment quality of orthodontic practitioners who use different forms of advertising.⁷⁷ They found that most patients do not consider advertising to

reflect poorly on the quality of treatment. They also determined that patients view newspaper, magazine, and direct mail advertisements most favourably of all advertising methods.

Online Presence

Many practice consultants and professional magazines advise that orthodontic practices cannot survive in the modern era without an online presence.⁷⁹ The model of the internet is heavily based on user interaction. People can share, comment, and review online content. In the digital age, consumers engagement has shifted away from outbound to inbound marketing.⁸⁰ Outbound marketing encompasses traditional marketing strategies such as newspaper advertisements. Inbound marketing draws customers to products and services through strategies such as content marketing, social media, and search engine optimization.⁸⁰ According to Jorgensen, there are three pillars of an orthodontic practice's online presence: (1) a practice website, (2) paid advertising, and (3) social media.⁷⁴

The centre of an orthodontist's online presence is their practice website.⁷⁹ It can explain the services, qualifications, and differentiating factors. All other social media, advertising and other online media, should direct patients to a practice website which should be easy to find and provide information on how to contact the office.⁷⁹ Paid online advertising comes in many forms, including Google advertisements, social media advertisements, search engine optimization, and pay per click (PPC).⁷⁴ Google and social media advertisements operate under the same principle as buying an advertisement in a magazine or newspaper, except the medium is now digital. Search engine optimization is the process of increasing the quality and quantity of website traffic by increasing the visibility of a website or a web page to users of a web search engine.⁸¹ PPC advertising is an advertising model used to drive traffic to websites, in which a business pays a publisher when their advertisement is clicked.⁸²

Social media is a key online tool for attracting new patients. If a new patient receives a referral from their dentist, they commonly go online to see reviews and acquire additional information about that provider.⁷⁹ Social media can also be used to highlight and interact with current patients, thus increasing their loyalty and engagement. This increases the likelihood that they will recommend the services to a friend or write a positive testimonial.⁷⁹ Conversely, there are websites where people can post anonymous reviews of physicians and other health care professionals, including orthodontists.⁸³ Since anonymity is ensured, patients are free to post harsher negative reviews without being personally linked to the post.⁸³ It has led to research efforts into understanding the likelihood of a patient posting a review and how positive or negative their appraisal will be.^{84,85} It has been suggested that increased time spent with a physician, specifically over one year, is positively correlated with a more encouraging review.⁸⁴

Within the last 15 years, social media websites have revolutionized the way the population communicates. Since their inception, social media platforms have evolved into major podiums for online marketing.⁸⁶ For example, a business can create a Facebook page which functions similarly to a personal profile. This page can interact with consumers and garner “likes” by engaging in advertising with the goal of influencing current fans and reaching new potential consumers.⁸⁶ It is important to note that social media advertising is differentiated from traditional online advertising because it allows for increased interaction with the population.⁸⁷ A survey-based study on the influence of Facebook marketing on consumers found that forty percent of respondents indicated they would visit an orthodontist’s Facebook page before receiving treatment at his or her practice, with thirty five percent indicating the page would be an important factor in their decision.⁸⁷ The respondents indicated the most important factors of Facebook marketing that would influence their

decision (in order of importance) were: 1) the orthodontist's credentials, 2) before and after photos, 3) consumer focused content, and 4) the orthodontist's photograph.⁸⁷

There is literature examining the factors that influence how potential patients select an orthodontist. It has been determined that the payment plan options were more influential than total cost of treatment.⁴⁸ The same authors also reported that higher income families selected orthodontic practices based on the perceived quality of treatment and expertise of the clinician.⁴⁸ A survey of 210 people distributed by Ohio State University examined the factors affecting patients' choice of orthodontic practice.⁴⁷ It was determined that the most important factors affecting patient decision-making are a caring attitude from the orthodontist/staff, being made to feel comfortable, clear communication, and a clean/professional looking office. The least important factors were office amenities such as Wi-Fi and refreshments.⁴⁷ A study of orthodontists' perception of factors affecting patient practice selection elucidated similar results.⁸⁸ Orthodontists believed that the most important factors for patients were "a doctor who makes them feel comfortable", "a doctor and staff with a caring attitude", and "the doctor's reputation".⁸⁸

Adoption of New Technology

There has been a trend of increased numbers of adults seeking orthodontic treatment over the most recent decades, that has led to the development of new appliances with increased aesthetics and comfort such as clear aligners.⁸⁹ Clear aligners are produced by several sources and have varying modes of production, methods of application, and ability to treat various orthodontic problems.⁹⁰ Clear aligner therapy was introduced to treat minor malocclusions, but with technological advances has slowly but surely increased the scope of orthodontic malocclusion degree of difficulty that can be treated through this application.⁹⁰ New technologies have also been developed to accelerate tooth movement.⁹¹ This includes non-surgical techniques such as

microvibration, low-intensity laser therapy, low-intensity pulsed ultrasound and photobiomodulation and surgical techniques such as micro-osteoperforations, piezocision, corticotomies, and osteotomies/PDL distractions.⁹¹

Orthodontics has seen significant changes due to digital technologies. The use of cone-beam computed tomography (CBCT) intra-oral scanning, and custom computer-aided design/computer-aided manufacture (CAD/CAM) appliances are becoming more accepted and used among orthodontists.⁹² CAD/CAM appliances can enhance the performance of many types of treatment modalities, including clear aligner therapy, custom formed archwires, and custom fabricated facial or lingual brackets.^{93–96} The orthodontic office is moving toward a digital workflow that is permeating multiple steps of the diagnosis and treatment administration. Some studies have shown that CAD/CAM appliances can reduce treatment times while maintaining equivalent or improved outcomes.^{93–95,97}

During the global pandemic of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and coronavirus disease 2019 (COVID-19) many dental related health care offices were forced to shut down.⁹⁸ In the dental field, the most effective preventative measure was deemed to limit the number of patients in a clinic with the exception of emergencies.⁹⁸ Technologies, such as telephone, WhatsApp, Zoom, etc. provided the means for orthodontists to connect with and monitor patient treatment and screen emergencies.^{98,99} After reopening clinics, the use of virtual consultation technologies could help limit and control the number of people passing through an orthodontic office.¹⁰⁰

Patient Centered Practices

Orthodontic business practices that focus on the patient are a very traditional form of marketing. In addition to relying on referrals from GPs, most orthodontic practices offer a reward

for current patients who refer new patients.¹⁰¹ An extension of this principle is offering a reduced price for family members of existing patients which is another popular convention. In fact, many orthodontists offer a free initial consultation to make their practice more competitive and attract new patients.¹⁰² There are many additional patient incentive types that can be used to attract people to a practice, such as lowering the cost of treatment or implementing additional financial incentives.¹⁰³

Community Outreach is another meaningful way to promote a practice. Health care providers and their practices have great value to their communities. Examples include public blog posts on oral health topics, volunteering professional services, and sponsoring or participating in community events.¹⁰³ Community outreach not only raises the profile of a business but, also engages with the community in a positive way.

Clinic-Centered Practices

Changing practice operations can be an effective strategy to increase competitiveness. Many options focus on patient convenience, such as a convenient location, availability of parking, expanded office hours, and additional practice locations.¹⁰⁴ Upgrading the outward appearance of a practice is a costly, yet effective way of leaving a positive impression on patients.¹⁰⁵ Furthermore, training staff effectively is also crucial for a successful practice. Providing adequate team training is a foundation that enhances the ability of staff to improve performance and meet higher goals.¹⁰⁶ Cross-training and the preparation of staff members to execute overlapping duties, maintains productivity when a member falls behind or must be absent.¹⁰⁶ Hiring additional staff to support an expanding practice may also be necessary.

The past decade has also seen a rapid expansion of corporate dental offices and an increased presence of practice management companies.¹⁰⁷ The reasons for this rise in corporate controlled

interests are many and nuanced.¹⁰⁸ Without elaborating on the history and causes, one can surmise that health care practitioners face a difficult challenge since the path to becoming an oral health care provider does not include basic business training.¹⁰⁹ It is therefore vitally important that oral health care providers conduct their practice in an efficient and competitive manner.

General Practitioners Applying Orthodontics

Significant changes have occurred in orthodontics over recent decades. One such transformation is the increasing number of non-specialists providing orthodontic services. Patients who would traditionally only consider an orthodontic specialist for their care now have an additional option for less severe malocclusions.

History

Surveys from the 1970's and 1980's reported a decline in orthodontic practice activity.^{110,111} Gottlieb suggested part of this decline was due to an increased number of providers of orthodontic care, that included orthodontists and dentists.¹¹¹ During these decades, a considerable number of GPs delivered orthodontic treatment. McGann conducted a survey of 10,607 American dentists and found that nearly two thirds provided some form orthodontic treatment.¹¹² McGann also reported that the dentists who provided orthodontic services became busier and saw financial benefits.¹¹² A survey of Indiana dental practitioners found that 62% of pediatric dentists and 18% of GPs provided comprehensive orthodontic treatment.¹¹³ A survey of Canadian dentists reported that between 20-34% of fully banded orthodontic patients were being treated by a GP.¹¹⁴ Wolsky and McNamara conducted a survey of a stratified random sample of GPs to determine the nature and extent of orthodontic services provided. They reported that 76% provided some form of orthodontic treatment, with 19% being comprehensive.² The results also

displayed no connection between practice location and number of orthodontists in close proximity, indicating that GP practice location did not influence the decision to provide orthodontic treatment.

In 1997 Align Technology was founded and began developing their version of clear aligner therapy.¹¹⁵ Align Technology received FDA approval in 1998 and they began marketing their Invisalign system in 2000.¹¹⁵ As previously noted, there is a significant number of GPs who provided some form of orthodontic therapy, however, many avoid orthodontic services entirely. The lack of engagement among GPs and orthodontics is often attributed to a lack of training in dental school or fear of the unknown in dealing with complex malocclusions.¹¹⁶ Originally, the Invisalign system was marketed solely to orthodontists.¹¹⁶ However, after only a few years, the Align Technology started to market the Invisalign technique to train and certify GPs in its use.¹¹⁶ Over the past 20 years treatment with clear aligner therapy has continued to become more popular, with the majority of the market share being consumed by Align Technology.

Comparison of Practitioner Usage and Outcomes

Evidence based decision making is the hallmark of modern health care. Patients want to know how to obtain the best quality of treatment. It is difficult to quantitatively measure outcomes of orthodontic treatment since malocclusions are not a disease, rather a collection of morphologic conditions. Improvement after treatment often varies subjectively.

There are valid and reliable indices that have been developed to measure the alignment of teeth before and after orthodontic treatment. Other measurements of success for orthodontic treatment include specialist self-assessment of occlusal and cephalometric changes after treatment and patient quality of life and oral health implications.¹¹⁷ The peer assessment rating (PAR) index has been used in both the United States and United Kingdom to compare the results of various orthodontic treatment.^{118,119} The PAR index uses before and after study models to measure the

relative alignment of teeth.¹¹⁸ The advantages of the PAR index are its ease of use, reliability, and validity.¹²⁰ The disadvantages of the PAR index are it requires two sets of models, only examines one aspect of alignment, the teeth, and may not capture all the fine details of alignment.¹²⁰

In order to address these disadvantages, the American Board of Orthodontists (ABO) developed their own index. The ABO index (ABOI) evaluates models and radiographs of finished cases to determine if they meet the ABO standards for alignment of teeth.¹²¹ There are eight criteria chosen by ABO examiners that are examined and whose scores are summed to give a score. An advantage of this system is only post-treatment models are needed accompanied by radiographs and specific measurement tools. Having only post-treatment models does not account for the initial severity of the malocclusion.

Orthodontists and GPs who provide orthodontic services must accurately assess the complexity of a case to provide successful therapy. Orthodontists receive an additional two to three years of training in the diagnosis and treatment of dental malocclusions and jaw discrepancies.¹¹⁶ As previously noted, many dentists report receiving limited training in orthodontics in dental school.¹¹⁶ Although some dentists elect to pursue further education in orthodontics via continuing education, their ability to provide adept comprehensive treatment is controversial.¹²² A recent study examining the ability of GPs to evaluate the complexity of orthodontic cases determined that orthodontists and orthodontic residents were more adept at judging the complexity of cases than GPs.¹²³

A study examining the orthodontic treatment outcomes between orthodontists and GPs conducted before the widespread adoption of clear aligner therapy showed that cases treated by orthodontists had a significantly better ABOI score compared to GPs.¹²⁰ Another study using the

ABOI to evaluate and compare orthodontic treatment between GPs and orthodontists found that specialists achieve a more rapid treatment and higher quality results.¹²⁴

The use of clear aligner therapy between orthodontists and GPs is an area of emerging research. A study examining treatment plans generated by orthodontists and GP providing Invisalign was conducted after this treatment modality had gained popularity with GPs.⁴ The authors noted that orthodontists had started more Invisalign cases overall. However, in the 12 months prior to the survey, GPs reported stating more cases than orthodontists. The authors suggested that this may be caused by an increased number of GPs providing Invisalign care and a subsequent decrease of referrals to orthodontists.

A recent survey of orthodontists and GPs found significant differences in case selection, treatment management, and aligner expertise between orthodontists and GPs.¹²⁵ The authors concluded that GPs were more willing to treat complex malocclusions with Invisalign, spend less time on the patient's digital treatment plan, and use fewer auxiliaries during treatment. They suggested that this may be due to a difference in provider experience and treatment goals.¹²⁵

Teledentistry

Teledentistry is the combination of telecommunications and dentistry to provide dental care to overcome geographic constraints. It is commonly employed to screen, treatment plan, and supervise the provision of care.¹ Essentially, digital information is communicated between patient and doctor when separated by a long distance that makes direct contact impractical.¹²⁶ With the advances in digital technology over the preceding decades, teledentistry has become a more feasible method to treat patients¹

Historical Perspective

Just as dentistry is a specialized branch of medicine, teledentistry is a subdivision of telemedicine. The field of telemedicine was conceived in the 1960s by NASA as a solution to the challenge of monitoring astronaut health remotely.¹²⁷ The introduction of teledentistry occurred in 1994 when the U.S. Army implemented its Total Dental Access (TDA) project.¹²⁸ The program transported patient records and information from dentists to remote specialists for assessment.¹²⁹ The specialists would diagnose and recommend a treatment plan for the dentist. The project was successful in reducing overall cost for provision of care, improving the quality of care delivered, and increasing patient access to care.¹²⁹ As technology advanced, it created new opportunities for teledentistry. Technologies currently available are beginning to change the dynamics of dentistry.

Usages

Digital technology and the Internet are the two foundational technologies whose advent made the development of teledentistry possible. The increased speed and accessibility of these technologies over the preceding decades has further extended the possible scope of teledentistry. There are two possible methods for administration of teledentistry: “Real-Time Consultation” and “Store-and-Forward Method”.¹³⁰ Real-Time Consultation involves a videoconference between the dental professionals and their patient(s) that allows them to communicate with each other concurrently.¹³¹ The Store-and-Forward Method has a practitioner take patient records and transmit them to a different location for a specialist to review at a later time.¹³¹ At the end of the twentieth century, it was suggested that remote diagnosis of common orofacial diseases using the Internet is an achievable project.¹³² Recent publications have supported the assertion that remote diagnosis of dental conditions can be achieved using the Internet.^{133,134}

Orthodontic Applications

Teledentistry allows orthodontists to remotely provide care for patients in rural facilities with limited access to orthodontic care, and to aid GPs to screen potential orthodontic patients based on the difficulty of their case.¹³⁰ Such treatment can be implemented using either the Real-Time Consultation or Store-and-Forward Method depending on what the type of care the practitioner is aiming to administer. The Store-and-Forward Method may be more efficient for screening patients.¹³⁰

The primary benefit of teledentistry in any setting is elimination of the need for the orthodontist or patient to travel. Other significant advantages are the potential for increased access to care for remote populations, reduction of cost and burden of care on the patient, and earlier patient diagnosis, closer monitoring throughout treatment, and enhanced collaboration among oral health care professionals.¹³⁵

The implementation of Teledentistry in the orthodontic field has support from practitioners. Several surveys of GPs revealed support for the idea of a teledentistry system to screen new patient orthodontic referrals.^{136,137} Another survey polling UK orthodontic consultants found a majority support for the concept of using teledentistry to make their advice more accessible to dentists and patients.¹³⁸

The concern of the validity of teledentistry has also been addressed in the literature. A study on the effect of remote specialist advice on the result of orthodontic treatment provided by general dental practitioners indicated that teledentistry enabled them to offer a better service for patients and more appropriate specialist referrals.¹³⁹ A randomized control trial of GPs to specialist referrals using store-and-forward records transfer found that Teledentistry is a valid system for positively identifying appropriate new patient orthodontic referrals.¹³⁶ However, Mandall et al. did

identify a risk that in some cases patients not accepted for treatment on the teledentistry system could benefit from a full orthodontic examination. They also carried out a trial to determine if photographs were reliable for orthodontic screening. The authors suggested that clinician agreement for screening and accepting orthodontic referrals based on clinical photographs was comparable to clinical decision making.¹⁴⁰ Berndt J *et al.* examined the outcomes of orthodontic treatment carried out by sufficiently prepared GPs under the supervision of remote orthodontic specialists. The authors found that teledentistry is a viable approach to reducing the severity of malocclusions in disadvantaged children when referral to an orthodontist is not feasible.¹⁴¹

A fairly recent development in orthodontics is Clear Aligner Therapy (CAT) whose main advantages are fewer in-office visits and reduced chair-side time.^{89,94} One of the difficulties of traditional orthodontics is caring for patients based on estimated response to treatment. Patients typically have in-office visits at pre-set intervals based on average time frames applied to all patients.¹⁴² The advent of tele-orthodontics has led to the possibility of remote monitoring and scheduling of in-office appointments personalized for patients' treatment progression.¹⁴² The main benefits of this approach are reduced or more efficient in-office visits and increased patient convenience.

Legal Concerns

Teledentistry allows orthodontists to practice across provincial and state boundaries in Canada and the US. This raises legal concerns, such as provincial licensure, malpractice liability, and confidentiality when transmitting digital information over the Internet.¹³⁵ This concern of jurisdictional boundaries means that a clinician monitoring or prescribing treatment could not legally do so unless licensed in both provinces.^{143,144}

Another potential legal concern is the question of liability. Kravitz and Bowman raise several good questions about liability such as: “Does teledentistry consultation create a legally binding relationship?”, “What standard of care applies to a specialist consulting between different jurisdictions?”, and “Would an orthodontist be covered by malpractice insurance for patients’ in different jurisdictions?”.¹ Traditionally, medical malpractice covers only face-to-face meetings within the jurisdiction in which the practitioner is licensed.

The transmission of digital information over the Internet also raises legal concerns. Transmission of digital data inherently makes it less secure than storage in a closed system.¹⁴⁵ The mode in which information is transmitted and stored will affect the security of patient confidentiality.¹⁴⁵ The second main question concerns the transmission of digital information, as to who is liable in the event of a security breach.¹⁴⁵

Ethical Concerns

Teledentistry, like many technological advances, raises ethical concerns. As previously mentioned, there is literature supporting the quality of teledentistry care provided by remote practitioners.^{136–138} However, more research is needed to definitively state that this new treatment modality can meet the standard of care of traditional orthodontics.¹⁴² During traditional orthodontic treatment, the orthodontist initiates the treatment and monitoring is carried out at set frequencies determined by the patient’s needs and progression.¹¹⁶ The concept of remote monitoring raises the concern that altering this conventional relationship may lead to mishandlings of patient supervision.¹³⁵ The question is: can the appeal of fewer visits, increased practitioner convenience, and more disconnected monitoring reduce the standard of care?

Future of Teledentistry

Many orthodontists currently utilize some form of tele-orthodontics. Online forums where clinical questions can be posed and answered qualify as tele-orthodontics.^{146,147} Online continuing education also often utilizes digital records to improve the knowledge of practitioners and improve treatment planning skills.^{148,149} From the patient's perspective, the smartphone essentially provides a portable digital computer that can be used for communication with the orthodontist.¹³⁵ This can facilitate instant communication and assessment between the orthodontist and patient should any problems arise.

A current and evolving area of research is the role of artificial intelligence (AI) in orthodontics. AI functions to expertly recognize patterns and can sort vast quantities of information.¹⁵⁰ An AI appraisal of biomechanics for digitally generated plans can also help the orthodontist choose between different treatment options.¹⁵⁰ The use of AI assessment of facial patterns and its implementation in diagnosis is still early in development.¹⁵⁰ AI has been deployed to analyze cephalometric radiographs and shown similar results to human examiners.¹⁵¹ Practitioners can send digital records to an AI program for diagnostic and treatment planning purposes.¹⁵⁰ Other areas of society have already comprehensively adopted a tele-model of business such as the banking industry and online transactions.^{152,153} The optimistic view is that patients will be empowered and have increased autonomy regarding their treatment as well.

DIY Orthodontics

The progression of teledentistry has led to the creation of DIY orthodontics. There are companies that currently offer DIY orthodontic products. Patients are often unaware of the implications of such methods of orthodontic tooth movement.¹⁵⁴ Such differences include the inherent risks associated with the omission of a clinical exam by a licensed practitioner.¹⁵⁵

The relatively new DTC providers have gained attention from the dental community in recent years.^{156,157} DTC providers offer patients the opportunity to take their own impressions at home using a mail order kit.¹⁵⁶ Alternatively, consumers may go to a scanning centre where a technician takes a 3-D scan of their teeth.¹ The impression or scan is used to fabricate clear aligners under the supervision of a licensed dentist or orthodontist. Patients receive their aligners by mail and wear them to straighten their teeth without the supervision of a provider.¹ DTC providers have made significant investments in advertisement through television and online mediums promoting their relative cost, convenience, and treatment time.¹

In the case of DTC providers, patients are altering their dentition without the direct supervision of an orthodontist.¹³⁵ There is currently no literature comparing the outcomes of orthodontic treatment delivered by a specialist and treatment delivered via DTC providers. There are also no studies on patient satisfaction with DTC provider treatment outcomes at this time. The only evidence currently available is testimonials and media reports.^{158,159}

Multiple dental and orthodontic associations have issued statements or consumer alerts to educate patients on the risks associated with DIY orthodontics. In 2017, the American Dental Association (ADA) issued a policy statement which “strongly discourages the use of DIY orthodontics because of the potential for harm to patients”.¹⁶⁰ The policy supports the importance of dentists being in charge of diagnosing and treating patients to ensure the safe delivery of appropriate care. The ADA further reinforced their position with an updated 2018 statement.⁵ The updated policy states that by circumventing the involvement of a licensed dentist, patients lose a very important quality control checkpoint that ensures all aspects of their treatment are performed and are progressing in the best interests of the patient.⁵ The American Association of Orthodontists (AAO) issued an alert to consumers considering DIY orthodontics in 2015.¹⁶¹ The alert stresses

that “orthodontic treatment involves the movement of biological material, which if not done correctly could lead to potentially irreversible and expensive damage such as tooth and gum loss, changed bites, and other issues”.

The Canadian Dental Association (CDA) has also released a statement warning the public to make informed decisions before purchasing or using DTC dental appliances.¹⁶² It states that “the convenience of purchasing dental appliances directly online or over-the-counter may seem attractive, you should be informed that using *direct-to-consumer* dental appliances may not give you the most appropriate care to achieve your desired results”. The statement goes on to say that “A dentist is in the best position to recommend dental treatment options that are right for you” and the Canadian Association of Orthodontists (CAO) takes the same stance as the CDA in their own public statement.¹⁶³

Over the last decade, there has been a marked increase in mail order, DTC providers that offer treatment without a clinical examination by a professional.¹³⁵ The main appeal of this service is twofold: the increased patient convenience via elimination of fixed appointments supervised by a professional and the reduced price.¹³⁵ The main argument from DTC providers justifying their approach is that their DTC aligner system is not DIY, but rather doctor directed and that they increase access to care for patients.¹³⁵

Patient Interest in Orthodontic Treatment Providers

There are only two articles to date that examines the factors that influence patient’s choice of provider type among orthodontists, GPs, and DTC providers.^{9,10} It was demonstrated that adults have a high level of interest in pursuing orthodontic treatment.⁹ Patients with the highest level of interest preferred an orthodontist as a treatment provider while those with a moderate level of interest preferred pursuing DTC providers.⁹ It is interesting to note that *Olson et al.* found that

parents who selected DTC providers for themselves were likely to select an orthodontist for their child's treatment.⁹ Based on the paucity of research available, patient preferences for providers of this relatively new treatment modality, remains ambiguous.

Study Purpose

There are two goals for this study. The first is to determine the relative influence of patient demographic factors on their choice of provider type (orthodontist, GPs, and DTC providers). This information will provide some clarity to orthodontists on choices patients will be making regarding their orthodontic treatment provider. The data presented herein will also provide a foundation from which future more focussed research questions may be posed. The second goal of this research project is to determine the perception orthodontists have of the changing external environment. By illuminating the majority opinion on the impact of the aforementioned modern transformations to the profession, practitioners can determine where they stand relative to their peers. The data presented herein will also provide a foundation from which future more focussed research questions may be posed.

Null Hypotheses

Patient Demographics

Do patient demographic factors influence their preference for provider choice of orthodontic treatment? The demographic variables to be considered and null hypothesis are listed below:

- H_0 : There is no influence of patient demographic factors such as age, ethnicity, gender, family status, education, employment, and income on preference for orthodontic treatment provider.
- H_1 : Patient demographic factors such as age, ethnicity, gender, family status, education, employment, and income do influence preference for orthodontic treatment provider.

The Changing External Environment

Do Canadian and American orthodontists see a change in their provision of orthodontic treatment to patients over the past 10 years? The practice and provision of care variables to be considered and null hypothesis are listed below:

Perception of Orthodontic Care Provisions

- H_0 : Orthodontists have not perceived a change in their provision of orthodontic care over the past 10 years.
- H_1 : Orthodontists have perceived a change in their provision of orthodontic care over the past 10 years.

Changes to Orthodontic Business Practices

- H_0 : Orthodontists have not made any changes to the administration of their practices over the past 10 years.
- H_1 : Orthodontists have made changes to the administration of their practices over the past 10 years.

Materials and Methods

Health Research Ethics Board approval was obtained to conduct this study by the University of Manitoba (No. H2020:028).

Two original surveys were developed. One was for the general population. The other was for orthodontists.

An original 19-question survey was developed with the assistance of a psychometrician and administered to the general population using a web-based delivery method (Appendix). The electronic survey was delivered using a commercial polling company (Dynata, Shelton, CT) that had existing databases of reliable participants. A total of 330 individuals received electronic invitations to participate in the survey from July 2020 through August 2020. The target population included adults aged 25-65 years, residing in Canada.

The survey was designed so participants could not return to previous questions. This approach prohibited participants from altering answers to earlier questions after being given additional information throughout the survey, consequently reducing bias. Specific dental and orthodontic vocabulary was explained in layman's terms to avoid misinterpretation by participants. For example, an increased overbite was described as "front teeth overlap too much". Additionally, responses from individuals who completed the survey too quickly or slowly, and those who selected the same answer choice continually were excluded.

The survey questions were designed to (1) determine the participant's demographic background; (2) assess if the participant valued their oral health; (3) evaluate the value participants placed on orthodontic treatment; (4) evaluate if the participant was interested in improving their dentition through orthodontic treatment, and their rationale; and (5) determine the participant's preference in each of the 3 provider options, as well as their rationale.

An original 29-question survey was developed with the assistance of a psychometrician and administered to orthodontists using a web-based delivery method (Appendix). The electronic survey was distributed via an email invitation to appropriate alumni of the University of Manitoba, an invitation post on an online orthodontic forum, and the American Association of Orthodontists' Partners in Research Program. A total of 270 individuals responded to the survey from March 2020 through August 2020. The target population was orthodontists practicing in the United States or Canada.

The survey was designed so participants could not return to previous questions. This approach prohibited participants from altering answers to earlier questions after being given additional information throughout the survey, consequently reducing bias. Additionally, responses from individuals who completed the survey too quickly or slowly, and those who selected the same answer choice continually were excluded.

The survey questions were designed to (1) establish basic information regarding the clinician's demographic background; (2) the size and relative location of the participant's practice; (3) the participant's perception of the impact GPs practicing orthodontics has had on their practice; (4) the participant's perception of the impact the rise in DTC providers has had on their practice; (5) whether participants had re-treated any orthodontic patients who had previously been treated by a GP or DTC providers, and the malocclusions they observed in those patients; (6) the changes that participants have made to their practice in the past 5 and 10 years; and (7) which changes participants perceived to be most beneficial.

Results

Study 1: Patient Preference for Orthodontic Care Provider

Given the challenges of COVID-19 in soliciting face-2-face participant feedback, Dynata (<https://www.dynata.com/>) was hired to electronically distribute the survey to (Canadian) participants. Dynata selected participants from their database by asking persons over the age of 16 if they were interested in orthodontic treatment. A total of 330 adults completed the questionnaire.

Demographics

A total of 171 (51.8%) participants were male and 159 (48.2%) were female. As seen in Figure 1 participants identified as Caucasian 185 (56.0%), followed by Asians 100 (30.3%), while the remaining ethnic categories had frequencies of less than 5%. A total of 295 (89.4%) participants reported education beyond a high school diploma or General Educational Development (GED). Only 1 (0.3%) did not complete high school, 34 (10.3%) completed high school or GED, 75 (22.7%) completed a college degree, 140 (42.4%) completed a bachelor's degree, 75 (22.7%) completed a master's degree or higher, and 4 (1.2%) completed a technical degree. The self-reported ages of participants were also fairly well distributed. Concerning age distribution, 3 (0.9%) were under 16 years of age, 2 (0.6%) were between 17-21, 60 (18.2%) were between 22-29, 145 (43.9%) were between 30-39, 85 (25.8%) were between 40-49, 34 (10.3%) were between 50-59, and 1 (0.3%) was 60 or older. Due to the exceedingly small number of participants in the 16 or younger and 17-21 groups, they were combined with the next closest age group of 22-29 to produce a block of ages with enough participants for meaningful statistical analysis.

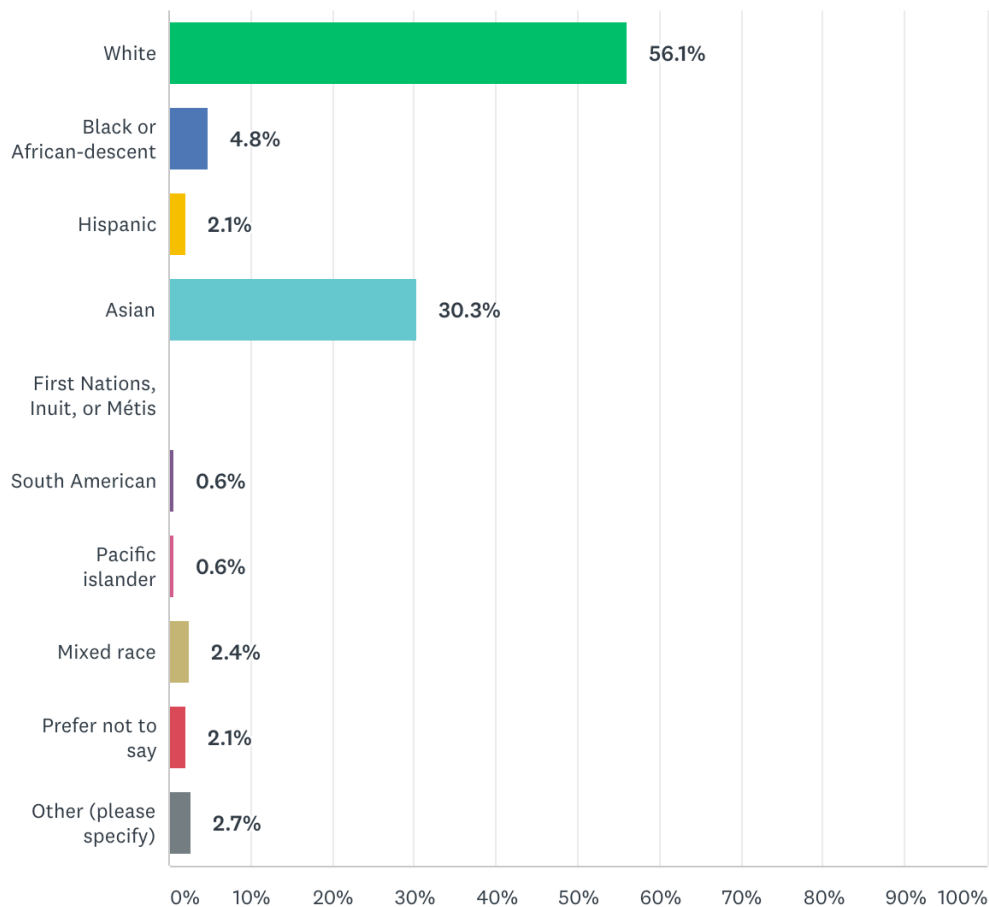


Figure 1. Participants self-reported ethnicity.

A majority of participants fell into only two categories of marital status. A significant number of participants were single and never married 105 (28.1%) and a clear majority were married or in a domestic partnership 224 (67.9%). The remaining categories of divorced, separated, and widowed received less than 5% of participants' selection when combined and so these groups were combined with the single group for statistical analysis. There was a relatively even distribution of household size. A total of 49 (14.9%) participants lived alone, 80 (24.4%) lived in a two-person household, 84 (25.5%) in a three-person household, 93 (28.2%) in a four-person household, 19 (5.8%) in a five-person household, and 5 (1.5%) in a household of six or more participants.

The majority of participants indicated that they were employed in some fashion. As seen in Figure 2, a total of 103 (31.2%) specified that they were employed part-time working fewer than forty hours a week and 203 (61.5%) were employed full-time working forty hours a week or more. The remaining categories of unemployed, retired, and current student garnered less than 5% of participants each and were combined for statistical analysis.

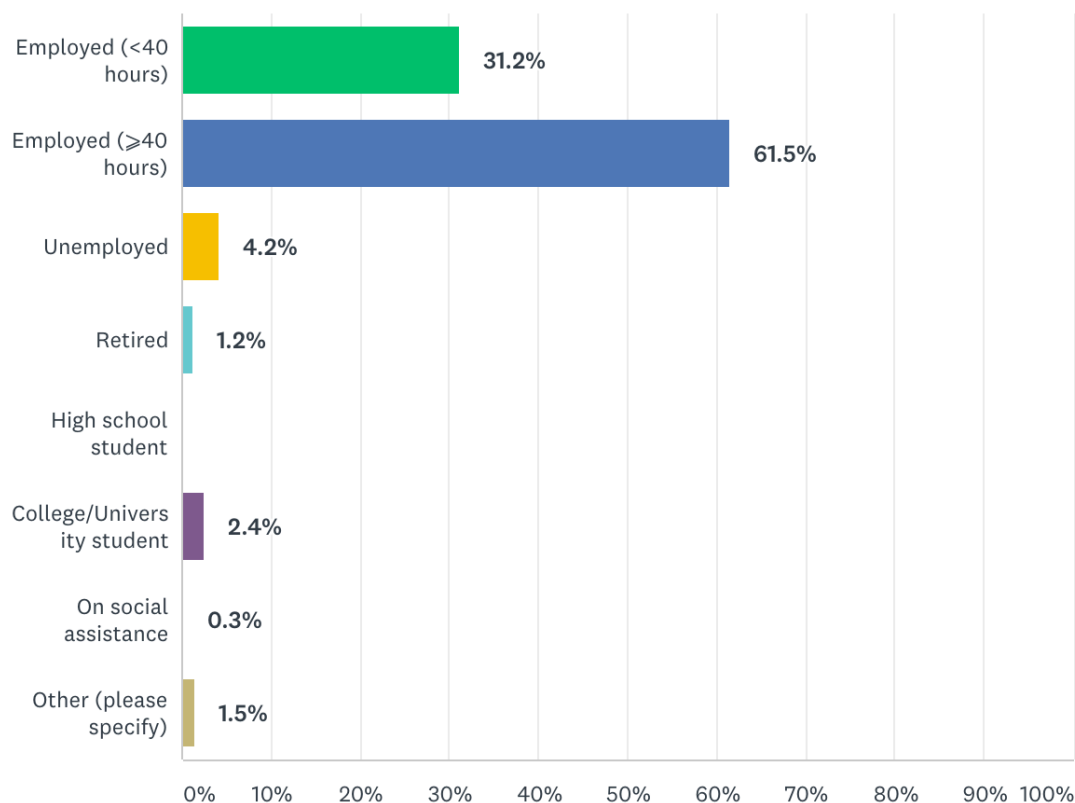


Figure 2. *Participants self-reported employment status.*

The majority of participants lived in a city or metropolitan area. A total of 144 (43.8%) of participants lived in a metropolitan area with more than five hundred thousand inhabitants, 150 (45.6%) lived in a city of between fifty and five hundred thousand inhabitants, 31 (9.4%) lived in a town of two thousand five hundred to fifty thousand inhabitants, and 4 (1.2%) lived in a small town of fewer than two thousand five hundred inhabitants. Therefore, 294 (89.4%) lived in a

community size of at least 50,000 inhabitants. For statistical analysis, the subgroups of small towns and cities were combined due to the small number of participants from small towns.

The mean household income of participants had an asymmetric distribution. Only 1 (0.3%) earned less than \$9,999, 2 (0.6%) earned between \$20,000-\$29,999, 3 (0.9%) earned between \$30,000-\$39,999, 5 (1.5%) earned between \$40,000-\$49,999, 32 (9.7%) earned between \$50,000-\$59,999, 35 (10.6%) earned between \$60,000-\$69,999, 39 (11.8%) earned between \$70,000-\$79,999, 36 (10.9%) earned between \$80,000-\$89,999, 40 (12.1%) earned between \$90,000-\$99,999, 134 (40.6%) earned more than \$100,00, and 3 (0.9%) preferring not to say. For statistical analysis, the categories with participants who earned a total family income of less than \$50,000 were combined.

Attitudes towards orthodontic treatment

Participants were asked to rate on a five-point Likert scale how much they value straight teeth and a beautiful smile (i.e., “1 = not important at all” to “5 = very important”). The greatest share of participants (N = 159, 48.5%) selected very important. The categories of somewhat important (N = 62, 18.9%) and between somewhat and very important (N = 102, 31.1%) each received an increased number of responses. Overall, 98.5% (N = 323) of participants indicated that they place a degree of value on straight teeth and a beautiful smile. Participants were asked how often they brush their teeth. Many participants (N = 232, 70.7%) indicated that they brush their teeth two times per day. Smaller percentages of participants indicated that they brush their teeth three times per day (N = 37, 11.3%) and once per day (N = 57, 17.4%). Only very small percentages of participants (N = 2, 0.6%) indicated that they do not brush their teeth at least once per day. Participants were asked if they have previously had orthodontic treatment. Most participants (N = 184, 56.1%) specified that they have not previously had orthodontic treatment. A noteworthy, yet

smaller percentage (N = 144, 43.9%) indicated that they have previously had orthodontic treatment. There was an association with youth and having previous orthodontic treatment. Participants who were aged 16-29 (N = 32/64, 50.0%) and 30-39 (N = 74/144, 51.4%) were far more likely to have previous orthodontic treatment relative to those aged 40-49 (N = 27/85, 31.8%) and 50 or older (N = 11/35, 31.4%) ($\chi^2(1, N= 328) = 11.54, p<0.01$).

Participants were asked if they think they have benefited or would benefit from having straight teeth. The concept of potential benefits was kept general to be interpreted by the participants. A strong majority of participants (N = 286, 87.2%) indicated they think they would benefit or have benefited from having straight teeth. Only a small portion (N= 22, 6.7%) of participants denoted that they would not benefit or have not benefited from having straight teeth. The remainder of participants (N = 20, 6.1%) designated that they were unsure if they would benefit from having straight teeth. Participants aged 30-39 (N= 136/144, 94.4%) and 50 or older (N = 32/35, 91.4%) were more likely than those aged 16-29 (N = 54/64, 84.4%) and 40-49 (N = 64/85, 75.3%) to have perceived a benefit from having straight teeth ($\chi^2(1, N= 328) = 29.19, p<0.001$). Those aged 16-29 (N = 9/64, 14.1%) and 40-49 (N = 9/85, 10.6%) were most likely indicate they did not see the value in having straight teeth, with all other subgroups having an incidence of less than 3% ($\chi^2(1, N= 328) = 29.19, p<0.001$). Those aged 40-49 (N = 12/85, 14.1%) and 50 or older (N = 3/35, 8.6%) were most likely to be unsure about the benefit gained from having straight teeth, with all other subgroups having an incidence of less than 3% ($\chi^2(1, N= 328) = 29.19, p<0.001$). Community size was positively associated with perceived benefit from having straight teeth. Participants in small cities or towns (N = 27/34, 79.4%) were least likely to have perceived a benefit relative to those in cities (N = 124/149, 83.2%) and metropolitan areas (N = 134/144, 93.1%) ($\chi^2(1, N= 327) = 14.29, p<0.01$).

As seen in Figure 3, participants were asked what treatment mode they would choose if they were going to have orthodontic treatment. The greatest number of participants (N = 149, 45.4%) indicated they would prefer to have clear braces. The next greatest quantity of participants (N = 112, 34.1%) indicated that they would prefer to have clear aligner therapy. A smaller percentage of participants (N = 47, 14.3%) specified that they would prefer metal braces. The smallest percentage of participants (N = 20, 6.1%) suggested that they are not interested in orthodontic treatment. There was an inverse relationship between age and desire for metal braces. Participants aged 16-29 (N = 18/64, 28.1%) and aged 30-39 (N = 21/144, 14.6%) were significantly more likely to prefer metal braces relative to those aged 40-49 (N = 7/85, 8.2%) and 50 or older (N = 1/35, 2.9%) ($\chi^2(1, N= 328) = 36.63, p<0.001$). The participants aged 50 and older (N = 24/35, 68.6%) were significantly more likely than other groups to prefer clear braces, with all other groups having an incidence of less than 44.0% ($\chi^2(1, N= 328) = 36.63, p<0.001$). The participants aged 50 and older (N = 7/35, 20.0%) were significantly less likely than other groups to prefer clear aligners, with all other groups having incidences between 31.0-39.0% ($\chi^2(1, N= 328) = 36.63, p<0.001$). There was an inverse association between community size and preference for metal braces. Participants in small cities or towns (N = 10/34, 29.4%) were significantly more likely than those in cities (N = 18/149, 12.1%) and metropolitan areas (N = 46/144, 12.5%) to prefer metal braces ($\chi^2(1, N= 327) = 22.34, p<0.005$). There was a positive association between community size and preference for clear aligners. Participants in small cities or towns (N = 6/34, 17.6%) were significantly less likely than those in cities (N = 43/149, 28.9%) and metropolitan areas (N = 63/144, 43.8%) to prefer clear aligners for mode of orthodontic treatment ($\chi^2(1, N= 327) = 22.34, p<0.005$).

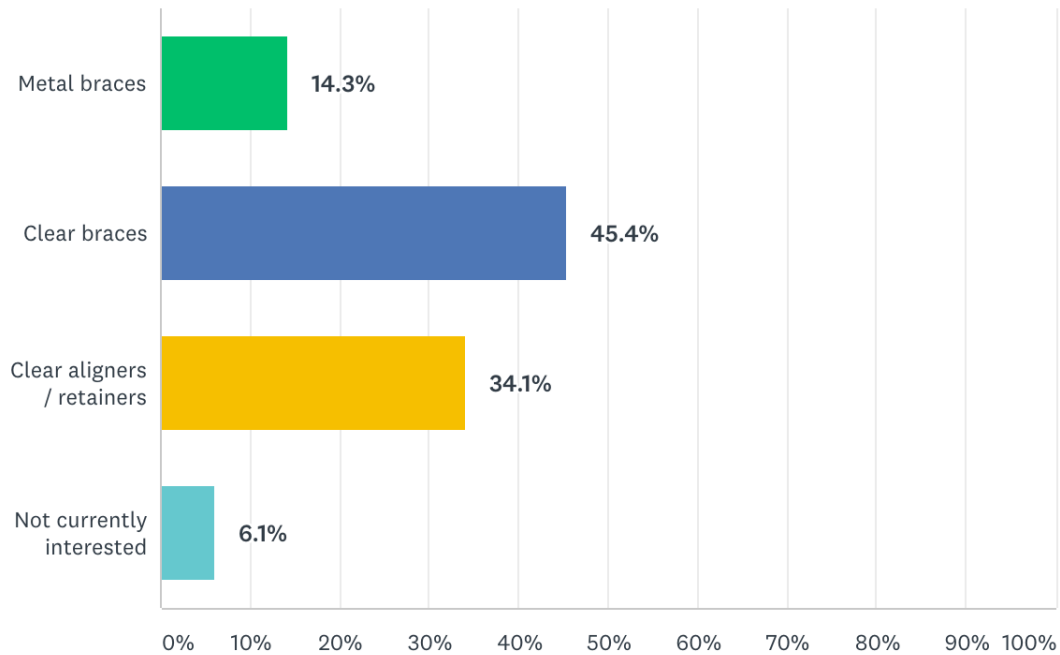


Figure 3. *Participants self-reported preference for mode of orthodontic treatment.*

Participants were asked what source created their current interest in orthodontic treatment. The greatest number of participants ($N = 138$, 42.1%) indicated that their interest stemmed from a member of their social circle of family and friends followed closely by those who indicated that their interest was created by a recommendation for orthodontic treatment by their dentist ($N = 106$, 32.3%). A significant number of participants ($N = 88$, 26.8%) specified that their interest originated from the internet, whereas a significant portion ($N = 61$, 18.6%) cited the influence of social media. A smaller number of participants ($N = 49$, 14.9%) designated that television created their interest in orthodontic treatment, followed by magazines and newspapers ($N = 41$, 12.5%). Only a small number ($N = 28$, 8.5%) of participants indicated that they are not currently interested in orthodontic treatment or have previously been treated. Note that a small number of participants ($N = 15$, 4.6%) specified another reason not available as within the preset categories. Age was inversely related to likelihood of interest in orthodontic treatment being generated by social media.

Participants who were 16-29 (N = 13/65, 20.0%) and 30-39 (N = 36/145, 24.8%) were far more likely than those aged 40-49 (N = 11/85, 12.9%) and 50 or older (N = 1/35, 2.9%) to report that their interest in orthodontic treatment was generated by social media ($\chi^2(1, N= 330) = 11.38, p<0.05$). Participants who were Asian (N = 50/100, 50.0%) were more likely than Caucasian participants (N = 78/185, 42.2%), Hispanic participants (N = 2/7, 28.6%), participants of African descent (N = 4/16, 25.0%) and mixed-race individuals (N = 2/8, 25.0%) to report that their interest in orthodontic treatment was generated by friends or family who had treatment ($\chi^2(1, N= 330) = 3.95, p<0.05$). Participants with households with four (N = 3/93, 3.2%) and five (N = 1/19, 5.3%) persons were significantly less likely than all other groups to report an interest in orthodontic treatment generated by a magazine or newspaper, all of which had incidences over 14.0% ($\chi^2(1, N= 330) = 12.72, p<0.05$). Participants with a high school or equivalent education (N = 4/34, 11.8%) were significantly less likely than those with a college degree or technical diploma (N = 42/79, 53.2%), a bachelor's degree (N = 61/140, 43.6%), and a master's degree or higher (N = 31/75, 41.3%) to have an interest in orthodontic treatment generated by a friend or family member who had treatment ($\chi^2(1, N= 328) = 16.95, p<0.005$). Participants with a college degree or technical diploma (N = 14/79, 17.7%) were significantly less likely than those with a high school diploma or equivalent (N = 13/34, 38.2%), a bachelor's degree (N = 46/140, 32.9%), and a master's degree or higher (N = 33/75, 44.0%) to have an interest in orthodontic treatment generated by a recommendation by a dental professional ($\chi^2(1, N= 328) = 12.94, p<0.01$). Participants who were employed full-time (N = 82/203, 40.4%), part-time (N = 21/103, 20.4%), and post-secondary students (N = 2/8, 25.0%) were significantly more likely than those who were unemployed (N = 1/14, 7.1%) to have an interest in orthodontic treatment created by the recommendation of a dentist or hygienist ($\chi^2(1, N= 330) = 9.45, p<0.005$). Participants who were employed full-time (N =

46/203, 22.7%) were significantly more likely than those who were employed part-time (N = 15/103, 14.6%), unemployed (N = 2/14, 14.3%) and post-secondary students (N = 0/8, 0.0%) to have an interest in orthodontic treatment generated by social media ($\chi^2(1, N= 330) = 6.10, p<0.05$). Participants with a total family income of less than \$50,000 (N = 5/11, 45.5%) were far more likely than all other groups to have an interest in orthodontic treatment generated by something they saw in a magazine, with all other groups having an incidence of less than 19.0% ($\chi^2(1, N= 327) = 14.15, p<0.05$). Overall, younger participants and those employed full-time were most likely to have an interest created by social media. Asian participants were most likely to have an interest shaped by their family and social circle. More highly educated participants and those employed full-time were most likely to have an interest created by a recommendation from their dentist.

Participants were asked what current issues with their occlusion that they would be interested in addressing by selecting all options that apply. The greatest number of participants (N = 91, 27.7%) designated that they would like to eliminate the crowding in their dentition. A similar number of participants (N = 80, 24.4%) indicated that they would like to eliminate spacing in their dentition. Another similar number of participants (N = 73, 22.3%) specified that they would like to remedy an increased overbite. A significant number of participants (N = 69, 21.0%) signified that they would like to address an uneven bite or cant. A noteworthy number of participants (N = 58, 17.7%) specified that they would like to straighten their teeth to facilitate more effective oral hygiene. Attrition (N = 44, 13.4%) was selected by a smaller number of participants. Concerns about an openbite were only selected by a small number of participants (N = 33, 10.1%). A lesser number of participants (N = 28, 8.5%) specified that they would like to address TMJ issues. An increased overjet was only a concern to a small number of participants (N = 28, 8.5%). There was a small number of participants (N = 25, 7.6%) who did not have any concerns of issues they would

like to address in their dentition or occlusion. The remaining categories of gingival display (N = 16, 4.9%), mastication difficulties (N = 15, 4.6%), speech difficulties (N = 4, 1.2%), and other (N = 13, 4.0%) were all selected by less than 5% of participants. Participants who were married (N = 24/224, 10.7%) were significantly more likely than those who were single (N = 4/105, 3.8%) to indicate they wanted to address an increased overjet through orthodontic treatment ($\chi^2(1, N= 329) = 4.38, p<0.05$). Male participants (N = 21/171, 12.3%) were significantly more likely than female participants (N = 7/159, 4.4%) to indicate they wanted to address an increased overjet through orthodontic treatment ($\chi^2(1, N= 330) = 6.59, p<0.05$). Participants who identified as black or of African descent (N = 4/16, 25.0%) were far more likely than individuals who identified as Caucasian (N = 14/185, 7.6%), Hispanic (N = 1/7, 14.3%), and Asian (N = 11/100, 11.0%) to indicate that they want to address an openbite via orthodontic treatment ($\chi^2(1, N= 330) = 4.20, p<0.05$). Mixed race individuals (N = 4/8, 50.0%) were significantly more likely than the average of all other races (16.8%) to indicate that they would like to address dental hygiene difficulties through orthodontic tooth movement ($\chi^2(1, N= 330) = 5.95, p<0.05$). Participants who lived in a household of five persons (N = 5/19, 26.3%) and six or more persons (N = 1/5, 20.0%) were significantly more likely to want to address an increased overjet via orthodontic treatment than those in all other household sizes (four or fewer), all of whom had an incidence of less than 12.0% ($\chi^2(1, N= 330) = 13.38, p<0.05$). Participants who lived in a household of five persons (N = 1/19, 5.3%) and six or more persons (N = 1/5, 20.0%) were significantly more likely to want to address speech difficulties via orthodontic treatment than those in all other household sizes (four or fewer), all of whom had an incidence of less than 2.0% ($\chi^2(1, N= 330) = 19.75, p<0.005$). Participants who lived in small cities or towns (N = 7/35, 20.0%) were more likely than those in

cities (N = 17/150, 11.3%) and metropolitan areas (N = 9/144, 6.3%) to want to address an open bite via orthodontic treatment ($\chi^2(1, N= 329) = 6.42, p<0.05$).

As seen in Figure 4, participants were asked what their motivation would be for undertaking orthodontic treatment and to select all options that apply. The greatest number of participants (N = 206, 62.8%) indicated that their motivation would be to have a more attractive smile. The next greatest number of participants (N = 134, 40.9%) designated that their motivation would be to improve confidence and self-esteem. A significant number of participants (N = 80, 24.4%) indicated that their impetus would be to improve their ability to perform oral hygiene. The next greatest number of participants (N= 75, 22.9%) reported that their motivation would be to improve their occlusion and mastication ability. A noteworthy number of participants (N = 61, 18.6%) indicated that their drive for treatment would be to improve the alignment of their jaws. A small number of participants (N = 33, 10.1%) specified that their motivation for treatment would be to prevent future injuries to their dentition. Only a small number of participants (N = 26, 7.9%) indicated that they are motivated to have treatment by a family member or friend who had treatment. A small number (N = 26, 7.9%) of participants denoted that there is nothing about their dentition or smile that they would want to address via orthodontic treatment. The smallest response category (N = 3, 0.9%) was other where participants could input a custom response. Marital status was associated with desire to improve self-esteem. Participants who were single, divorced, separated, and widowed (N = 51/105, 48.6%) were significantly more likely than those who were married or in a domestic partnership (N = 82/224, 36.6%) to select improving self-esteem as the main motivation for orthodontic treatment ($\chi^2(1, N= 329) = 4.25, p<0.05$). Gender was associated with the desire to improve ease of performing dental hygiene. Female participants (N = 47/159, 29.6%) were more likely than male participants (N = 33/171, 19.3%) to select improving ease of

performing oral hygiene as the main motivation for orthodontic treatment ($\chi^2(1, N= 330) = 4.72, p<0.05$). Race was associated with satisfaction with current smile aesthetics and occlusion. Participants who identified as Caucasian (N = 20, 185, 10.8%) were more likely than those reporting as Black (N = 1/16, 6.3%), Hispanic (N = 0/7, 0.0%), Asian (N = 3/100, 3.0%) to report not wanting to change anything about their current smile aesthetics and occlusion ($\chi^2(1, N= 330) = 4.99, p<0.05$). Race was associated with desire to improve self-esteem. Participants who identified as Black (N = 2/16, 12.5%) were less likely than those who reported as Caucasian (N = 74/185, 40.0%), Hispanic (N = 2/7, 28.6%), Asian (N = 48/100, 48.0%), and mixed race (N = 3/8, 37.5%) to indicate that their main motivation for orthodontic treatment was to improve self-esteem ($\chi^2(1, N= 330) = 5.51, p<0.05$). Race was associated with the influence of a family member or friend receiving orthodontic treatment. Participants who identified as Asian (N = 13/100, 13.0%) were more likely than those who reported as Caucasian (N = 13/185, 7.0%), Black (N = 0/16, 0.0%), Hispanic (N = 0/7, 0.0%), and mixed race (N = 0/8, 0.0%) to indicate that their main motivation for orthodontic treatment was the influence of a family member or friend receiving treatment ($\chi^2(1, N= 330) = 5.19, p<0.05$). Household size was positively associated with the desire to improve occlusion and oral function. Participants with a household size of one (N = 5/49, 10.0%) were least likely to want orthodontic treatment to improve oral function and the incidence increased of this response increased with number of persons in household, reaching its maximum among those with a household size six or more persons (N = 4/5, 80.0%) ($\chi^2(1, N= 330) = 15.99, p<0.01$). Participants with an education level of a master's degree or higher (N = 12/75, 16.0%) were significantly more likely than all other groups (<8.0%) to indicate that their main motivation for wanting orthodontic treatment is a friend or family member who has received treatment ($\chi^2(1, N= 328) = 10.16, p<0.05$). Participants who were employed full-time (N =

140/203, 69.0%) were more likely than those employed part-time (N = 60/103, 58.3%), those who were unemployed (N = 8/14, 57.1%), and post-secondary students (N = 3/8, 37.5%) to desire orthodontic treatment to improve the attractiveness of their smile ($\chi^2(1, N= 330) = 9.62, p<0.005$).

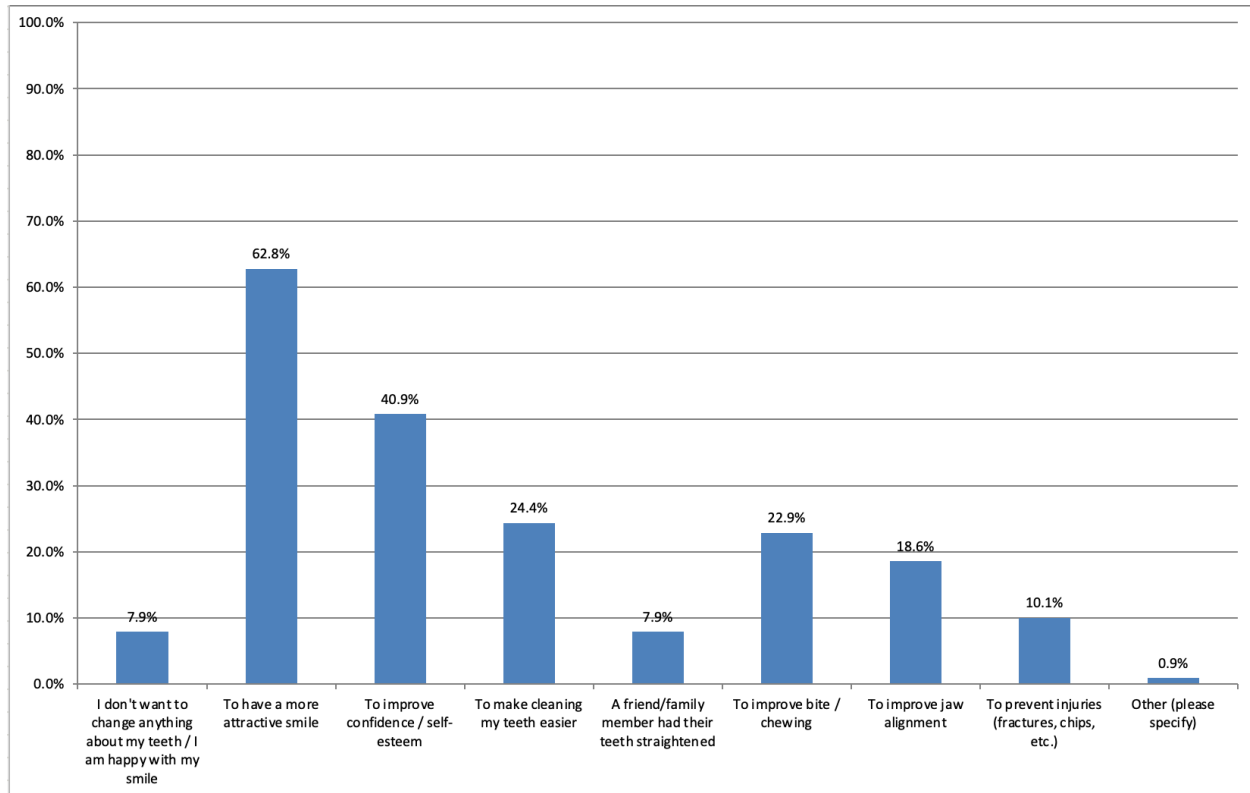


Figure 4. *Participants self-reported motivation for potential orthodontic treatment.*

As seen in Figure 5, participants were asked what orthodontic treatment provider they would prefer and were only allowed to select one response. The greatest number of participants (N = 162, 49.4%) indicated that they would prefer orthodontic treatment provided by an orthodontist. The second most common response was whichever provider is suggested by their GP (N = 63, 19.2%). The next greatest number of responses (N = 62, 18.9%) was orthodontic treatment provided by a general dentist. The lowest number of participants (N = 41, 12.5%) indicated that they would want orthodontic treatment facilitated by a clear aligner company utilizing a DTC provider. There was an inverse relationship between choosing a clear aligner company utilizing a

DTC model and participant age. Participants aged 16-29 ($N = 11/64$, 17.2%) were more likely than those aged 30-39 ($N = 17/144$, 11.8%), aged 40-49 ($N = 10/85$, 11.8%), and 50 or older ($N = 3/35$, 8.6%) to indicate they preferred treatment facilitated by a clear aligner company utilizing a DTC model ($\chi^2(1, N = 328) = 17.86, p < 0.05$). There was a positive relationship between choosing whichever option is recommended by respondent's family dentist and age. Participants aged 16-29 ($N = 8/64$, 12.5%) were less likely than those aged 30-39 ($N = 19/144$, 13.2%), aged 40-49 ($N = 25/85$, 29.4%), and 50 or older ($N = 11/35$, 31.4%) to indicate they would follow the recommendation of their family dentist for orthodontic treatment provider ($\chi^2(1, N = 328) = 17.86, p < 0.05$). Younger participants aged 16-29 ($N = 36/64$, 56.3%) and 30-39 ($N = 75/144$, 52.1%) were more likely than older participants aged 40-49 ($N = 37/85$, 43.5%) and 50 and older ($N = 14/35$, 40.0%) to indicate they would prefer to have orthodontic treatment provided by an orthodontist ($\chi^2(1, N = 328) = 17.86, p < 0.05$). Participants employed full-time ($N = 113/203$, 55.7%) and post-secondary students ($N = 5/8$, 62.5%) were more likely to select treatment provided by an orthodontist relative to those employed part-time ($N = 42/102$, 41.2%), those who were unemployed ($N = 5/14$, 35.7%) ($\chi^2(1, N = 328) = 10.53, p < 0.05$). Community size was inversely related to the selection of a GP as a treatment provider. Participants in small cities or towns ($N = 10/34$, 29.4%) were more likely than those in cities ($N = 33/149$, 22.1%) and metropolitan areas ($N = 19/144$, 13.2%) to select orthodontic treatment provided by a GP ($\chi^2(1, N = 327) = 25.57, p < 0.001$). Participants in small cities or towns ($N = 1/34$, 2.9%) were significantly less likely than those in metropolitan areas ($N = 20/144$, 13.9%) and cities ($N = 42/149$, 28.2%) to pursue whichever option is recommended to them by their family dentist ($\chi^2(1, N = 327) = 25.57, p < 0.001$). Participants living in metropolitan areas ($N = 85/144$, 59.0%) were

more likely than those living in small cities or towns (N = 17/34, 50.0%) and cities (N = 59/149, 39.6%) to select an orthodontist as treatment provider ($\chi^2(1, N= 327) = 25.57, p<0.001$).

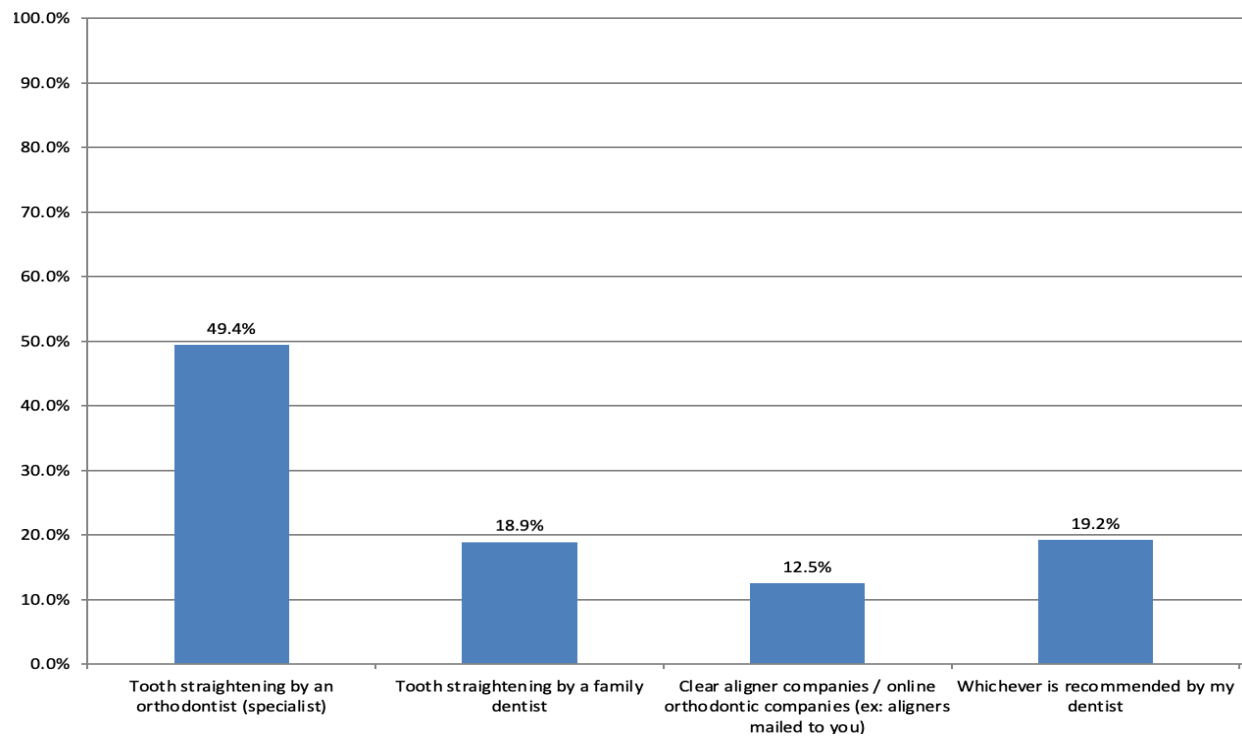


Figure 5. *Participants choice for provider of orthodontic treatment.*

Participants were asked to select the reason behind their selection to the question of preference for orthodontic treatment provider type from a series of predetermined categories. As seen in Figure 6, participants answering the survey were only allowed to select one response. The greatest number of participants (N = 137, 41.8%) indicated that the expertise of their chosen provider type was the main motivating factor of their selection. The next most common response (N = 59, 18.0%) was the successful treatment outcomes participants associate with their choice of provider type. The capacity to be treated in a professional office (N = 31, 9.5%) was the next most common motivation. Testimonials from family and friends (N = 30, 9.2%) was the next most frequently selected response. A significant number of participants (N = 25, 7.6%) indicated that the cost of treatment with their chosen provider type was the motivating factor. The convenience

of having aligners delivered to their home (N = 18, 5.5%) was the next most commonly selected response. A small number of participants (N = 16, 4.9%) indicated that the reason for their selection was the capacity to interact with the person providing their orthodontic treatment. The responses of being treated outside of a professional office or at home (N = 6, 1.8%), convenience of location (N = 4, 1.2%), and other custom response (N = 2, 0.6%) were all selected significantly less than 5% of participants. Age had an inverse relationship with likelihood of choosing treatment provider based on testimonials from family and friends. Younger participants aged 16-29 (N = 11/64, 17.2%) were most likely to make their choice of orthodontic treatment provider based on testimonials, and each subsequent age group had a decreased incidence, bottoming out among those aged 50 or older (N = 1/35, 2.9%) ($\chi^2(1, N= 328) = 42.86, p<0.05$). Choosing treatment provider based on cost related with treatment was positively associated to age. Participants aged 16-29 (N = 2/64, 3.1%) were least likely and those aged 50 and older (N = 6/35, 17.1%) were most likely to have the cost of their selected treatment provider affecting the decision ($\chi^2(1, N= 328) = 42.86, p<0.05$). Participants living in metropolitan areas (N = 75/144, 52.1%) were more likely than those in cities (N = 52/149, 34.9%) and small cities or towns (N = 10/34, 29.4%) to indicate that the expertise and training of orthodontic treatment provider as the reason motivating their selection ($\chi^2(1, N= 327) = 29.16, p<0.05$).

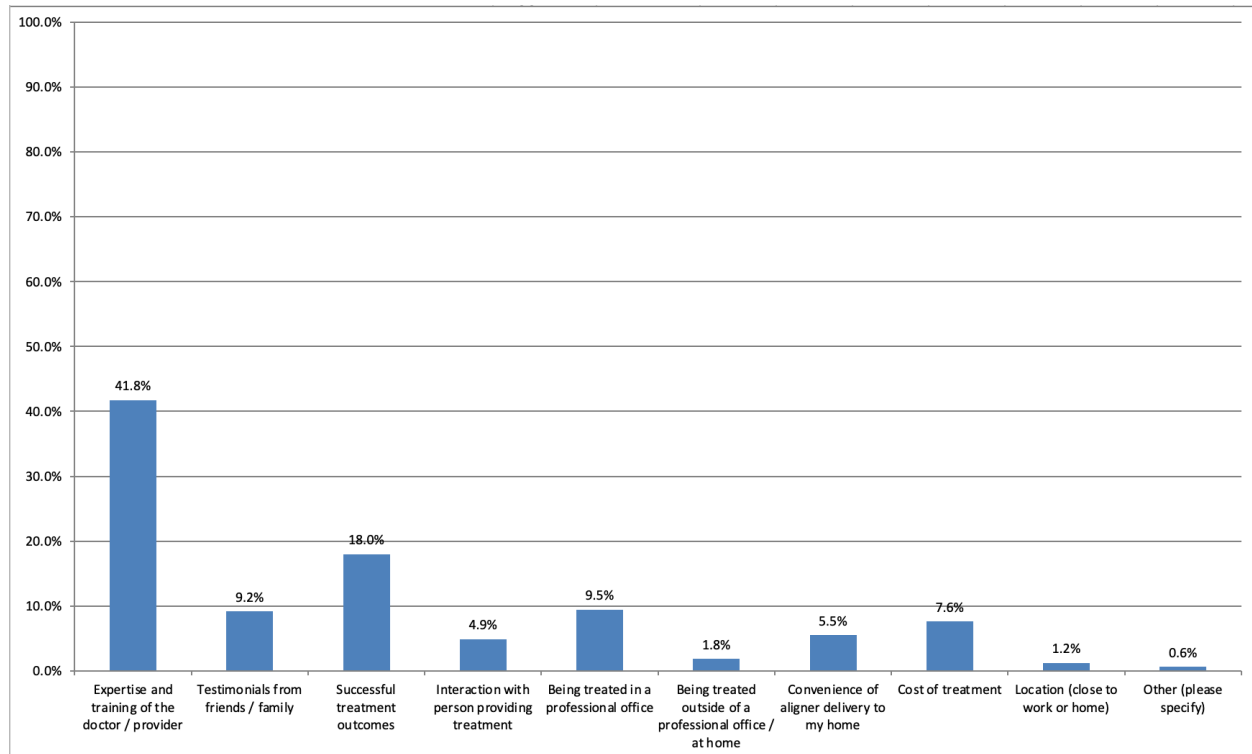


Figure 6. *Participants reason for choice of orthodontic treatment provider type.*

Study 2: The Changing External Environment and Orthodontic Practices

The second part of the study included soliciting input from orthodontic specialists. A link was posted on an orthodontic group within a social media forum. Further participants were reached via the American Association of Orthodontics (AAO) Partners in Research program. A total of 270 participants completed the survey and all were included in the results.

Demographics

The participants were predominantly male ($N = 189$, 70.0%), with a significant number of females ($n = 79$, 29.3%), and 2 preferred not to say. There is a relatively well dispersed spread of years practicing as an orthodontic specialist as seen in Figure 7.

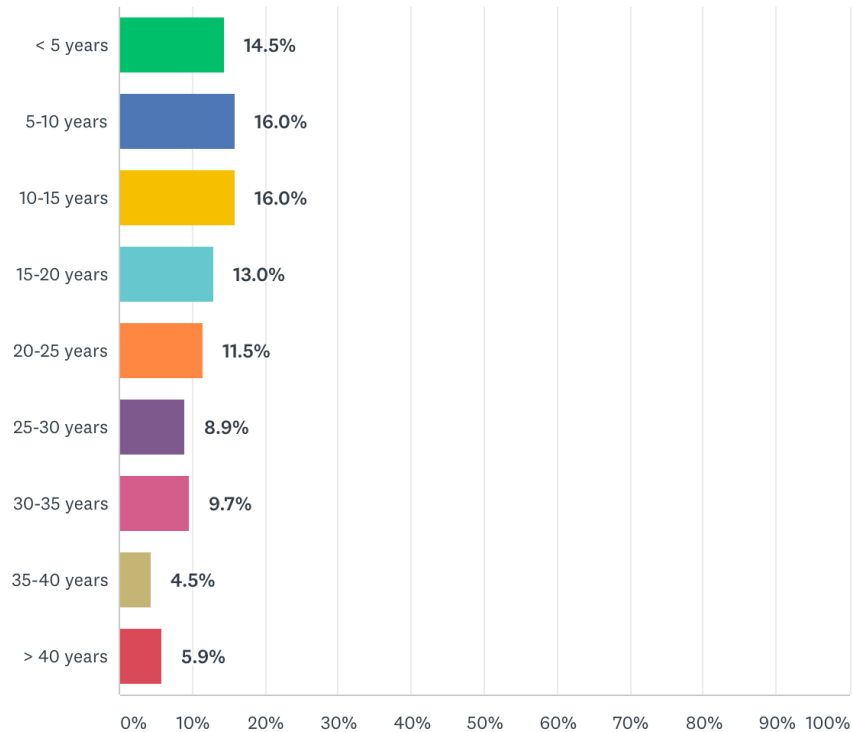


Figure 7. Participant distribution by years in practice as a provider of orthodontic services.

Practice profile

Most participants (N = 203, 75.5%) practiced in the United States vs. Canada (N = 66, 24.5%). Additionally, as seen in Figure 8, many participants practiced within or in relatively close proximity to a city or urban centre with only a small minority (N = 4, 1.5%) of clinicians practicing in a rural setting. Regarding patient population, the majority of participants had 3,000 or fewer patients in their practice (N = 218, 82.0%) (Figure 9). Specifically, 91 (34.2%) had fewer than 1000 patients, 80 (30.1%) had between 1000-2000 patients, and 47 (17.7%) having between 2000-3000 patients.

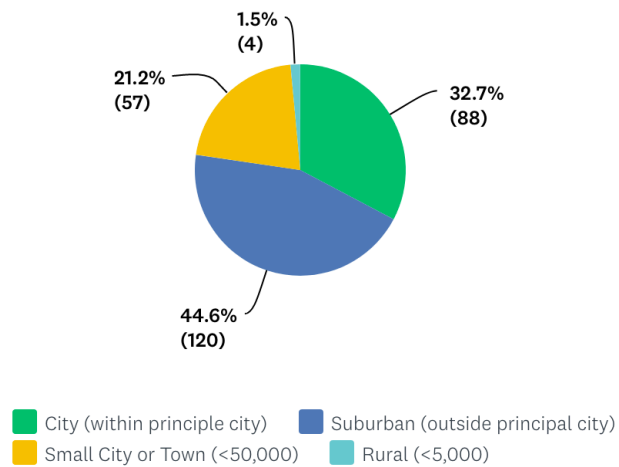


Figure 8. Participant distribution by community size serviced.

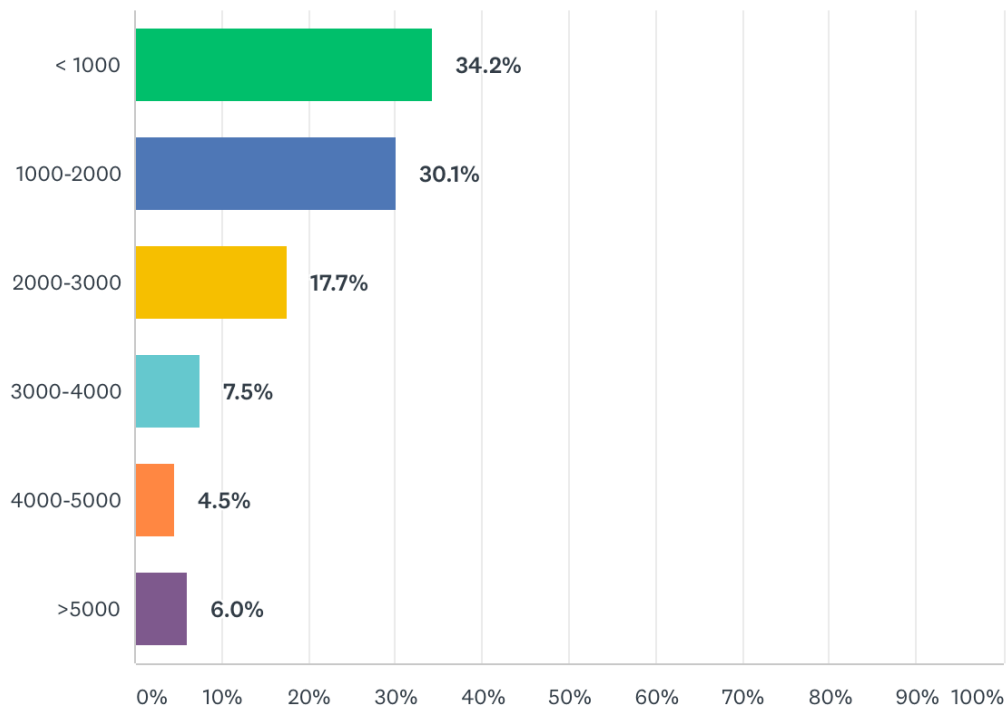


Figure 9. Participant distribution by practice patient population.

Most participants (N = 245, 96.5% vs. N = 9, 3.5%) indicated that they provide clear aligner therapy in their practice. There was an inverse association with years in practice and the likelihood that an orthodontist provides clear aligner therapy. The orthodontists who had been in practice for

<10 years (N = 72/73, 98.6%), 10-20 years (N = 73/75, 97.3%), and 20-30 years (N = 53/53, 100%) were significantly more likely to provide clear aligner therapy than those who have been in practice for 30-40 years (N = 34/37, 91.9%) and >40 years (N = 13/16, 81.3%) ($\chi^2(1, N= 254) = 16.21, p<0.005$). There was no predilection for any response among different genders ($p = 0.534$), community sizes ($p = 0.751$), nationalities ($p = 0.572$), or practice population sizes ($p = 0.157$). Many participants (N = 190; 77.9% vs N = 54; 22.1%) who provide clear aligner therapy in their practice (N = 130, 52.8%) also indicated that they have been doing so for over ten years. There was a positive association with years in practice and length of time as a provider of clear aligner therapy ($\chi^2(1, N= 246) = 121.42, p<0.001$). The only significant number of orthodontists who have been providing this service for <5 years are those who have been in practice for <10 years (N = 35/72, 48.6%). Furthermore, the only significant number of orthodontists who have been providing this therapy for 5-10 years are the groups who have been practicing for <10 years (N = 36/72, 50.0%), 10-20 years (N = 16/73, 21.9%), and 20-30 years (N = 12/53, 22.6%). All groups who have been practicing for >10 years had a greater than 70.0% likelihood of providing clear aligner therapy for >10 years. There was no predilection found for any response among the groups for years providing clear aligner therapy among gender ($p = 0.547$), community size ($p = 0.629$), nationality ($p = 0.098$), or patient population size ($p = 0.160$). Most participants who provide clear aligner therapy (N = 190, 77.9%) specified that they do not fabricate aligners in their office. There was no association between years in practice ($p = 0.819$), gender ($p = 0.655$), community size ($p = 0.276$), nationality ($p = 0.233$), or patient population size ($p = 0.157$) with the probability of fabricating aligners in-office. The orthodontists who indicated that they did not provide clear aligner therapy were asked if they are considering adding that service to their practice. There was an inverse relationship between years in practice and considering adding clear aligner therapy to a

practice. The aspiration would be high among the newest practitioners of fewer than 10 years ($N = 16/28, 57.1\%$), peak with those practicing between 10-20 years ($N = 13/18, 72.2\%$) and decline among those practicing 20-30 years ($N = 6/17, 35.3\%$), 30-40 years ($N = 3/14, 21.4\%$), and >40 years ($N = 1/6, 16.7\%$) ($\chi^2(1, N= 83) = 12.58, p<0.05$). There was no association between gender ($p = 0.546$), community size ($p = 0.964$), or nationality ($p = 0.726$), or practice patient population ($p = 0.358$) with the desire to add clear aligner therapy to clinical services. The vast majority of participants who provide clear aligner therapy ($N = 216, 86.1\%$) saw an increase in the number of clear aligner cases in their practice relative to ten years prior. There was an overall inverse relationship between years in practice and experiencing an increase in clear aligner cases over the past decade. Orthodontists in practice for <10 years ($N = 57/73, 78.1\%$) experienced a significant increase, as did those practicing 10-20 years ($N = 68/74, 91.9\%$) and 20-30 years ($N = 49/53, 92.5\%$), which started to decline among the 30-40 years group ($N = 31/36, 86.1\%$) and >40 years group ($N = 11/15, 73.3\%$) ($\chi^2(1, N= 251) = 15.75, p<0.05$). The association of likelihood to have an increase in clear aligner cases in the past decade and patient population size followed a normal distribution. The probability increased from orthodontists <1000 patients ($N = 62/83, 74.7\%$), 1000-2000 patients ($N = 68/77, 88.3\%$), peaking among those with 2000-3000 patients ($N = 42/43, 97.7\%$), and decreasing among those with 3000-4000 patients ($N = 18/19, 94.7\%$) and >4000 patients ($N = 22/25, 88.0\%$) ($\chi^2(1, N= 247) = 23.44, p<0.005$). There was no association of gender ($p = 0.290$), community size ($p = 0.415$), or nationality ($p = 0.445$) with an increase in clear aligner cases within the past decade.

As seen in Figure 10, the most frequent modes of advertisement employed by orthodontists was elucidated. Online modalities such as having a practice website ($N = 222, 90.6\%$), having a practice social media presence ($N = 193, 78.8\%$), and internet advertisement ($N = 105, 42.9\%$)

were the most significant categories. There was an inverse association with the use of internet advertising and years in practice. The most inexperienced orthodontists practicing for <10 years (N = 42/82, 51.2%) were most likely to use internet advertisements while those practicing for >40 years (N = 2/16, 12.5%) were least responsive ($\chi^2(1, N= 269) = 13.03, p<0.05$). There exists an association between years in practice and probability of having a practice website. The probability increased from orthodontists with <10 years of experience (N = 60/82, 73.2%), 10-20 years of experience (N = 67/78, 85.9%), peaking among those with 20-30 years of experience (N = 51/55, 92.7%), and decreasing among those with 30-40 years of experience (N = 32/38, 84.1%) and >40 years of experience (N = 12/16, 75.0%) ($\chi^2(1, N= 269) = 10.27, p<0.05$). The orthodontists located within a city or metropolitan area (N = 4/88, 4.5%) were least likely to utilize newspaper advertisements and those located in a town or rural setting (N = 10/61, 16.4%) were most likely to utilize that form of advertisement ($\chi^2(1, N= 269) = 6.32, p<0.05$). Orthodontists in the United States (N = 153/203, 75.4%) were significantly more likely than those in Canada (N = 40/66, 60.6%) to employ social media to promote their practices ($\chi^2(1, N= 269) = 5.36, p<0.05$). Orthodontists in the United States (N = 86/203, 42.4%) were also significantly more likely than those in Canada (N = 18/66, 27.3%) to utilize event marketing to market their practices ($\chi^2(1, N= 269) = 4.78, p<0.05$). Orthodontists with a patient population of <1000 patient (N = 26/91, 28.6%) were significantly less likely to employ internet advertising than all other groups with patient populations larger than 2000 patients, all of which reported at least a 40% selection frequency ($\chi^2(1, N= 266) = 9.83, p<0.05$). If an orthodontist had a patient population of <1000 (N = 10/91, 11.0%) or >4000 (N = 4/28, 14.3%) they were significantly less likely to utilize online videos as advertisement than all other categories which were displayed approximately a 30% selection frequency each ($\chi^2(1, N= 266) = 16.31, p<0.005$). There was an association between patient

population and the probability of using mail advertisement. Orthodontists with practices of <1000 patients (N = 3/91, 3.3%) were least likely to utilize mail advertisements and this likelihood increased with the populations of 1000-2000 (N = 9/80, 11.3%), 2000-3000 (N = 19/47, 19.1%), 3000-4000 (N = 5/25, 25.0%) before decreasing in practices above 4000 patients (N = 4/28, 14.3%) ($\chi^2(1, N= 266) = 12.72, p<0.05$).

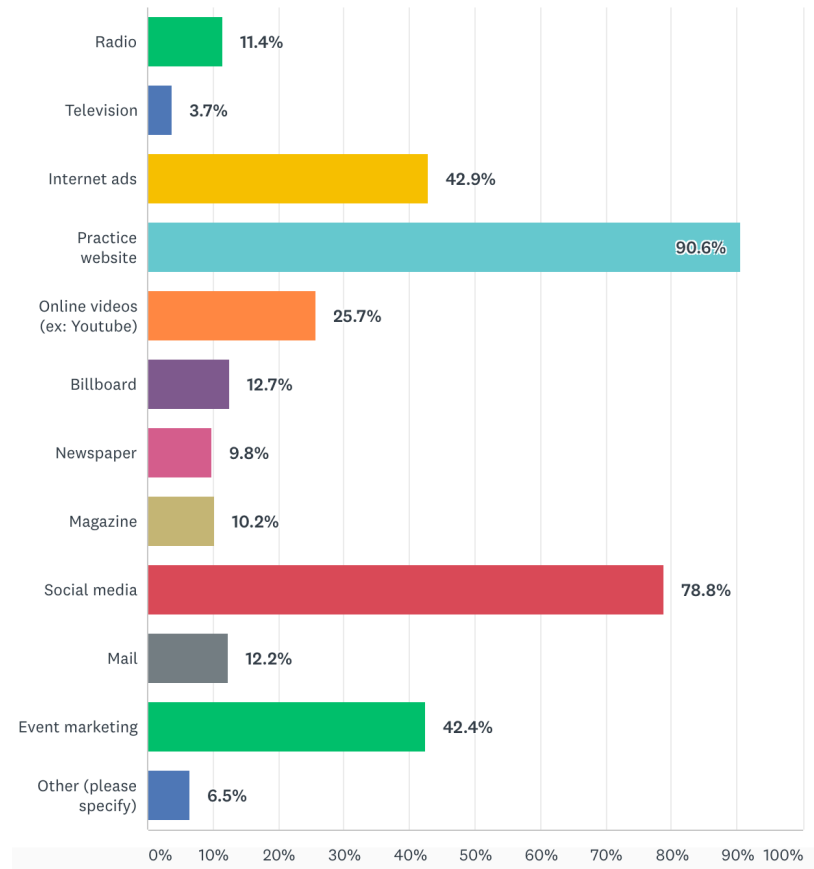


Figure 10. Modes of advertisement employed in orthodontic practices.

Perception of role GPs should occupy in orthodontics

As seen in Figure 11, participants were asked what role they believe GPs should occupy in the provision of orthodontic treatment by selecting all answers that apply. Most orthodontists indicated they believe GPs can occupy a role of providing limited clear aligner therapy (N = 138,

54.6%), referring difficult orthodontic cases (N = 130, 51.4%), and referring all orthodontic cases (N = 120, 47.4%). A smaller number of participants indicated that GPs may occupy part of the niche for interceptive orthodontics (N = 49, 19.4%) and limited full fixed orthodontics (N = 42, 16.6%). Furthermore, only a minor number of participants indicated GPs should be providers of comprehensive full fixed (N = 5, 2.0%) and clear aligner (N = 7, 2.8%) therapies. There was an association between years in practice and selecting general practitioner provision of interceptive orthodontics, with participants in practice less than ten years (N = 9/82, 11.0%) selecting that response the least, and each subsequent age group increasing up to those in practice over forty years (N = 4/16, 25.0%) who selected that response the most ($\chi^2(1, N= 269) = 10.26, p<0.05$). Orthodontists practicing in a metropolitan area were significantly more likely (N = 27/88, 30.7%) to indicate that GPs' scope of practice can include interceptive orthodontic therapy when compared to orthodontists in suburban (N = 14/120, 11.7%) and small cities/towns (N = 7/61, 11.5%) ($\chi^2(1, N= 269) = 14.70, p<0.005$). Canadian orthodontists (N = 28/66, 42.4%) were significantly more likely to indicate that the scope of general dentistry includes providing interceptive orthodontics than their American colleagues (N = 21/203, 10.3%) ($\chi^2(1, N= 269) = 34.41, p<0.001$). Canadian orthodontists (N = 19/66, 28.8%) were also significantly more likely to be comfortable with GPs providing limited full fixed orthodontic treatment when compared with those from the United States (N = 23/203, 11.3%) ($\chi^2(1, N= 269) = 11.52, p<0.005$). Canadian orthodontists (N = 44/66, 66.7%) were significantly more likely than American orthodontists (N = 86/203, 42.4%) to support the notion that GPs refer difficult orthodontic cases ($\chi^2(1, N= 269) = 11.78, p<0.005$).

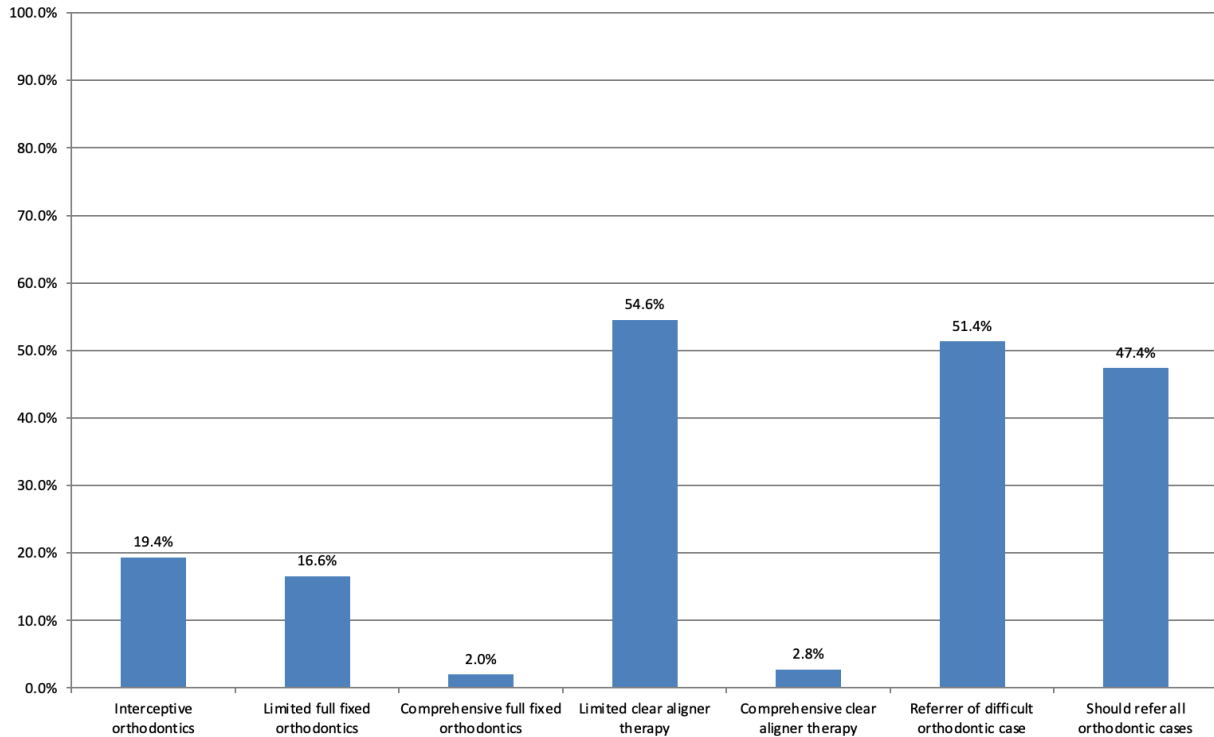


Figure 11. *Participants' perception of role GPs should occupy in orthodontics.*

Perception of external effects on practice

The majority of participants (N = 182, 67.7%) indicated that they have perceived an impact on their practice attributed to increased numbers of GPs providing orthodontic services, whereas a minority had not perceived an impact (N = 52, 19.3%), or were unsure (N = 35, 13.0%). There was a positive association between years in practice and perceived impact from GPs providing orthodontic treatment. Clinicians who have been in practice for less than 10 years (N = 51/82, 62.2%) were less likely to indicate that they have been impacted by GPs providing orthodontic treatment than the practitioners who have been working longer than 40 years (N = 14/16, 87.5%) ($\chi^2(1, N= 268) = 33.47, p<0.001$). Male orthodontists (N = 135/188, 71.8%) were more likely than female orthodontists (N = 46/79, 58.2%) to indicate that their practice has been impacted by GPs providing orthodontic services ($\chi^2(1, N= 269) = 10.93, p<0.05$). The orthodontists' community

size ($p = 0.847$), country of practice ($p = 0.724$), and practice patient population ($p = 0.295$) were not perceived to be associated with a perceived impact of GPs providing orthodontic services. The sentiment was less focused when considering the effect of DTC providers. A plurality of participants ($N = 108, 40.1\%$) indicated that they have been impacted by DTC providers, while a similar number of participants ($N = 89, 33.1\%$) indicated no effect, with the number of participants being unsure also being significant ($N = 72, 26.8\%$). Participants in the United States ($N = 91/202, 45.0\%$) were significantly more likely than those in Canada ($N = 17/66, 25.8\%$) to perceive that their practice has been impacted by DTC providers ($\chi^2(1, N = 268) = 8.11, p < 0.05$). The participants' years of practice ($p = 0.259$), gender ($p = 0.439$), community size ($p = 0.868$), and practice patient population ($p = 0.249$) were not associated with how they perceived the effects of DTC orthodontics on their practice.

The majority of participants ($N = 165, 61.1\%$) indicated that they have noted a reduction in the number of referrals received from GPs in the past ten years. While a smaller portion of participants ($N = 63, 23.3\%$) indicated they had not seen a reduction in referrals and the smallest quota of participants ($N = 42, 15.6\%$) indicated they were unsure. As the amount of time in practice increased, participants noted a greater reduction in number of referrals. Participants who have been in practice between 10-20 years ($N = 51/78, 65.4\%$) noted less of a reduction in than those who had been in practice for more than 40 years ($N = 12/16, 75.0\%$) ($\chi^2(1, N = 269) = 52.28, p < 0.001$). Respondent gender ($p = 0.935$), community size ($p = 0.740$), country of practice ($p = 0.532$), and practice patient population ($p = 0.814$) were not associated with perceived reduction in GP referrals. Furthermore, a majority of participants ($N = 160, 59.3\%$) expressed that the case difficulty received via referrals from GPs has increased in the past ten years, while smaller portions of participants indicated negative ($N = 72, 26.7\%$) and uncertainty ($N = 38, 14.1\%$). There was no

significant difference in responses relating to years in practice ($p = 0.124$), gender ($p = 0.495$), community size ($p = 0.143$), country of practice ($p = 0.238$), or practice patient population ($p = 0.578$). A clear majority of participants ($N = 185$, 74.0% vs. $N = 65$, 26.0%) indicated they currently feel the need to make their practice more competitive. Years in practice was inversely related to perceived need to improve competitiveness. The orthodontists who have been in practice for <10 years ($N = 60/73$, 82.2%) were much more likely to feel a need to improve practice competitiveness than those who had been in practice for 30-40 years ($N = 19/36$, 52.8%) ($\chi^2(1, N=250) = 11.50, p<0.05$).

Cases previously treated by general practitioner or DTC providers

Most participants indicated that they have re-treated orthodontic patients who had previously been treated by a GP ($N = 211$, 83.4%) or via a DTC provider ($N = 122$, 48.2%). Male orthodontists ($N = 156/189$, 82.5%) were more likely than female orthodontists ($N = 54/79$, 68.4%) to indicate having re-treated an orthodontic patient who was previously treated by a GP ($\chi^2(1, N=270) = 7.50, p<0.05$). American orthodontists ($N = 107/203$, 52.7%) were significantly more likely than Canadian orthodontists ($N = 15/66$, 22.7%) to indicate that they have re-treated an orthodontic patient previously treated via DTC provider ($\chi^2(1, N=269) = 18.07, p<0.001$). Orthodontists with a larger practice population were more likely to have re-treated an orthodontic patient who was previously treated by a DTC provider. Those with a practice size of <1000 ($N = 27/91$, 29.7%) were less likely than those with a practice of 1000-2000 ($N = 39/80$, 48.8%), 2000-3000 ($N = 26/47$, 55.3%), 3000-4000 ($N = 13/20$, 65.0%), and >4000 ($N = 15/28$, 53.5%) ($\chi^2(1, N=266) = 15.17, p<0.005$). There was no association between an orthodontist's years in practice and an affirmative selection of having retreated a general practitioner case ($p = 0.103$) or DTC case ($p = 0.471$).

As seen in Figure 12, the participants who answered yes to re-treating patient previously treated by a different orthodontic service provider were also asked which negative dental outcomes they encountered in those cases. Male orthodontists (N = 75/189, 39.7%) were more likely than female orthodontists (N = 17/79, 21.5%) to indicate that they have observed gingival recession as a negative outcome of previous orthodontic treatment ($\chi^2(1, N= 270) = 9.22, p<0.05$). Male orthodontists (N = 74/189, 39.2%) were also more likely than female orthodontists (N = 19/79, 24.1%) to indicate that they have observed anterior open bite as a negative outcome of previous orthodontic treatment ($\chi^2(1, N= 270) = 6.69, p<0.05$). Male orthodontists (N = 80/189, 43.2%) were also more likely than female orthodontists (N = 20/79, 25.3%) to indicate that they have observed a deep bite as a negative outcome of previous orthodontic treatment ($\chi^2(1, N= 270) = 7.02, p<0.05$). Canadian orthodontists (N = 37/66, 56.1%) were more likely than American orthodontists (N = 84/203, 41.4%) to indicate that they have observed an increased overjet as a negative outcome of previous orthodontic treatment ($\chi^2(1, N= 269) = 4.34, p<0.05$). Canadian orthodontists (N = 31/66, 47.0%) were more likely than American orthodontists (N = 62/203, 30.5%) to indicate that they have observed an anterior openbite as a negative outcome of previous orthodontic treatment ($\chi^2(1, N= 269) = 5.94, p<0.05$). Orthodontists with a practice patient population of 2000-3000 (N = 17/47, 36.2%) and 3000-4000 (N = 9/20, 45.0%) were significantly more likely to have observed root resorption as a negative outcome of previous orthodontic treatment with the other population categories which all had a selection frequency of less than 22% ($\chi^2(1, N= 266) = 13.14, p<0.05$). Orthodontists with a practice patient population of 2000-3000 (N = 21/47, 44.7%), 3000-4000 (N = 10/20, 50.0%) and >4000 (N = 13/28, 46.4%) were significantly more likely to have observed gingival recession as a negative outcome of previous orthodontic treatment with the smallest population categories which both had a selection frequency of less than

28% ($\chi^2(1, N= 266) = 9.91, p<0.05$). Orthodontists with a practice patient population of 2000-3000 (N = 21/47, 44.6%), 3000-4000 (N = 10/20, 50.0%) and >4000 (N = 11/28, 39.3%) were significantly more likely to have observed periodontally involved teeth as a negative outcome of previous orthodontic treatment with the smallest population categories which both had a selection frequency of less than 28% ($\chi^2(1, N= 266) = 10.78, p<0.05$). The practice population also showed a positive association with the observed frequency of anterior open bite as a negative outcome of previous orthodontic treatment. Orthodontists with a practice patient population of <1000 (N = 21/91, 23.1%), 1000-2000 (N = 29/80, 36.3%), 2000-3000 (N = 19/47, 40.4%), and 3000-4000 (N = 13/20, 65.0%) showed an increased likelihood of having observed anterior openbite as a negative outcome of previous orthodontic treatment with the only exception being patient populations >4000 (N = 9/28, 39.3%) ($\chi^2(1, N= 266) = 14.44, p<0.01$). The practice population also showed a positive association with the observed frequency of traumatic occlusion as a negative outcome of previous orthodontic treatment. Orthodontists with a practice patient population of <1000 (N = 28/91, 30.8%), 1000-2000 (N = 38/80, 47.5%), 2000-3000 (N = 19/47, 40.4%), and 3000-4000 (N = 14/20, 70.0%) showed an increased likelihood of having observed traumatic occlusion as a negative outcome of previous orthodontic treatment with the only exception being patient populations >4000 (N = 13/28, 46.4%) ($\chi^2(1, N= 266) = 12.41, p<0.05$). The practice population also showed a positive association with the observed frequency of tooth mobility as a negative outcome of previous orthodontic treatment. Orthodontists with a practice patient population of <1000 (N = 15/91, 16.5%), 1000-2000 (N = 16/80, 20.0%), 2000-3000 (N = 16/47, 34.0%), and 3000-4000 (N = 10/20, 50.0%) showed an increased likelihood of having observed tooth mobility from previous orthodontic treatment with the only exception being patient populations >4000 (N

= 8/28, 28.6%) ($\chi^2(1, N= 266) = 13.66, p<0.05$). There was no association between years in practice or community size with selection of any specific negative outcome ($p>0.05$).

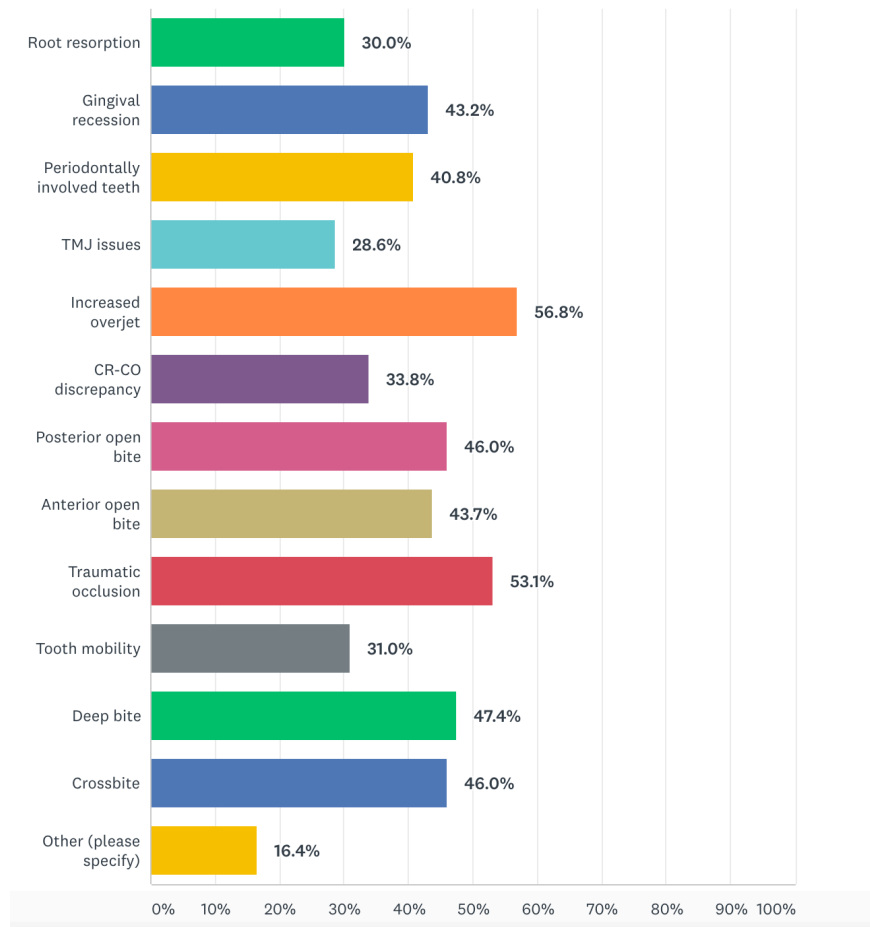


Figure 12. *Frequency of select negative dental outcomes observed among patients previously treated via general GP or DTC provider who require re-treatment.*

Modifications performed to administration and operation of practice

Participants were asked to answer questions regarding the manner in which they manage their practice. Possible changes and policies were presented to the participants and they were asked to specify if they have implemented such alterations in their practice. Furthermore, participants were asked to identify whether they had implemented each change within the previous ten years.

For the following analyses, orthodontists having less than 10 years of experience are excluded from interpretation of results examining practices in place for greater than 10 years.

As seen in Figure 13, the patient centered practices that have been implemented by most orthodontists prior to ten years ago are discounts for family members of existing patients (N = 134, 69.4%) and a free initial consult (N = 118, 67.4%). The most recent changes implemented by participants are new patient incentives such as discounted records and diagnosis (N = 57, 62.6%) and lowering the cost of clear aligner therapy (N = 94, 82.5%). The implementation of a referral reward program was associated with years in practice ($\chi^2(1, N= 120) = 39.33, p<0.001$). Orthodontists who had been practicing less than 10 years (N = 32/36, 88.9%) were most likely to have implemented a referral reward program within the past 10 years while those in practice over 40 years (N = 0/5 0.0%) having the lowest probability. There was a positive association between years of experience and time providing discounts to family members of existing patients ($\chi^2(1, N= 193) = 72.08, p<0.001$). The only significant group of orthodontists who have begun providing patient family discounts in the past 10 years was those who have been practicing for less than 10 years (N = 39/50, 78.0%), with all other groups having an incidence of less than 19.0%. Additionally, all groups who have been practicing for more than 10 years had an incidence of greater than 81.0%. The only group of orthodontists who have begun offering free initial consults in the past 10 years are those who have been practicing for less than 10 years (N = 36/4, 76.6%) and more than 40 years (N = 3/10, 30.0%), with all other groups having an incidence of less than 17.0% ($\chi^2(1, N= 175) = 57.79, p<0.001$). There was a positive association between years of experience and time offering new patient incentives ($\chi^2(1, N= 91) = 21.35, p<0.001$). The orthodontists who were most likely to have begun offering new patient incentives such as discounted records or diagnosis in the past 10 years are those who have been practicing for less

than 10 years ($N = 28/31, 90.3\%$) and over 40 years ($N = 3/4, 75.0\%$). The group of orthodontists who have been offering new patient incentives for over 10 years are those who have been in practice for between 30-40 years ($N = 7/8, 87.5\%$). Male orthodontists ($N = 51/85, 60.0\%$) were most likely to have begun implementation of a referral reward program over 10 years ago and female orthodontists ($N = 26/35, 74.3\%$) were most likely to have implemented that change within the past 10 years ($\chi^2(1, N= 120) = 11.66, p<0.005$). Male orthodontists ($N = 106/138, 76.8\%$) were significantly more likely to have begun offering patient family member discounts over 10 years ago when compared with female orthodontists ($N = 28/55, 50.9\%$) ($\chi^2(1, N= 193) = 12.43, p<0.001$). Male orthodontists ($N = 93/123, 75.6\%$) were also significantly more likely to have started offering free initial consults over 10 years ago when compared with female orthodontists ($N = 25/52, 48.1\%$) ($\chi^2(1, N= 175) = 12.62, p<0.001$). Female orthodontists ($N = 28/33, 84.8\%$) were significantly more likely to have begun offering discounted records and diagnosis within the last 10 years when compared with male orthodontists ($N = 29/58, 50.0\%$) ($\chi^2(1, N= 91) = 10.91, p<0.001$). The community size which the orthodontic practices were located in was associated with the decision to lower clear aligner therapy. Orthodontists practicing in a metropolitan area ($N = 33/36, 91.7\%$) were most likely to have lowered the price of clear aligner therapy within the past 10 years, with a decreasing incidence in suburban areas ($N = 45/52, 86.5\%$) and small cities and towns ($N = 16/25, 64.0\%$) ($\chi^2(1, N= 113) = 8.85, p<0.05$). American orthodontists ($N = 102/142, 71.8\%$) were most likely to have begun offering a free initial consult over 10 years ago and Canadian orthodontists ($N = 16/33, 51.5\%$) were most likely to have implemented that change within the past 10 years ($\chi^2(1, N= 175) = 6.65, p<0.05$). Canadian orthodontists ($N = 16/19, 84.2\%$) were more likely to have begun offering discounted records and diagnosis within the past 10 years relative to American orthodontists ($N = 41/72, 56.9\%$) ($\chi^2(1, N=$

91) = 4.78, $p < 0.05$). Orthodontists with a patient population less than 1000 (N = 25/47, 53.2%) were least likely to have begun offering a free initial consult over 10 years ago and this association became stronger as patient population increased, peaking among orthodontists with a patient population greater than 4000 (N = 11/13, 85.7%) ($\chi^2(1, N = 172) = 9.65, p < 0.05$).

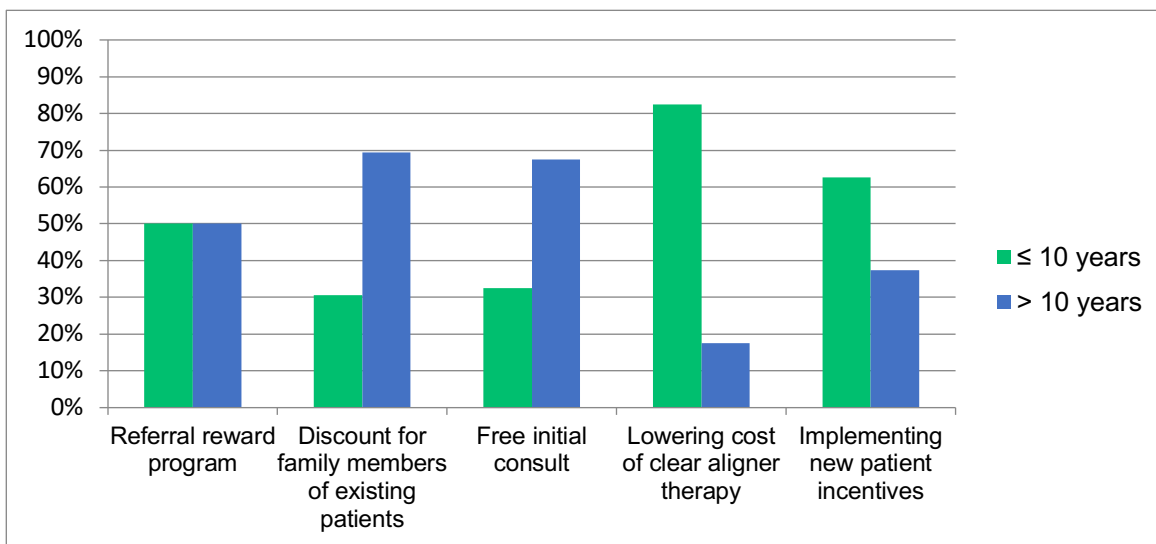


Figure 13. Patient centered practices to the administration of orthodontic practices.

As seen in Figure 14, the data on community outreach indicates that most participants have sponsored local events and sports teams (N = 117, 68.4%) and sought referrals from other dental specialists (N = 81, 66.4%) as a custom for over ten years. A small majority of participants indicated that they have begun submitting press releases to media platforms (N = 33, 54.1%) in the past ten years. Orthodontists who had been practicing for over 10 years indicated that they have been sponsoring local events and sports teams for over 10 years with a frequency of at least 80.0% for each group partitioned by years of experience ($\chi^2(1, N = 171) = 41.01, p < 0.001$). There was an association between years of experience and time utilizing press releases to local media outlets ($\chi^2(1, N = 61) = 15.04, p < 0.01$). Orthodontists who have less than 10 years of experience (N = 14/18, 77.8%) and 10-20 years of experience (N = 14/21, 66.7%) were more likely to have begun

press releases to local media outlets within the past 10 years. Contrarily, more experienced orthodontists who have been in practice for 20-30 years ($N = 9/11$, 81.8%), 30-40 years ($N = 6/9$, 66.7%), and more than 40 years ($N = 2/2$, 100.0%) were most prone to have been submitting press releases to local media outlets for more than 10 years. Orthodontists who had been practicing for over 10 years indicated that they have been seeking referrals from other dental specialists for over 10 years with a frequency of at least 70.0% for each group partitioned by years of experience ($\chi^2(1, N= 122) = 41.03, p<0.001$). Male orthodontists ($N = 93/123$, 75.6%) were significantly more likely than female orthodontists ($N = 24/48$, 50.0%) to have begun sponsoring local events and sports teams over 10 years ago ($\chi^2(1, N= 171) = 10.48, p<0.005$). Male orthodontists ($N = 63/85$, 74.1%) were significantly more likely than female orthodontists ($N = 18/37$, 48.6%) to have begun seeking referrals from other dental specialists over 10 years ago ($\chi^2(1, N= 122) = 7.49, p<0.01$). Orthodontists practicing in a metropolitan area ($N = 14/16$, 87.5%) were significantly more likely than those in suburban communities ($N = 16/30$, 53.3%) and small cities or towns ($N = 2/14$, 21.4%) to have begun submitting press releases to local media outlets within the past 10 years ($\chi^2(1, N= 60) = 13.24, p<0.005$). Canadian orthodontists ($N = 10/12$, 83.3%) were more likely to have begun submitting press releases to local media outlets within the past 10 years while American orthodontists ($N = 26/49$, 53.1%) were more associated with performing this exercise for over 10 years ($\chi^2(1, N= 61) = 5.14, p<0.05$).

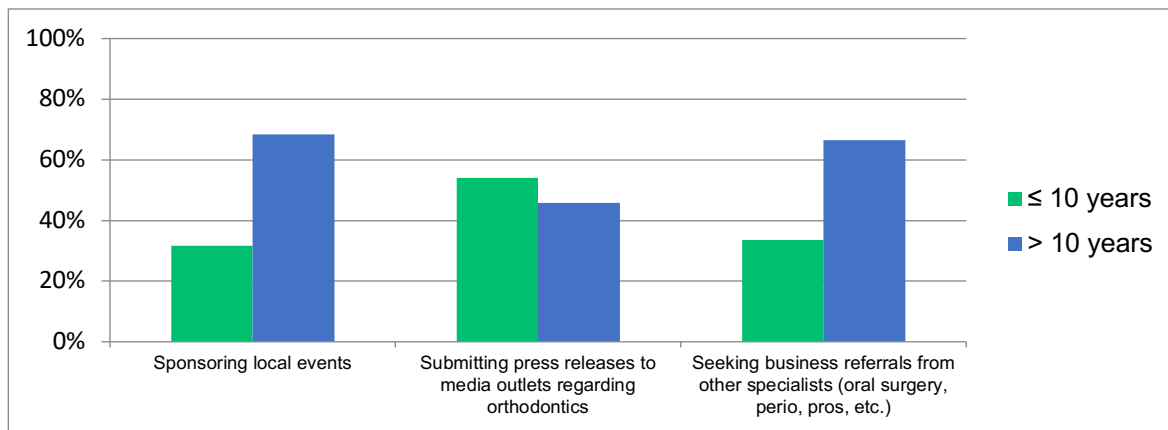


Figure 14. *Community outreach customs of orthodontic practices.*

Figure 15 illustrates the responses concerning changes in an orthodontic practice's online presence have been updated by most practitioners in the past ten years. A clear majority of participants have updated their practice website (N = 141, 79.2%), implemented search engine optimization (N = 121, 82.3%), implemented pay-per-click advertising (N = 73, 86.9%), increased the number of online directory listings of their practice (N = 73, 82.9%), made effects to ensure consistency of practice across all online listings (N = 99, 81.8%), increased practice social media presence (N = 153, 85.9%), implemented online advertisement retargeting (N = 48, 85.7%), encouraged patients to write online reviews (N = 143, 85.6%), and devoted resources to addressing negative online reviews (N = 60, 84.5%). Orthodontists who had been in practice for 10-20 years (N = 14/45, 31.1%) and 20-30 years (N = 10/32, 31.3%) were the only groups likely to have started utilizing search engine optimization over 10 years ago, while all other groups had a probability of at least 95% of initialing that practice within the last 10 years ($\chi^2(1, N= 147) = 20.73, p<0.001$). Orthodontists who had been in practice for 20-30 years (N = 8/21, 38.1%) and 30-40 years (N = 6/21, 28.6%) were the only groups likely to have ensured consistency among all their online directory listings for greater than 10 years, while all other groups displayed an incidence of less than 17% likelihood ($\chi^2(1, N= 121) = 14.09, p<0.01$). Orthodontists who have been in practice for

30-40 years ($N = 7/25, 28.0\%$) were the only group to have increased their practice social media presence over 10 years ago, while all other groups have occurrences of less than 17.0% ($\chi^2(1, N=178) = 10.91, p<0.05$). Female orthodontists ($N = 47/48, 97.9\%$) were significantly more likely than male orthodontists ($N = 94/130, 72.3\%$) to have professionally redesigned their practice website within the past 10 years ($\chi^2(1, N=178) = 13.96, p<0.001$). Female orthodontists ($N = 37/40, 92.5\%$) were significantly more likely than male orthodontists ($N = 84/107, 78.5\%$) to have begun employing search engine utilization within the past 10 years ($\chi^2(1, N=147) = 3.92, p<0.05$). Female orthodontists ($N = 23/23, 100.0\%$) were significantly more likely than male orthodontists ($N = 50/61, 82.0\%$) to have begun using pay-per-click online advertising within the past 10 years ($\chi^2(1, N=84) = 4.77, p<0.05$). Female orthodontists ($N = 52/53, 98.1\%$) were significantly more likely than male orthodontists ($N = 101/125, 80.8\%$) to have increased their practice social media presence within the past 10 years ($\chi^2(1, N=178) = 9.24, p<0.005$). Female orthodontists ($N = 17/17, 100.0\%$) were significantly more likely than male orthodontists ($N = 31/39, 79.5\%$) to have begun employing ad retargeting within the past 10 years ($\chi^2(1, N=56) = 4.07, p<0.05$). Female orthodontists ($N = 49/49, 100.0\%$) were significantly more likely than male orthodontists ($N = 94/118, 79.7\%$) to have emphasized encouraging patients to leave online reviews within the past 10 years ($\chi^2(1, N=167) = 11.64, p<0.005$). Canadian orthodontists ($N = 37/41, 90.2\%$) were significantly more likely than American orthodontists ($N = 104/137, 75.9\%$) to have professionally redesigned their practice website within the past 10 years ($\chi^2(1, N=178) = 3.94, p<0.05$). Orthodontists with a patient population of <1000 ($N = 34/36, 94.4\%$) were most likely to have begun utilizing search engine optimization within the past 10 years, and as patient population increased the likelihood of this change decreased, reaching its lowest percentage probability among orthodontists with a patient population >4000 ($N = 10/17, 58.8\%$) ($\chi^2(1, N=145) =$

10.39, $p < 0.05$). Orthodontists with a patient population of <1000 ($N = 18/18$, 100.0%) were most likely to have begun utilizing pay-per-click advertising within the past 10 years, and as patient population increased the likelihood of this change decreased, reaching its lowest percentage probability among orthodontists with a patient population >4000 ($N = 6/10$, 60.0%) ($\chi^2(1, N = 84) = 10.51, p < 0.05$).

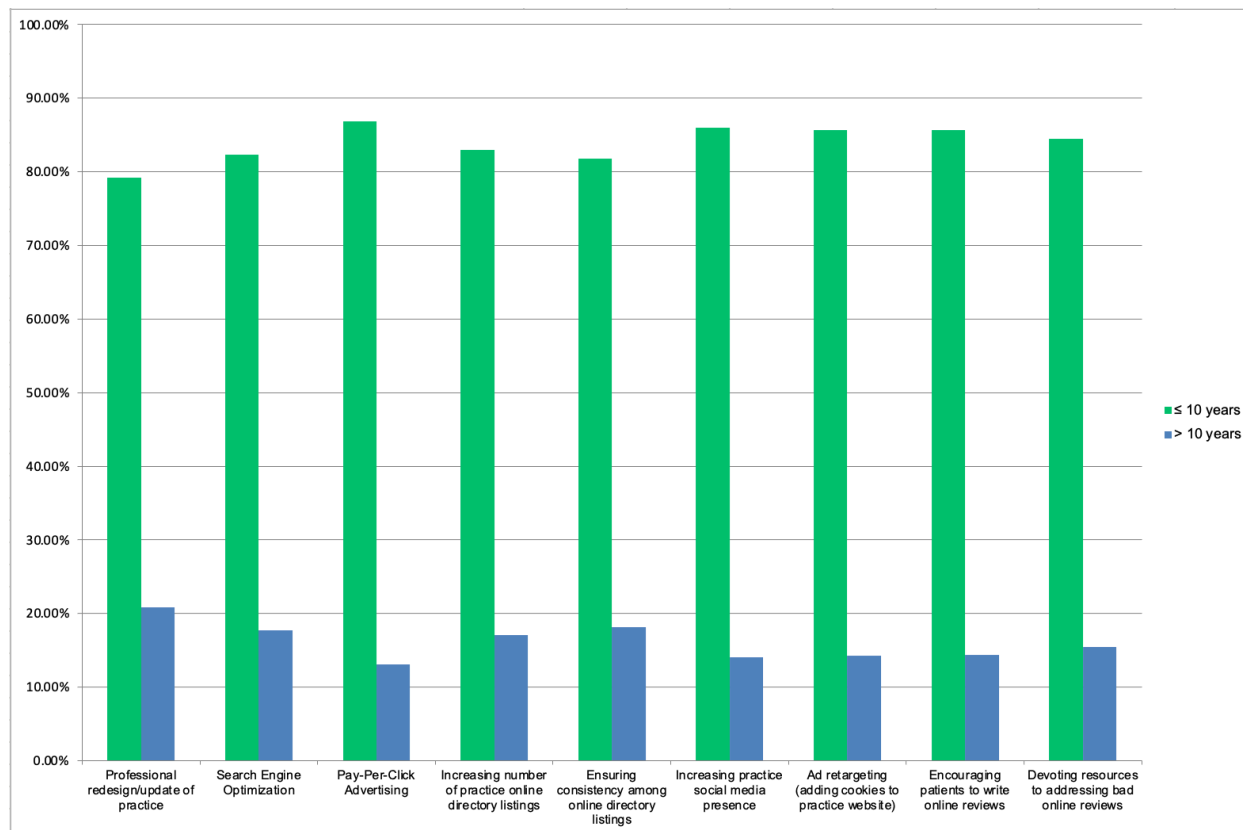


Figure 15. Online presence changes to orthodontic practices.

As displayed in Figure 16, the responses for changes to staffing policies of orthodontic practices was evenly distributed across the different time scales for most categories. The practice of paying staff for conference attendance has been applied by a majority of participants ($N = 88$, 60.3%) for more than ten years. The practices that have been implemented in the past ten years by a majority of participants are hiring a market and patient referral coordinator ($N = 60$, 73.2%), hiring additional dental assistants ($N = 82$, 63.1%), and hiring additional dental hygienists ($N =$

27, 67.5%). Orthodontists' years in practice was positively associated with the length of time having specific staff performance goals, a staff bonus system, staff team-building activities, cross training staff for various duties delegating increased responsibilities to staff, and hiring additional assistants and hygienists. Orthodontists who had been in practice for 10-20 years (N = 21/41, 51.2%) were the least likely to have been setting staff performance goals for greater than 10 years, and percentage within each subgroup increased with years of experience, peaking among orthodontists practicing for more than 40 years (N = 5/6, 83.3%) ($\chi^2(1, N= 120) = 28.07, p<0.001$). Orthodontists who had been in practice for 10-20 years (N = 20/43, 46.5%) were the least likely to have been using a staff bonus system for greater than 10 years, and percentage within each subgroup increased with years of experience, peaking among orthodontists practicing for 30-40 years (N = 12/17, 70.6%) ($\chi^2(1, N= 131) = 25.55, p<0.001$). Orthodontists who had been in practice for 20-30 years (N = 22/30, 73.3%) and 30-40 years (N = 17/23, 73.9%) were the most likely to have been organizing team-building activities and outings for greater than 10 years ($\chi^2(1, N= 157) = 34.57, p<0.001$). The likelihood of cross training staff for various duties for greater than 10 years increased from clinicians with 10-20 years of experience (N = 39/56, 69.6%), 20-30 years of experience (N = 31/40, 77.5%), and 30-40 years of experience (N = 22/24, 91.7%), before significantly dropping off among those with greater than 40 years of experience (N = 7/12, 58.3%) ($\chi^2(1, N= 180) = 54.60, p<0.001$). The likelihood of having begun delegating increased responsibilities to staff members for greater than 10 years increased from clinicians with 10-20 years of experience (N = 25/51, 49.0%), 20-30 years of experience (N = 23/34, 67.6%), and 30-40 years of experience (N = 19/24, 79.2%), before significantly dropping off among those with greater than 40 years of experience (N = 6/10, 60.0%) ($\chi^2(1, N= 158) = 43.94, p<0.001$). Orthodontists who had been in practice for 10-20 years (N = 28/49, 57.1%) were the least likely to have been

paying staff for conference attendance for greater than 10 years, and percentage within each subgroup increased with years of experience, peaking among orthodontists practicing for more than 40 years ($N = 9/10, 90.0\%$) ($\chi^2(1, N= 146) = 40.37, p<0.001$). Orthodontists who had been in practice for less than 10 years ($N = 33/35, 94.3\%$) were the most likely to have hired additional dental assistants within the past 10 years, and percentage within each subgroup decreased with years of experience, reaching a minimum among orthodontists practicing for more than 40 years ($N = 2/7, 28.6\%$) ($\chi^2(1, N= 130) = 25.77, p<0.001$). Female orthodontists ($N = 26/37, 70.3\%$) were significantly more likely than male orthodontists ($N = 38/83, 45.8\%$) to have begun setting staff performance goals within the past 10 years ($\chi^2(1, N= 120) = 6.17, p<0.05$). Female orthodontists ($N = 28/40, 70.0\%$) were significantly more likely than male orthodontists ($N = 43/91, 47.3\%$) to have begun implementing a staff bonus system within the past 10 years ($\chi^2(1, N= 131) = 5.79, p<0.05$). Female orthodontists ($N = 27/38, 71.1\%$) were significantly more likely than male orthodontists ($N = 38/78, 48.7\%$) to have assigned or hired a staff member to the position of treatment coordinator within the past 10 years ($\chi^2(1, N= 116) = 5.17, p<0.05$). Female orthodontists ($N = 27/50, 54.0\%$) were significantly more likely than male orthodontists ($N = 46/130, 35.4\%$) to have begun cross training staff on various duties within the past 10 years ($\chi^2(1, N= 180) = 5.19, p<0.05$). Female orthodontists ($N = 33/47, 70.2\%$) were significantly more likely than male orthodontists ($N = 5-/111, 45.0\%$) to have begun delegating increased responsibilities to staff members within the past 10 years ($\chi^2(1, N= 158) = 8.39, p<0.01$). Female orthodontists ($N = 22/37, 59.5\%$) were significantly more likely than male orthodontists ($N = 36/109, 33.0\%$) to have begun paying staff for conference attendance within the past 10 years ($\chi^2(1, N= 146) = 8.06, p<0.01$). Female orthodontists ($N = 29/35, 82.9\%$) were significantly more likely than male orthodontists ($N = 53/95, 55.8\%$) to have hired additional dental assistants within the past 10 years

$(\chi^2(1, N= 130) = 8.05, p<0.01)$. Orthodontists practicing in suburban areas ($N = 16/19, 84.2\%$) were most likely to have hired additional dental hygienists within the past 10 years, followed by those in metropolitan areas ($N = 8/12, 66.7\%$) and small cities and towns ($N = 3/9, 33.3\%$) ($\chi^2(1, N= 40) = 7.21, p<0.05$). Canadian orthodontists ($N = 20/28, 71.4\%$) were significantly more likely than American orthodontists ($N = 44/92, 47.8\%$) to have begun setting specific production goals for staff within the past 10 years ($\chi^2(1, N= 120) = 4.81, p<0.05$). Orthodontists who had a practice population of <1000 ($N = 11/30, 36.7\%$) were the least likely to have been setting staff performance goals for greater than 10 years, and percentage within each subgroup increased with practice patient population, peaking among orthodontists with more than 4000 patients ($N = 11/12, 91.7\%$) ($\chi^2(1, N= 118) = 14.56, p<0.01$). Orthodontists who had a practice population of <1000 ($N = 13/37, 35.1\%$) were the least likely to have implemented a staff bonus system more than 10 years ago, and percentage within each subgroup increased with practice patient population, peaking among orthodontists with more than 4000 patients ($N = 11/14, 78.6\%$) ($\chi^2(1, N= 130) = 11.66, p<0.05$). Orthodontists who had a practice population of <1000 ($N = 19/27, 70.4\%$) were the most likely to have assigned or hired a staff member to be a treatment coordinator within the past 10 years, and percentage within each subgroup decreased with practice patient population, bottoming out among orthodontists with more than 4000 patients ($N = 2/14, 14.3\%$) ($\chi^2(1, N= 114) = 12.58, p<0.05$). The groups of orthodontists with the greatest likelihood to have been planning staff team-building activities for more than 10 years are those with patient populations of 3000-4000 ($N = 9/14, 64.3\%$) and >4000 ($N = 17/20, 85.0\%$), with all other subgroups having an incidence of approximately 50% ($\chi^2(1, N= 148) = 11.39, p<0.05$). Orthodontists who had a practice population of <1000 ($N = 22/48, 45.8\%$) were the least likely to have been cross training staff on various duties for more than 10 years ago, and percentage within each subgroup increased with

practice patient population, peaking among orthodontists with more than 4000 patients (N = 18/22, 81.8%) ($\chi^2(1, N= 177) = 12.96, p<0.05$). Orthodontists who had a practice population of <1000 (N = 14/38, 36.8%) were the least likely to have begun delegating increased responsibilities to staff members for more than 10 years, and percentage within each subgroup increased with practice patient population, peaking among orthodontists with more than 4000 patients (N = 14/18, 77.8%) ($\chi^2(1, N= 154) = 9.83, p<0.05$). Orthodontists with a practice population of <1000 (N = 21/27, 77.8%), 1000-2000 (N = 26/40, 65.0%), and 2000-3000 (N = 20/28, 71.4%) were significantly more likely than other subgroups to have hired additional dental assistants within the past 10 years, with other subgroups having an incidence of less than 50% ($\chi^2(1, N= 128) = 9.60, p<0.05$).

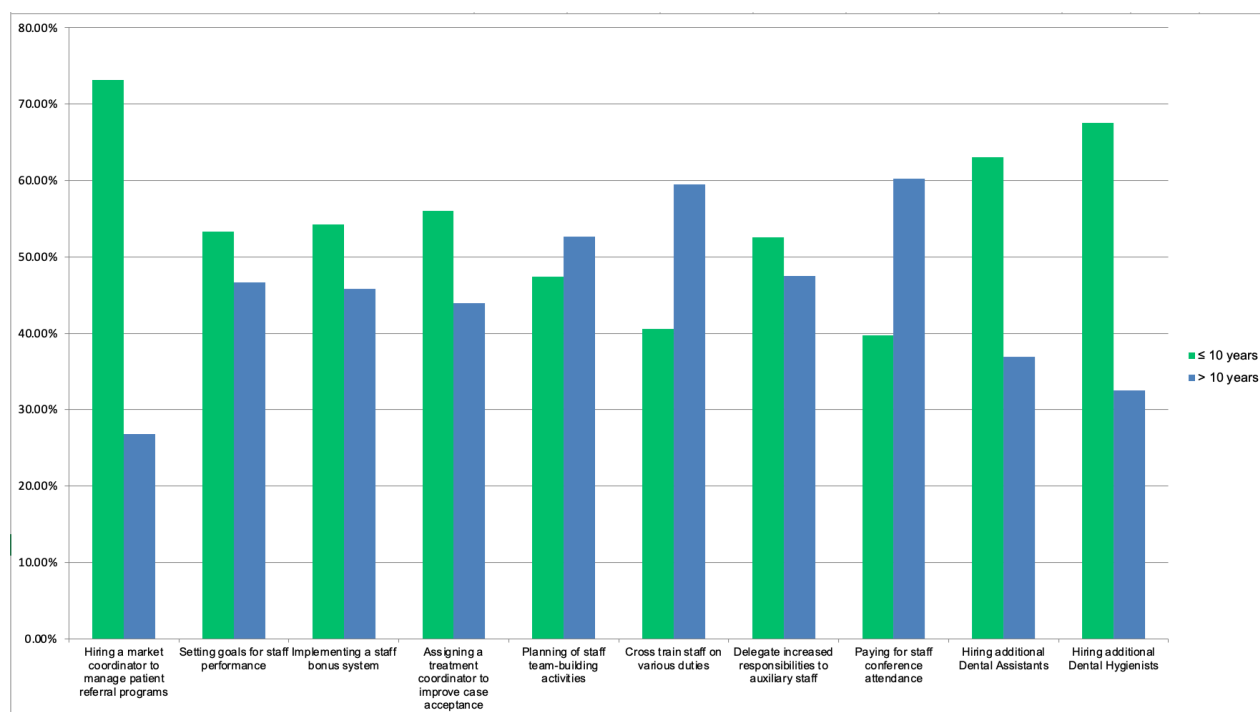


Figure 16. *Changes in staffing policies of orthodontic practices.*

Figure 17 shows that the majority of participants indicated that they have recently made changes to the technology present integrated into their practices. A clear majority of participants (N = 164, 87.2%) indicated that they had purchase new office technology in the past ten years. Most participants (N = 145, 90.1%) have updated or replaced existing office technology in the past

ten years. A majority of participants (N = 137, 75.3%) have added automation to their patient correspondence. Most participants (N = 118, 70.2%) have purchased new or updated existing practice management software in the past ten years. A strong majority of participants (N = 78, 87.6%) indicated that they have integrated app related practices such as elastic reminders and appointment request abilities to their practice in the past ten years. Most participants (N = 29, 63.0%) have added a biometric scanner or patient check in aid to their practice in the past ten years. Orthodontists who had been in practice for less than 10 years (N = 49/51, 96.1%) were most likely to have purchased new technology for their practice within the past 10 years and the likelihood decreased with added years of experience, bottoming out among orthodontists practicing for more than 40 years (N = 6/9, 66.7%) ($\chi^2(1, N= 188) = 10.34, p<0.05$). Orthodontists who had been in practice for less than 10 years (N = 48/51, 94.1%) were most likely to have added automation to patient correspondence within the past 10 years and the likelihood decreased with added years of experience, bottoming out among orthodontists practicing for more than 40 years (N = 6/10, 60.0%) ($\chi^2(1, N= 182) = 16.68, p<0.005$). Female orthodontists (N = 52/54, 96.3%) were significantly more likely than male orthodontists (N = 112/134, 83.6%) to have purchased new technology for their practice within the past 10 years ($\chi^2(1, N= 188) = 5.59, p<0.05$). Female orthodontists (N = 45/52, 86.5%) were significantly more likely than male orthodontists (N = 92/130, 70.8%) to have added automation to patient correspondence within the past 10 years ($\chi^2(1, N= 182) = 4.96, p<0.05$).

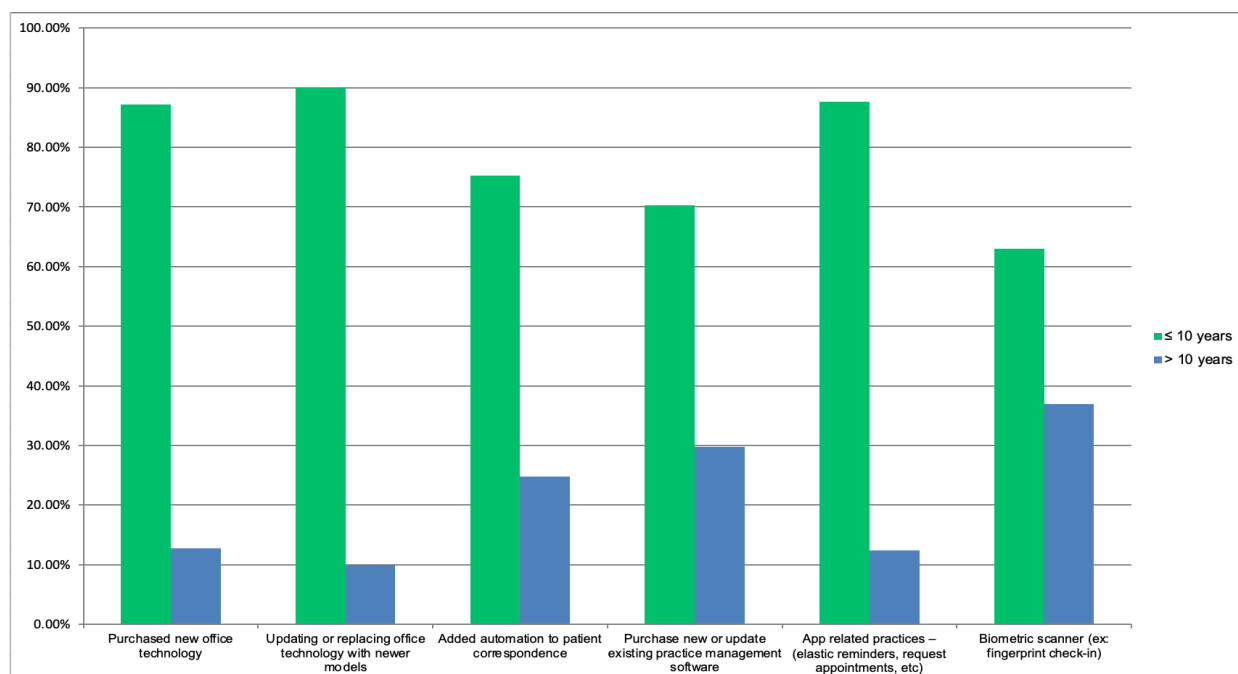


Figure 17. *Changes in office technology of orthodontic practices.*

As seen in Figure 18, the data on clinic centered practices shows most categories being updated within the last ten years. A majority of participants (N = 55, 64.7%) have expanded their office hours within the last ten years. Most participants (N = 43, 75.4%) have added new open days to their practice within the past ten years. Many participants (N = 96, 78.7%) have redesigned their practice reception area within the past ten years. Most participants (N = 94, 77.7%) have redesigned their operatories within the last ten years. The majority of participants (N = 98, 80.3%) have changed a major supply provider in the past ten years. A strong majority of participants (N = 40, 81.6%) have purchased a competing practice within the past ten years. A small majority of participants (N = 49, 57.7%) have opened a satellite clinic within the past ten years. Most participants (N = 58, 69.9%) have had a lab technician on-site for over ten years. Many participants (N = 33, 60.0%) began working in a multidisciplinary clinic in the last ten years. Orthodontists who had been in practice for the between 0 and 40 years all had a likelihood of changing a major supply provider of at least 75%, however, those with greater than 40 years of experience (N = 2/6,

33.3%) were significantly less likely to have changed major supply providers ($\chi^2(1, N= 122) = 11.81, p<0.05$). Male orthodontists ($N = 49/65, 75.4\%$) were significantly more likely than females ($N = 9/18, 50.0\%$) to have an on-site lab technician for greater than 10 years ($\chi^2(1, N= 83) = 4.32, p<0.05$). Orthodontists practicing in metropolitan areas ($N = 22/36, 61.1\%$) were significantly less likely than those in suburban areas ($N = 48/56, 85.7\%$) and rural areas ($N = 27/29, 93.1\%$) to have changed a supply provider for major purchases in the past ten years ($\chi^2(1, N= 121) = 12.36, p<0.005$). Orthodontists practicing in suburban areas ($N = 21/25, 84.0\%$) were significantly more likely than those in metropolitan areas ($N = 8/22, 36.4\%$) and rural areas ($N = 4/8, 50.0\%$) to have begun working in a multidisciplinary clinic in the past ten years ($\chi^2(1, N= 55) = 11.46, p<0.005$). Orthodontists with a patient population of >4000 patients ($N = 5/11, 45.5\%$) were significantly less likely to have changed major supply providers within the last 10 years, with all other subgroups of less than 4000 patients having an incidence of at least 80.0% ($\chi^2(1, N= 119) = 9.80, p<0.05$).

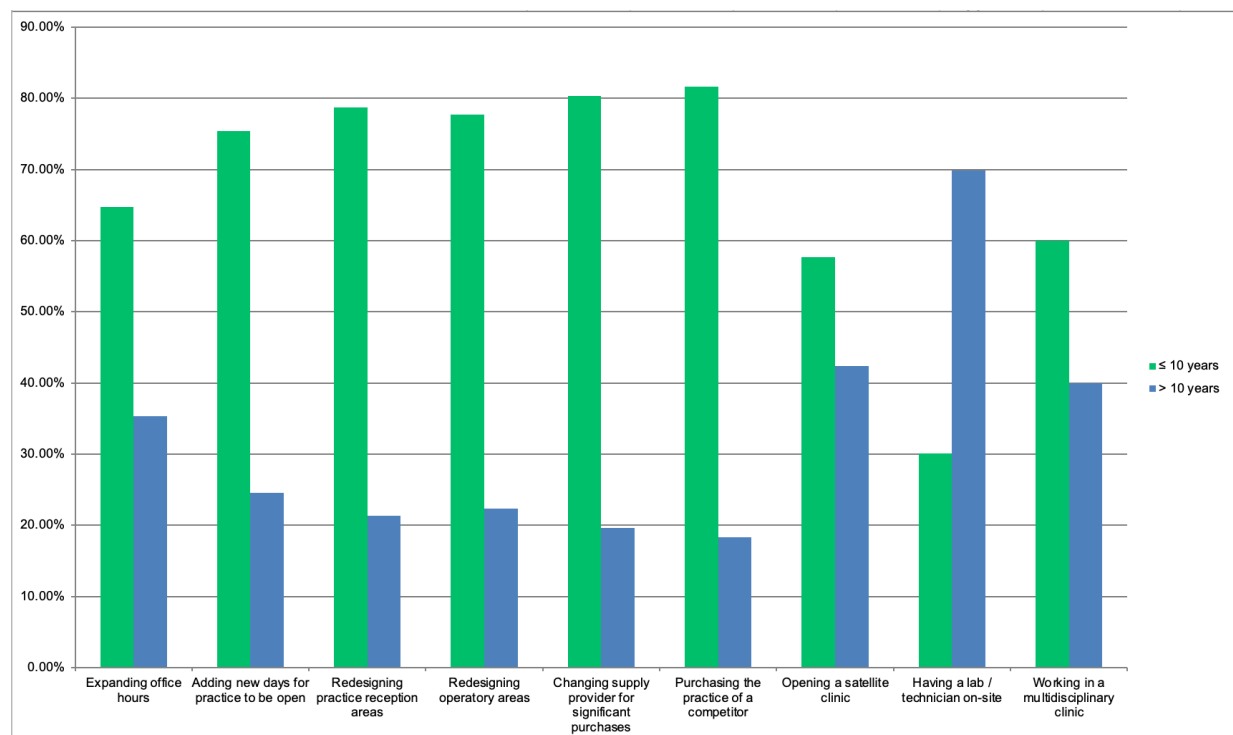


Figure 18. Changes in clinic centric practices to the administration of orthodontic practices.

Discussion

This study was undertaken to assess the effect of the changing external environment on modern orthodontics. The prevalence of GPs providing orthodontic treatment and the advent of DTC providers has doubtlessly had some effect on both the orthodontic patient population and orthodontists. Only two studies to date have examined the changing preferences of patients for orthodontic treatment provider.^{9,10} They specifically evaluated the demographic factors that could potentially be associated with patients' choice for orthodontic treatment provider and sought to quantify the level of interest in each provider type. One aim of the present study was to expand on the work of Olson by evaluating how patient demographic factors could be related not just to choice of provider type, but also motivators for orthodontic treatment. There is no literature we are aware of examining the effect of an increased prevalence of GPs providing orthodontic treatment and DTC providers on orthodontists or their practices at this time. Therefore, this study was aimed to detect any association between the variables of patient demographics and orthodontists practice profiles with preference for orthodontic treatment provider and recent changes in practice administrative practices respectively. The survey of patient population was distributed to Canadian participants and 330 responses were collected. The survey of orthodontists was distributed to Canadian and American orthodontists and 270 responses were collected.

Survey Study Design

The response rate of a survey, a measure of the representativeness of the sample, is generally a good indicator of its quality.¹⁶⁴ According to Funkhouser, there is no minimum acceptable response rate, however online dental surveys typically exhibit response rates of approximately 70.0%. Historically and currently, response rates for a survey are lower for healthcare professionals than the general public, possibly due to lack of time, saliency, perceived

lack of importance, concerns about confidentiality, concerns about bias of the survey, and the presence of an office “gate keeper” personnel who screen mail and email requests.¹⁶⁴

Previous literature has suggested that mail-based surveys have higher response rates than those that are email-based.¹⁶⁵ However, in the present study both surveys were distributed electronically for the benefits of efficiency, cost-effectiveness, and the limitation of interpersonal interaction amid COVID-19. The expected response rate of an email-based survey is 20.7%.¹⁶⁵ The survey of the general public was distributed by a data collection company to their bank of anonymous participants; therefore, an estimation of the response rate cannot be made. Similarly, the survey of orthodontists was distributed mainly via an online forum and the number of potential participants who may have seen the invitation to participate cannot be elucidated, therefore no response rate can be fathomed. The only existing survey of a similar topic achieved a response rate of 81.4%, far exceeding the expected quotient of 70.0%.⁹ There are examples in the literature of surveys of dental patients having achieved response rates above 60%.^{166,167} There are also examples in the literature of surveys of dental practitioners having achieved similarly high response rates.^{168,169} The present study has an unknown response rate. However even if the response rate for the surveys examined herein were significantly lower than expected, research has shown that the bias introduced by non-responses is relatively small.¹⁷⁰ Since the response rate is not discernible another method had to be implemented to reduce bias and increase representativeness. Olson’s survey of the American public was completed by 249 adults. As a protection, this study acted to achieve a 33.0% increase over Olson’s number of respondents. A survey-based study carried out by a Canadian orthodontic resident achieved a sample size of 82 orthodontists.¹⁷¹ As a protection, this study aimed for a higher sample size and achieved 270 responses which is 230% higher than the only similar survey conducted by a resident of capturing

the perspective of Canadian orthodontists. Therefore, the total number of responses gathered was deemed adequate to allow a glimpse into how the general public and orthodontists perceive the effects of the changing orthodontic environment.

There is a possibility of bias in survey response rates for this study. Orthodontists with an interest or talent for the business aspect of their profession may have been more easily persuaded to complete the survey than orthodontists who have little or no interest in such dealings. On the other hand, such orthodontists may have less free time and may be less inclined to complete a voluntary survey. There was no possibility to attempt to evenly disperse the survey irrespective of business acumen without lengthening the already extensive survey or significantly reducing the number of prospective participants.

Study 1: Patient Preference for Orthodontic Care Provider among the Canadian Public

Demographics

Individuals who responded to this survey were almost evenly split between male (51.8%) and female (48.2%). This is consistent with the overall expected equivalent ratio between males and females in Canada and the United States.

The majority of participants were aged 30-39 (43.9%), followed by those aged 40-49 (25.8%), and 22-29 (18.2%). The distribution of age among participants skews younger than that of the 2016 Canadian census in which the most populous age was 53 years old.¹⁷² However, the distribution observed is more relevant to orthodontists as it favours individuals who are of working age, or making a decision about their school going or post-secondary aged children.

The majority of participants identified as Caucasian (56.1%), followed by Asian (30.3%), Black (4.8%), mixed race (2.4%), and Hispanic (2.1%). This does not match well with the

demographic information reported in the 2016 Canadian census or 2010 American census.^{172,173}

In the Canadian census, persons identifying as Caucasian constituted 72.9% of the total population, those identifying as Asian (all Asian ethnicities combined) were 15.0%, Black were 3.5%, mixed race were 0.7%, and Hispanic were 1.3%. In the American census, persons identifying as Caucasian constituted 73.0% of the total population, those identifying as Hispanic were 17.6%, Black were 12.7%, Asian were 5.4%, mixed race were 3.1%, and indigenous were 0.0%. All ethnic categories except Asian were under-represented in this survey to some extent. This should not affect the results as the number of persons identifying as Caucasian and Asian were substantial enough to form deductions with a high degree of certainty.

The majority of participants were married (67.9%), followed by those who were single and never married (28.2%), with all other groups occurring with less than 3%. For the purposes of statistical analysis, the groups of ‘separated’, ‘divorced’, and ‘widowed’ were combined with single and never married. The population of this study was slightly over-representative of married and common law individuals who make up 57.6% of the Canadian population and 48.2% of the American population.^{172,173} The population of this study was slightly under-representative of single individuals who make up 42.4% of the Canadian population and 51.8% of the American population.^{172,173} This should not affect all of the results as the number of persons identifying as single or married were substantial enough to form deductions with a high degree of certainty.

The highest percentage of participants were in four person households (28.2%), followed by three (25.5%), two (24.2%), one (14.8%), five (5.8%), and six (1.5%). For the purposes of statistical analysis, households of five and six were combined into a category of ‘five or more’. Stats Canada did not report single persons among household size data, only those with two or more. The majority of Canadians live in two-person (50.9%) and (24.1%) three-person

households.¹⁷² Conversely the majority of Americans live in two-person (34.3%) and one-person (28.3%) households.¹⁷³ The data presented herein is slightly under-representative of Canadian two-person households and American one- and two-person households. This should not affect the results as the number of participants is substantial enough to form deductions with certainty.

The highest percentage of participants had a bachelor's degree (42.2%), followed by master's degree or higher (22.7%), college degree (22.7%), and high school or GED (10.3%), with all other categories being less than 1.5%. It is not practical to compare the education level of participants with the 2016 Canadian census or 2020 American census as those surveys are divided among differing categories related to field of educational study.^{172,173}

The majority of participants were employed full-time (61.5%), followed by part-time employment (31.2%), those on who were unemployed or on social assistance (total = 4.5%), and post-secondary students (2.4%). According to the 2016 Canadian census, 60.2% of the total eligible workforce (above the age of 15) are employed and 92.3% of those within the labor force are employed, leaving the unemployment rate at 7.7%.¹⁷² According to the 2020 American census, 63.6% of the total eligible workforce (above the age of 16) are employed and 95.5% of those within the labor force are employed, leaving the unemployment rate at 4.5%.¹⁷³ The total percentage of survey participants who were employed was 92.7% which correlates well to the national data sets. Conclusions drawn from employment demographics in this survey can be considered very reliable.

A plurality of participants lived in a city of 50,000-500,000 people (45.6%), followed by those living in a metropolitan area of more than 500,000 people (43.8%), and those living in small cities of 2,500-50,000 people and small towns of less than 2,500 people were combined (total = 10.6%) for statistical analysis. Statistics Canada subdivides community size based on different numbers of people than this study.¹⁷² As of 2019, 81.5% of Canadians lived in urban or large

population centres.¹⁷² In 2020, approximately 80.0% of Americans lived in urban population centres.¹⁷³ A comparable percentage of participants of this survey (89.4%) lived in community sizes of greater than 50,000 people. The similarity to national data sets and large sample size indicates that conclusions drawn from community size demographics can be considered reliable.

A strong plurality of participants reported a total family income of greater than \$100,000 (40.6%), with all other groups having an incidence of less than 13%. Having additional subdivisions above \$100,000 might have given further insight into higher income individuals. The average family income for Canadian and American private households is \$88,306 and \$87,864 respectively.^{172,173} The results pertaining to family income are skewed positively toward higher levels. Additionally, the survey did not account for such factors as after-tax income or individual income. These differences may indicate that the data is not representative of the national population and should be interpreted thoughtfully.

The results of this study are based on a sample that accurately represents the general adult population in Canada. Additionally, may be interpreted regarding the general adult population in the United States based on reported census values. Surveys of orthodontic patients are characteristically restricted to a sample of convenience consisting of current patients, past patients, limited geographic areas, and easily obtainable mailing lists.^{77,174,175} These studies are often retrospective in nature, polling patients whose treatment is already complete.¹⁷⁴ A commercial polling company was used to obtain an improved representation of the Canadian general adult population, eliminating bias associated with small sample sizes and retrospective studies.

Attitudes towards orthodontic treatment

The demographic factor that was significantly associated with having previous orthodontic treatment was age. Specifically, participants younger than 39 indicated that they had previous

orthodontic treatment significantly more than their older counterparts. One study of orthodontic treatment need demonstrated that 25% of adults aged 18 and older had previous orthodontic treatment.¹⁷⁶ Over the past few decades, there has been a trend toward increased perceived treatment need among middle-aged and older adults.^{21,177} While the number of older adults who have had previous orthodontic treatment is increased, it is not yet equivalent to that of young adults at this time. Regarding other demographic factors, the participant's gender, ethnicity, education level, marital status, household size, employment status, community size, and income were not significantly associated with having previous orthodontic treatment.

The demographic factors that were significantly associated with the perceived benefit of having orthodontic treatment were age and community size. Specifically, participants aged 30-39 and 50 or older were most likely to perceive a benefit from having straight teeth. Participants aged 16-29 and 40-49 were most likely to indicate that they did not perceive value in having straight teeth. Regarding community size, participants in the largest population centres valued straight teeth and a beautiful smile significantly more highly than those in rural areas. Recently, the value of smile and facial aesthetics as an indicator of social value has increased.¹⁷⁸ Age has been shown to be a factor affecting smile aesthetics, with increased age being associated with diminished aesthetics.^{178,179} The data collected indicates that older individuals perceived higher value in straight teeth and pleasing smile aesthetics. This may be due to an increased scrutiny among older individuals. Smile aesthetics evaluation among laypersons can conform to differing values and standards based on geographic location.^{180,181} However, to date, there is no data among the literature examining the effect community size has on evaluation of smile aesthetics. Increased community size appears to be correlated to a higher value placed on smile aesthetics. Regarding other demographic factors, the participant's gender, ethnicity, education level, marital status,

household size, employment status, and income were not significantly associated with the value placed on pleasing smile aesthetics.

The demographic factors that significantly affected choice of treatment mode were age and community size. Younger participants were more likely to prefer metal braces. Older participants were most likely to prefer clear braces and least likely to prefer clear aligners. As the participant's community size increased, their likelihood of indicating a preference for clear aligners as the favoured mode of orthodontic treatment increased. It has been well established in orthodontic literature that patients have a clear preference for orthodontic appliances that are perceived to be more aesthetic.^{182,183} In fact, previous research examining age and choice for orthodontic appliance indicates that children tend to rate metal appliances with coloured ligatures higher than adults and older subjects rated clear appliances higher.^{18,184} The current appears to conform to that previously demonstrated among the literature. To date, there is no data among the literature examining the association between community size with choice for mode of orthodontic treatment. Regarding other demographic factors, the participant's gender, ethnicity, education level, marital status, household size, employment status, and income were not significantly associated with preference for mode of orthodontic treatment.

The most frequent sources for interest in orthodontic treatment were a friend or family member receiving treatment, a recommendation by a dental professional, and the internet. The demographic factors that significantly affected current interest in orthodontic treatment were age, race, education, employment status. Younger participants were more likely than their older counterparts to have an interest in orthodontic treatment that was generated by social media. It has been demonstrated that younger individuals utilize social media at a greater rate than older adults.¹⁸⁵ This data suggests that younger adults are more prone to be interested in orthodontic care

based on their social media engagement. Asian and Caucasian participants were more likely than those who identified as Hispanic, Black, and mixed race to have an interest in orthodontic treatment created by friends of family who had treatment. It is well established that Class II problems are most prevalent among Caucasian populations and Class III problems are most prevalent among Asian populations.¹⁸⁶ Family generated referrals are a significant source of new orthodontic patients.¹⁸⁷ Young adults also show great dependence on family and friends when demonstrating psychological motives for treatment.¹⁸⁸ This data provides further evidence that Caucasian and Asian individuals are influenced by social norms to seek treatment for self-perceived aesthetic outcomes. Participants with a high school or equivalent education were least likely to have interest in orthodontic treatment generated by a friend or family member. Participants with a college or technical degree were least likely to have interest in orthodontic treatment created by the recommendation of a dental professional. Individuals with higher education levels demonstrate better oral health behaviours.¹⁸⁹ Better oral health behaviours can be extrapolated to an increased awareness and interest. This data adds to the literature of higher education individuals, such as those with bachelor's and master's degrees, exhibiting a keener interest in orthodontic treatment. Participants who were employed full-time were more likely than those employed part-time and those who were unemployed to have an interest in orthodontic treatment produced by a recommendation from a dental professional or from social media. Cost is a significant barrier for access to dental and orthodontic care.¹⁹⁰ It is probable that individuals with secure full-time employment are more able to access orthodontic care and therefore have a greater interest. They are also more likely to have access to orthodontic insurance. Regarding other demographic factors, the participant's gender, marital status, employment status, and income were not significantly associated with preference for mode of orthodontic treatment.

The demographic factors that significantly affected what current occlusal problems participants were interested in addressing were marital status, gender, ethnicity, household size, and community size. Participants who were married were significantly more likely to address an increased overjet through orthodontic treatment. This is interesting as literature has shown that single people are more likely than those who are married to report an orthodontic visit.¹⁹¹ Male participants were more likely than female participants to indicate that they wanted to address an increased overjet with orthodontic treatment. There is a general impression that males suffer more dental trauma than females, perhaps due to an increased propensity for contact sports and recreational activities, which would justify a desire for overjet correction.^{192–194} Note this may also be the case for males with a retrognathic mandible and weak chin as laypersons have a more favourable perception of male facial profiles containing an average to strong mandible and chin.¹⁹⁵ Participants who identified as Black were more likely to want to address an open bite through orthodontic treatment. This is logical as the incidence of openbite in persons of African descent is several times higher than the rate for Caucasians.^{196,197} Mixed race individuals were significantly more likely than all other races to want to address hygiene issues via orthodontic treatment. This cannot be compared to the literature as a ‘mixed-race’ individual could belong to a variety of potential ethnic backgrounds. Participants from larger family units were more likely to want to address an increased overjet and speech difficulties via orthodontic treatment than participants from smaller families. This stands to reason as greater family size is often related to lower socioeconomic status, even among traditionally advantaged countries such as the United States.¹⁹⁸ Families of lower socioeconomic status would also have an increased barrier for access to care. Additionally, subjects of lower socioeconomic status demonstrate a higher index of orthodontic need.¹⁹⁹ Interestingly, participants in small towns and cities were most likely to want to address an

openbite via orthodontic treatment. This is likely due to a reduced access to orthodontic care among rural communities.^{200,201} Regarding other demographic factors, the participant's education, age, employment status, and income were not significantly associated with which occlusal problems participants wished to correct via orthodontic treatment.

The demographic factors that significantly affected participant motivation for undertaking orthodontic treatment were marital status, gender, ethnicity, household size, and education. Participants who were single were significantly more likely than those who were married to want orthodontic treatment to improve self-esteem. These compliment previous data in which single persons were more likely to report an orthodontic visit.¹⁹¹ Female participants were more likely than males to want to address difficulties in performing dental hygiene. This is in concurrence with previous data which suggests that females perform hygiene activities closer to the recommended frequency, and associate flossing more with a cleanliness behaviour than males.^{202,203} Participants who identified as Black were less likely than all other groups to report a motivation of improving self-esteem. This is an expected result as greater self-esteem scores of persons of African descent relative to Caucasians have been found in numerous studies.^{204–206} Participants who identified as Asian were more likely than all other groups to cite a friend or family member receiving orthodontic treatment as their motivation. A major difference between Asian communities and Caucasians is that Asian subjects cited embarrassment rather than fear as the main deterrent for seeking orthodontic treatment.²⁰⁷ It stands to reason that if a friend or family member were receiving orthodontic treatment, a person may be less embarrassed about receiving their own orthodontic appliance. Participants with the highest number of persons in their household were most likely to desire to improve oral function via orthodontic treatment. This is a predictable result as large families often have lower socioeconomic status and a higher index of orthodontic

need.^{198,199} Participants with the highest education level were most likely to cite a friend or family member receiving treatment as their main motivation for orthodontic treatment. Unfortunately, there is no research on patient education level and motivation for orthodontic treatment to compare this result. Participants who were employed full-time were more likely than all other groups to be motivated by a desire to improve smile aesthetics. As cost is a significant barrier to orthodontic care, it is logical that those with the means to access it would have a greater interest.¹⁹⁰

A plurality of participants selected an orthodontist as their preferred provider of orthodontic treatment, followed by whichever provider their dentist recommended, a general dentist, and lastly clear aligner companies. The orthodontist being the option most frequently selected agrees with previous research carried out by Olson and colleagues.⁹ However, a notable difference is that the option for a GP or the provider a dentist recommends were both selected more frequently than DTC providers. This is in opposition to the results of Olson's study as the participants of that survey chose DTC providers more frequently than a general dentist.⁹ This disparity may be caused by the sample sizes for each study not being large enough or a national difference as DTC providers are more prevalent in the United States and thus Olson's survey population being more exposed to advertising of DTC providers.

The demographic factors that significantly affected participant choice for orthodontic treatment provider were age, employment status, and community size. The younger the participants, the more likely they were to choose orthodontic treatment carried out by a DTC provider. The older the participant, the more likely they were to adopt the suggestion of their dental professional. Participants younger than 39 were more likely than their older counterparts to select orthodontic treatment provided by an orthodontist. This would suggest that in order to reach the audience with the most interest, orthodontists should focus advertisements to younger adults.

Participants in small cities or towns were more likely than those in larger population centres to select a GP as their orthodontic treatment provider. The same group was also least likely to choose whichever option was recommended by their GP. Those employed full-time and post-secondary students were more likely than those employed part-time and unemployed to select an orthodontist as their treatment provider. This further supports the notion that cost affects access to care. Additionally, the larger the population centre, the more likely the participant was to select an orthodontist as their treatment provider. These phenomena are likely due to reduced access to orthodontic care in rural communities which could limit choice.^{200,201} This suggests that as the availability of a specialist orthodontist increases, so does the likelihood that a person would choose that provider for their care. Regarding other demographic factors, the participant's gender, ethnicity, education level, marital status, household size, and income were not significantly associated with preference for mode of orthodontic treatment.

When asked the reason for their choice of provider a plurality of participants cited the expertise and training of the provider, followed in succession by the successful treatment outcomes of the selection, and treatment occurring in a professional office. The demographic factors that significantly affected participant reason for choice of treatment provider were age, employment status, and community size. The younger the participant, the more likely they were to make their choice of provider based on the testimonials of friends and family. Additionally, older participants were more likely to select their treatment provider based on the cost associated the provider type. This data suggests that younger participants are more susceptible to influence from their social circle when selecting provider type and as they age people are looking for a provider that provides treatment at an advantageous cost. A possible inference from this finding is that adults will give priority to the treatment of their children and may be more cost-restrictive concerning their own

treatment which supports the suggestion of previous research.⁹ Studies have shown that having a flexible and beneficial payment plan has a far greater impact on patient choice than overall cost.^{48,88,123} As cost is a limiting factor for access to care and has such influence on patient choice, it would be prudent for orthodontists to offer more adaptable payment plans to satisfy patient needs. The larger the community size, the more likely the participant was to indicate the expertise and training of the treatment provider as a motivator for their selection. This further supports the observation that when the experienced specialist is available geographically, participants value the additional qualification.

The true utility of this study is in the application of the interpreted data. Two examples will be outlined herein to fully demonstrate the potential value of this information.

Scenario 1

An orthodontist is opening a practice in a new community and wants to be able to reach out to potential patients in the most effective manner. By utilizing census data, he/she observes that the majority of inhabitants of this neighbourhood within a city are married, young adults below the age of 30, predominantly of Caucasian ancestry, largely educated at a bachelor's level, living in mostly 3-person households, and fully-employed with high household incomes. Through application of this study's data, the orthodontist realizes that inhabitants of cities place more value on smile aesthetics and prefer an orthodontist as a treatment provider. The young Caucasian population is influenced greatly by social media and may have a notable interest in DTC providers and wanting treatment to improve their self-esteem. Upon connecting these demographic variables with the preceding information, the orthodontist decides to spend extra resources advertising on social media and prominently displaying past patient testimonials that emphasize an improved self-esteem after treatment.

Scenario 2

An orthodontist who has been practicing in the same location for 20 years has noticed a decrease in new patients over the past 36 months. By utilizing population data, he/she realizes that his/her community demographics have changed in the past few years. Their once young community has been changed by an influx of older adults purchasing retirement homes in the area. The average age has risen to 50, the most prevalent ethnic group is now Asian, inhabitants occupy mostly 4-person households, with an increase in single adults, and mostly retired inhabitants are likely collecting a smaller income on social security. Through application of this study's data, the orthodontist realizes that inhabitants of small towns are most likely to follow the suggestion of a GP and choose a dentist as their orthodontic treatment provider. The single population is more likely to report an ortho visit. Since the population is also older and predominantly Asian, the orthodontist surmises that they understand the value of straight teeth, have embarrassment be their biggest barrier to booking an appointment, and strongly prefer aesthetic treatment options. Therefore, the orthodontist decides to spend extra resources forming professional connections with new GPs in the area, and tailoring advertisements to emphasize range of aesthetic treatment options available.

Study 2: The Changing External Environment and Orthodontic Practices

Demographics

The demographic information of the participants of this survey was compared to the 2017 Orthodontic Workforce Report to determine their representativeness.²⁰⁸ The number of male orthodontists in this survey (70.0%) matches well to the American (72.0%) and Canadian (76.0%) national averages.^{208,209} The well dispersed years of experience among the participants correlates well to the age dispersion of American and Canadian orthodontists.^{208,209}

Practice profile

The practice location community size data matches that of the American and Canadian orthodontists almost exactly.^{208,209} There was no data to compare the numbers in this study of orthodontists who provide clear aligner therapy. Orthodontists in practice for less than 30 years were significantly more likely to provide clear aligner therapy. As years of experience increased, desire to begin providing clear aligner therapy decreased among those not currently practicing this treatment modality. It appears that orthodontists who are younger are keener to adopt clear aligners. This also correlates well to the advent of AlignTech just over two decades ago. Most orthodontists have been providing clear aligner therapy for over ten years. The only groups who had not been providing this therapy for over ten years, were the groups with less experience. Thus, we can conclude that orthodontists who provide clear aligner therapy likely adopted it early in their career. Among the orthodontists who provide clear aligner therapy, the majority have seen the percentage of clear aligner cases in their practice increase over the past ten years. This trend was stronger as years of experience decreased, indicating that younger orthodontists are increasing their provision of clear aligner therapy at an increased rate. The provision of clear aligner therapy was highest among practitioners with the largest patient population. Therefore, as the number of

patients being cared for increases, the orthodontist tends to offer more possible treatment modalities. In addition, as the trend grows for orthodontists to undertake less intra-oral adjustments through wire bending techniques, aligners such as clear aligners and robotically manufactured and bended archwires is a future direction in orthodontics.

The vast majority of orthodontists advertise using a practice website, followed by social media, and internet ads. Advertisement in the orthodontic field appears to be firmly cemented in the digital age. The less experienced the orthodontist, the more likely they are to use internet ads. More experienced orthodontists are likely comfortable in their professional life and do not feel the need to expand their modes of advertisement. The smaller the population centre in which a practice was located, the more likely an orthodontist was to utilize newspaper advertisements. Orthodontists in the United States were significantly more likely than Canadians to utilize social media and event marketing to promote their practices. This national difference indicates that American orthodontists are more proficient at employing advertising methods that engage members of their community both online and in-person. A possible explanation for this trend is that the traditional model for orthodontic marketing which involved appealing to primary care dentists has changed over the past several decades, with companies that advertise DTC originating in the United States.¹ The paradigm shift in orthodontic marketing began in the United States, and thus it appears that American orthodontists were first to adapt. Orthodontists with a patient population less than 1000 were least likely to utilize online video advertisement and mail advertisement. This data, while interesting, cannot be interpreted without further research into the correlation between practice size and business practices.

Perception of role GPs should occupy in orthodontics

When asked what role GPs should occupy in orthodontics, approximately half of orthodontists indicated that a GP should provide ‘limited clear aligner therapy’, ‘refer difficult cases’, and ‘should refer all cases’. This indicates that orthodontists believe the role of GPs in orthodontics to be limited to simple clear aligner therapy and referring all difficult cases. As years of experience enlarged, orthodontists’ opinion on GPs providing interceptive orthodontics increased. More experienced orthodontists have likely seen over their careers a variety of patients whose malocclusions would be less severe had they received interceptive treatment. Studies have found that interceptive orthodontics can significantly reduce the severity of malocclusions, removing them from the “medically necessary” category.²¹⁰ It seems they would be more accepting of a GP providing that treatment if it decreased the severity of the patient’s malocclusion. Orthodontists in larger population centres were more likely to indicate that GPs’ scope of practice can include limited orthodontic therapy. Rural populations have fewer GPs per population and greater distance travelled to access general and specialist dental care.²¹¹ Dentists practicing in rural areas must be proficient in all aspects of general dentistry to service their community. It is possible that dentists in urban centres with higher dentist per population ratios and access to specialists are more likely to focus on developing unique differentiating factors such as clear aligner therapy. Canadian orthodontists were more likely to consider that GPs are capable of providing interceptive orthodontics and limited full fixed treatment while also being more likely to suggest that difficult cases be referred. A potential explanation for these phenomena is that Canadian dental schools possibly provide more didactic and clinical orthodontic training relative to their American counterparts, making GPs more comfortable providing orthodontic care. Canadian dental schools provide orthodontic instruction across all four years, while American schools provide the majority

of orthodontic teaching material in third year.²¹² Alternatively, one could suggest that the external environment in the United States is more competitive which could contribute to the beliefs of American orthodontists.

Perception of external effects on practice

A greater number of orthodontists perceived that their practice had been impacted by GPs providing orthodontic treatment relative to DTC providers. The more experienced the orthodontist, the more likely they were to indicate that they have been impacted by GPs providing orthodontic care. Additionally, male orthodontists were more likely to perceive an impact from GPs providing orthodontic care. More experienced orthodontists are more likely to be male and may have had more time in practice to experience a decrease in referrals. The only demographic factor that affected perceived impact of DTC providers was Nationality. American orthodontists were significantly more likely than Canadian orthodontists to perceive an impact on their practice from DTC providers. This is likely due to the origin of most DTC providers being in the United States and the delay in growth in Canada.

The majority of orthodontists indicated that they perceived a reduction in GP referrals, increase in referral case difficulty, and need to improve practice competitiveness within the past ten years. As years of experience increased, orthodontists were more likely to note a reduction in GP referrals and less likely to feel a need to improve practice competitiveness. Older orthodontists have likely already grown their practice to a level at which they are comfortable and are more likely to be slowing down closer to retirement. The data suggests that increased years of experience correlates with contentment and an ability for reflective hindsight.

Cases previously treated by a general practitioner or DTC providers

Most orthodontists indicated they had re-treated a case previously by a GP and almost half of orthodontists had re-treated a case previously treated via a DTC provider. Regarding re-treating cases previously performed by a general dentist, the only demographic factor of significance was gender. Male orthodontists were significantly more likely than female orthodontists to indicate they have re-treated a case previously treated by a general dentist. This is likely due to the fact that most experienced orthodontists are male and having been in practice longer probably correlates to an increased prospect of having to re-treat a GP orthodontic patient.

Regarding re-treating cases previously treated via DTC providers, the only demographic factors of significance were nationality and practice patient population. American orthodontists and those with larger practice patient populations were significantly more likely to have re-treated a case previously treated via DTC provider. This is likely because DTC providers are more prevalent in the United States relative to Canada and a larger practice has an increased chance of receiving orthodontic patients previously treated through this treatment provider.

When asked what complications of previous treatment by GPs and DTC providers they had to address, the top three results were ‘increased overjet’, ‘traumatic occlusion’, and ‘deep bite’. The demographic factors that were associated with observation of particular complications were gender, nationality, and practice population. Male orthodontists were significantly more likely than female orthodontists to observe gingival recession, anterior open bites, and deep bites as a result of previous orthodontic treatment by a GP or the DTC provider. Canadian orthodontists were significantly more likely than American orthodontists to note an increased overjet and anterior open bite as a result of previous orthodontic treatment by a general dentist or the DTC provider. At this time, there is no discernable reason for these differences between genders and nationality.

Orthodontists with moderate to large sized patient populations were more likely than those with smaller patient populations to detect root resorption, gingival recession, periodontally involved teeth as a result of previous orthodontic treatment by a GP or DTC provider. As practice population increased, orthodontists were progressively more likely to observe anterior openbite, traumatic occlusion, and tooth mobility as a negative outcome of previous orthodontic treatment by a GP or the DTC provider. A possible explanation for this phenomenon is that larger urban centres where more GPs are providing orthodontic treatment can support these larger orthodontic practices.

Modifications performed to administration and operation of practice

When asked what changes to patient centred practices had been made within the past ten years, a majority of orthodontists indicated that they had been offering discounts for family members of existing patients and free initial consults for over ten years. A majority of orthodontists indicated that they had begun offering discounted records and diagnosis and lowered the cost of clear aligner therapy in the last ten years. There was a stark difference between genders in recent patient centered adaptations. Female orthodontists were significantly more likely than males to have begun implementing a referral reward program, family member discounts, free initial consults, and discounted records within the past ten years. This occurrence can be explained by the age and gender distribution among the profession. Approximately 70% of all orthodontists in the US are male and the current demographics of most dental schools and residency programs are equally distributed between male and female. This distribution indicates that the average female orthodontist is younger relative to the average male orthodontist and newer practitioners are still gaining experience and building their practices. As community size increased, so did the likelihood of implementing a reduced clear aligner therapy fee within the past ten years. A possible explanation is that orthodontists in larger urban centres feel a greater need to stay competitive.

American orthodontists were more likely than Canadian orthodontists to have begun offering a free initial consult and discounted records over ten years ago. This indicates that the environment in the US has had a greater degree of competitiveness for longer than Canada. As patient population increased, so did the likelihood of having begun offering a free initial consult for over ten years. This indicates that larger practices tend to adapt more to remain competitive.

The community outreach practices that have been adopted by most orthodontists for over ten years are sponsoring local events and sports teams and seeking referral from other dental specialists. A small majority of orthodontists have begun submitting press releases to media platforms within the past ten years. As years of experience increased so did the likelihood that an orthodontist had been sponsoring local events and sports teams and submitting press releases for over ten years. This indicates that experienced orthodontists are most practiced at community outreach. Furthermore, a gender difference was that female orthodontists were more likely to have begun sponsoring local events and sports teams as well as seeking referrals from other dental specialists within the past ten years. This is added evidence that a greater percentage of younger orthodontists are female. Orthodontists in larger population centres were more likely to have been submitting press releases to media platforms for over ten years. This supports the notion that those practicing in larger urban centres have been early adopters of measures that would make their practice more engaged within the community. Canadian orthodontists were less likely to have been submitting press releases to media platforms for over ten years. This supports the notion that American orthodontists have been earlier adopters of measures that would make their practice more engaged within the community.

When asked what changes orthodontists had been made to their practices' online presence in the last ten years, the vast majority of participants indicated that they have made all updates to

all the options listed. These options included updating their practice website, implemented search engine optimization, implemented pay-per-click advertising, increasing the number of online directory listings of their practice, ensuring consistency across all online listings, increased practice social media presence, implemented ad retargeting, encouraging patients to write online reviews, and devoted resources to addressing negative online reviews. Orthodontists who had been in practice for 10-30 years were the only group more likely to start using search engine optimization over ten years ago. Orthodontists who had been in practice for 20-40 years were the only group to have ensured consistency among online directory listing for over ten years. Orthodontists who had been practicing for 30-40 years were the only group to have increased their practice social media presence over ten years ago. These observations seem to indicate that orthodontists in the latter half of their careers adapted to digital outreach in the middle of their careers when online advertising was a new phenomenon. This statement is based on the assumption that the average age of a graduating orthodontist is 31.4 and the average retirement age is 65.^{209,213} However, much has changed in the digital world over the past decade with the advent of multiple social media platforms. The data would suggest that younger orthodontists are recently adapting to modern digital outreach strategies. One would expect the older generation to undertake these measures to boost their practice. Yet, this does not seem to be the case and perhaps they have already well-established practices, a comfortable income, less debt, and an interest in slowing down or retiring. There was a substantial gender difference between responses. Female orthodontists were significantly more likely than male orthodontists to have redesigned their practice website, implemented search engine optimization, implemented pay-per-click online advertising, increased their practice social media presence, implemented ad retargeting, and begun encouraging patients to leave online reviews within the past ten years. According to recent studies,

the orthodontic workforce is becoming more feminized, with the average female orthodontist being 4-6 years younger than the average male orthodontist and with 4-6 years less work experience.^{209,214} Furthermore, American orthodontists under 35 are equally distributed among male and female despite the overall demographics being 72% male.²⁰⁸ The gender differentiation observations in this study indicate that younger and less experienced female orthodontists are significantly more likely to make an effort to innovate in their practice online presence to reach and interact with patients. Practice patient population was also associated with online presence. The lower the practice patient population the greater the likelihood that orthodontists had begun using search engine optimization and pay-per-click advertising within the past ten years. This indicates that smaller practices may be looking to adapt more digital marketing strategies to appeal to more patients.

Response distribution for staffing policies was evenly distributed across most categories. The convention of paying staff for conference attendance has been applied by a majority of participants for more than ten years. The practices that have been implemented in the past ten years by a majority of participants are hiring a market and patient referral coordinator, hiring additional dental assistants and hygienists. Orthodontists' years in practice was positively associated with the length of time having specific staff performance goals, a staff bonus system, staff team-building activities, cross training staff for various duties delegating increased responsibilities to staff, and hiring additional assistants and hygienists. It would appear that more experienced orthodontists are more likely to be early adopters of various staffing policies. Although no literature could be found examining these variables, one could postulate that experienced orthodontists may have underwent a period of experimentation with staffing policies before finding their footing and achieving a successful workplace balance. There was a significant gender difference among responses. Female

orthodontists were more likely than male orthodontists to have begun setting staff performance goals, implementing a staff bonus system, assigned or hired a staff member to the position of treatment coordinator, begun cross training staff on various duties, begun delegating increased responsibilities to staff members, begun paying staff for conference attendance, and to have hired additional dental assistants within the last ten years. This data indicates that female orthodontists are more likely to have taken ownership and begun managing an orthodontic practice within the last ten years. Previously noted gender equality among graduating and young orthodontists supports this suggestion.²⁰⁸ Orthodontists' practice population was positively associated with the length of time having specific staff performance goals, a staff bonus system, assigned or hired a staff member to be a treatment coordinator, planning team building activities, cross training staff on various duties, delegating increased responsibilities to staff members, and hiring additional dental assistants. This would suggest that larger practices have adopted multiple competitive staffing policies in order to achieve their previous growth and current patient population level.

The majority of orthodontists indicated that they have recently made changes to the technology integrated into their practices. A preponderance of surveyed orthodontists specified that they had purchased new technology, updated existing technology, added automation to patient correspondence, updated or replaced practice management software, integrated app related practices, and added a biometric scanner to their practice within the past ten years. There was an association between years of experience and changes made to office technology. As years of experience decreased, the likelihood of purchasing new technology and adding automation to patient correspondence within the last ten years increased. This indicates that orthodontists new to the field are more likely to have recently updated practice technology. There was also an association with gender and recent changes to office technology. Female orthodontists were

significantly more likely than male orthodontists to have purchased new technology and added automation to patient correspondence within the past ten years. This is in contrast to previous research almost a decade ago which noted that male orthodontists utilized nearly every available orthodontic technology and newer technology was almost completely absent from female owned offices.²¹⁵ The data presented herein would suggest that female orthodontists are more likely to have recently updated practice technology.

The majority of orthodontists indicated that they have recently made changes to their clinic centered administrative practices. Most surveyed orthodontists specified that they have expanded their office hours, added new operating days, redesigned their reception areas, redesigned their operatories, changed supply providers for major purchases, purchased the practice of a competitor, opened a satellite clinic, and begun working in a multidisciplinary clinic within the past ten years. The orthodontists with the most experience of over 40 years were the only group who had not changed a supply provider for significant purchases within the past ten years. Furthermore, orthodontists in practices with patient populations greater than 4000 were less likely than all other groups to have changed a supply provider for significant purchases within the past ten years. These observations would suggest that most orthodontists tend to be flexible in choosing supply providers unless they are near the end of their career or have very large practices. There was an association between community size and changes made to clinic centered administrative practices. Orthodontists practicing in metropolitan areas were significantly less likely than those in smaller population centres to have changed a supply provider for major purchases within the past ten years. Those practicing in suburban areas were significantly more likely than those in metropolitan areas and small cities and towns to have started working in a multidisciplinary specialty clinic in the past ten years. This data suggests that orthodontists in smaller population centres are more likely

be flexible in their supply providers and that multidisciplinary specialty clinics appear to be growing most rapidly in suburban areas. A recent survey of Canadian orthodontists demonstrated that 8.8% of men and 7.1% of women orthodontic practitioners work in a multidisciplinary practice.²⁰⁹ Additionally, 10.6% of male and 9.5% of female orthodontists currently work in a general dental practice.²⁰⁹ Furthermore, it appears that approximately 9.0% of American orthodontists currently work in some form of group practice environment.²⁰⁸ While there is no historical data for these practice circumstances, changes in future data will be of interest in examining the state of the profession.

The true utility of this study is in the application of the interpreted data. Two examples will be outlined herein to fully demonstrate the potential value of this information.

Scenario 1

An orthodontist decides to open a new practice in a neighboring city. Without knowing any of their new colleagues they don't feel comfortable reaching out to discuss the current popular business practices. By examining the demographic data of local orthodontists, one can surmise which administrative practices to expect. This American city has several orthodontic practices or approximately 3,000 patients run by male orthodontists with a mean 30 years' experience. Orthodontists with such a level of experience have likely faced an impact from GPs and DTC providers offering orthodontic services as well as a decrease in referrals and increase in case difficulty. Additionally, it likely that their practices have a strong digital outreach program and well-established staffing policies. Being American, they are likely less tolerant of GPs providing orthodontic services and more likely to be retreating cases previously treated by DTC providers. Armed with this knowledge, the orthodontist decides to spend extra resources advertising their

ability to resolve previously treated orthodontic cases and offer their expertise to GPs attempting simple or interceptive orthodontic cases to encourage future referrals.

Scenario 2

An orthodontist practicing in a Canadian town realizes that over the past decade a majority of his/her colleagues have retired and been replaced by a new cohort of orthodontists. S/he estimate that the majority of his/her colleagues are female, have less than 15 years of experience, and possess an average practice patient population of approximately 1,500 persons. Knowing these demographic variables, the orthodontist deduces that the new orthodontists have not noticed a decrease in referrals. Being female and Canadian, s/he has also likely not perceived an impact from GPs and DTC providers providing orthodontic care. These new colleagues have probably purchased their practices within the past few years and are still tailoring their administrative policies. After coming to these realizations, the orthodontist decides to devote extra resources on marketing his/her extensive experience and proficiency to differentiate his/herself while advertising to potential patients.

Limitations of the Current Study

The main source of limitations associated with the present study was the necessity of using a commercial polling company. One restriction associated with this collection partner is the researcher does not have direct control over recruitment of participants. Furthermore, the organization pays participants for the partaking in the survey. The survey question design was designed to capture as much data as possible in questions where participants could select every answer that applied. Another possible strategy would be asking participants to select the answer that most applied. Interpretation relative to demographic information would be easier and more productive.

Educational Implications

The data presented herein could be used in a practice management curriculum taught to dental students at the pre- or post-doctoral level. Students would benefit from current orthodontic private practice environment as it relates to DTCs. Application through scenario-based teaching would be a valuable tool for utilization in orthodontic continuing education courses. Orthodontists and GPs would benefit from the ability to apply the present study to their practices as it relates to targeted advertising for potential patients. Additionally, orthodontists would benefit from examining how their practices compare to those of their colleagues who share their experience.

Political Implications

The advent of clear aligner therapy has expanded the scope of practice for GPs to include more orthodontic services. Additionally, DTC providers have acquired a growing percent of the orthodontic patient population. More participants in a field traditionally occupied by orthodontists alters the equilibrium and can create friction. Licensing bodies, governments, and the public will have to decide how a new balance will be achieved.

Considerations for Future Research

Based on the present findings, orthodontists can gain insight into the preferences of different patient groups regarding their orthodontic care. Future studies focusing on specific variables that had the most significant impact from the current research are warranted. The findings of the current research provide an overview of the current mindset of orthodontists regarding the state of the profession in the current competitive marketplace. Further studies focusing on the perceptions of GPs regarding the current state of orthodontics and the provision of care would also be useful. A 5- or 10-year follow-up study to investigate the long-term changes in the phenomena observed in both surveys would be of value.

Revisiting the Null Hypotheses

Patient Demographics

H₀: There is no influence of patient demographic factors such as age, ethnicity, gender, family status, education, employment, and income on preference for orthodontic treatment provider.

- Significant differences were found between demographic groups with regard to preference for orthodontic treatment provider – **Null hypothesis rejected**

The Changing External Environment

Perception of Orthodontic Care Provisions

H₀: Orthodontists have not perceived a change in their provision of orthodontic care over the past 10 years.

- A majority of orthodontists indicated perceiving an impact from GPs and DTC providers to their practice over the past ten and noted a decrease in referral frequency, increase in referral difficulty, patients treated by non-specialists requiring retreatment, and a belief of needing to be more competitive. – **Null hypothesis rejected**

Changes to Orthodontic Business Practices

H₀: Orthodontists have not made any changes to the administration of their practices over the past 10 years.

- Significant differences were found between demographic groups and practice profile characteristics with regard to changes made to the administration of practices over the past 10 years. – **Null hypothesis rejected**

Conclusions

Traditionally, patients have sought orthodontic treatment from dental specialists. The rise of GPs and DTC providers offering orthodontic treatment gave patients further choices. This study reported the patient preference for provider type and mode of treatment as well as analyzed the perceived impact orthodontists have felt and their adaptation in response.

Study 1: Patient Preference for Orthodontic Treatment

Orthodontists were the treatment provider of choice, especially among younger persons and those in metropolitan areas, followed by general dentists and DTC providers. Younger participants tended to prefer metal braces while older participant preferred clear braces. Preference for clear aligners was positively correlated to an increased community size. Family/social circle, a GP recommendation, and the internet were the most frequent sources of interest, motivated mostly by the aspiration of having an attractive smile and a higher self-esteem.

Study 2: The Changing External Environment and Orthodontic Practices

The majority of orthodontists perceived a greater impact from GPs than DTC providers and noted a reduction in referrals from GPs and an increase in referred case difficulty. More experienced and male orthodontists were more likely to have been impacted by GPs providing orthodontic care while American orthodontists were significantly more likely than Canadian orthodontists to perceive a negative impact from DTC providers. Canadian, female, and less experiences orthodontists are more likely to have made significant changes to the administration of their practice in the last 10 years.

Final Thoughts

The preceding decades have seen many changes to how orthodontics is practiced, and also who provides such treatment. Despite the recent rise of adjunctive orthodontic treatment providers,

orthodontists remain the provider of choice in the current equilibrium. Additionally, in response to a perceived negative impact from adjunctive orthodontic treatment providers, the majority of orthodontists have made adaptive changes to the administration of their practices.

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Appendix 1 – Ethics Approval



University
of Manitoba

Research Ethics and Compliance

Research Ethics Bannatyne
P126-770 Bannatyne Avenue
Winnipeg, MB R3E 0W3
T: 204 789 3255
F: 204 789 3414
bannreb@umanitoba.ca

HEALTH RESEARCH ETHICS BOARD (HREB) CERTIFICATE OF FINAL APPROVAL FOR NEW STUDIES Delegated Review

PRINCIPAL INVESTIGATOR: Dr. Matthew Brown	INSTITUTION/DEPARTMENT: U of M/Dentistry/Orthodontics	ETHICS #: HS23589 (H2020:028)
APPROVAL DATE: January 31, 2020	EXPIRY DATE: January 31, 2021	
STUDENT PRINCIPAL INVESTIGATOR SUPERVISOR (If applicable): Dr. William Wiltshire		

PROTOCOL NUMBER: NA	PROJECT OR PROTOCOL TITLE: The influence of the changing external environment and demographics on orthodontic practices
SPONSORING AGENCIES AND/OR COORDINATING GROUPS: NA	

Submission Date of Investigator Documents: January 6 and January 23, 2020	HREB Receipt Date of Documents: January 6 and January 24, 2020
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THE FOLLOWING ARE APPROVED FOR USE:

Document Name	Version(if applicable)	Date
Protocol: Protocol including Clarifications as per Letter dated January 23, 2020 and Revised REB Submission Form submitted January 23, 2020	V. 2.0	January 23, 2020
Consent and Assent Form(s): Participant Information and Consent Form - Patient (Consent Disclosure Statement) Participant Information and Consent Form - Orthodontists (Consent Disclosure Statement)	V. 2.0	January 23, 2020 November 20, 2019
Other: Email for University of Manitoba Orthodontic Graduates Soliciting Participation Questionnaires/Scales/Instruments Appendix (Undated)	V. 1.0 V. 1.0	January 23, 2020 submitted January 6, 2020 November 20, 2019
Invitation to Participate (Orthodontists)		

CERTIFICATION

The above named research study/project has been reviewed in a **delegated manner** by the University of Manitoba (UM) Health Research Board (HREB) and was found to be acceptable on ethical grounds for research involving human participants. The study/project and documents listed above was granted final approval by the Chair or Acting Chair, UM HREB.

HREB ATTESTATION

The University of Manitoba (UM) Research Board (HREB) is organized and operates according to Health Canada/ICH Good Clinical Practices, Tri-Council Policy Statement 2, and the applicable laws and regulations of Manitoba. In respect to clinical trials, the HREB complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations of Canada and carries out its functions in a manner consistent with Good Clinical Practices.

A unit of the office of the Vice-President (Research and International)

umanitoba.ca/research



**University
of Manitoba**

Research Ethics and Compliance

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HEALTH RESEARCH ETHICS BOARD (HREB)

CERTIFICATE OF FINAL APPROVAL FOR AMENDMENTS AND ADDENDUMS

PRINCIPAL INVESTIGATOR: Dr. Matthew Brown	INSTITUTION/DEPARTMENT: U of M/Dentistry/Orthodontics	ETHICS #: HS23589 (H2020:028)
HREB MEETING DATE (if applicable):		APPROVAL DATE: June 16, 2020
STUDENT PRINCIPAL INVESTIGATOR SUPERVISOR (if applicable): NA		
PROTOCOL NUMBER: NA	PROJECT OR PROTOCOL TITLE: The influence of the changing external environment and demographics on orthodontic practices	
SPONSORING AGENCIES AND/OR COORDINATING GROUPS: NA		

REMINDER: THE CURRENT HREB APPROVAL FOR THIS STUDY EXPIRES: January 31, 2021

REVIEW CATEGORY OF AMENDMENT:	Full Board Review <input type="checkbox"/>	Delegated Review <input checked="" type="checkbox"/>
Submission Date of Investigator Documents: June 10, 2020	HREB receipt date of Documents: June 10, 2020 (Email)	

THE FOLLOWING AMENDMENT(S) and DOCUMENTS ARE APPROVED FOR USE:

Document Name	Version(if applicable)	Date
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Protocol:

Revisions as per Amendment Form dated June 10, 2020

Consent and Assent Form(s):

Other:

Survey

V. 2

June 10, 2020

CERTIFICATION

The University of Manitoba (UM) Health Research Board (HREB) has reviewed the amendment to the research study/project named on this ***Certificate of Approval*** as per the category of review listed above and was found to be acceptable on ethical grounds for research involving human participants. The amendment and documents listed above were granted final approval by the Chair or Acting Chair, UM HREB.

HREB ATTESTATION

The University of Manitoba (UM) Health Research Board (HREB) is organized and operates according to Health Canada/ICH Good Clinical Practices, Tri-Council Policy Statement 2, and the applicable laws and regulation of Manitoba. In respect to clinical trials, the HREB complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations of Canada and carries out its functions in a manner consistent with Good Clinical Practices.

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umanitoba.ca/research

Appendix 2 – Survey of Canadian Public

Patient Preference for Mode of Orthodontic Treatment

* Which category below includes your age?

☐ 16 or younger

☐ 40-49

☐ 17-21

☐ 50-59

☐ 22-29

☐ 60 or older

☐ 30-39

* What ethnic group, if any, do you identify with? (Select all that apply)

☐ White

☐ South American

☐ Black or African-descent

☐ Pacific islander

☐ Hispanic

☐ Mixed race

☐ Asian

☐ Prefer not to say

☐ First Nations, Inuit, or Métis

☐ Other (please specify)

* What is your gender?

- ☐ Male
- ☐ Female
- ☐ Prefer not to say
- ☐ Other (please specify)

* What is your marital status?

- | | |
|---|---|
| <input type="radio"/> Single (Never married) | <input type="radio"/> Separated |
| <input type="radio"/> Married, or in a domestic partnership | <input type="radio"/> Divorced |
| <input type="radio"/> Widowed | <input type="radio"/> Prefer not to say |

* How many people are in your household?

- | | |
|-------------------------|--------------------------|
| <input type="radio"/> 1 | <input type="radio"/> 4 |
| <input type="radio"/> 2 | <input type="radio"/> 5 |
| <input type="radio"/> 3 | <input type="radio"/> 6+ |

* What is the highest level of school you have completed or the highest degree you have received?

- | | |
|---|---|
| <input type="radio"/> Did not complete high school | <input type="radio"/> Bachelor's degree |
| <input type="radio"/> Completed High school diploma / equivalent (e.g. GED) | <input type="radio"/> Master's degree or higher |
| <input type="radio"/> College degree | <input type="radio"/> Technical diploma |
| <input type="radio"/> Other (please specify) | |

* Which of the following categories best describes your employment status? (Select all that apply)

- | | |
|--|--|
| <input type="checkbox"/> Employed part time (<40 hours) | <input type="checkbox"/> High School or equivalent student |
| <input type="checkbox"/> Employed, full time (≥40 hours) | <input type="checkbox"/> College/University student |
| <input type="checkbox"/> Unemployed | <input type="checkbox"/> On social assistance |
| <input type="checkbox"/> Retired | |
| <input type="checkbox"/> Other (please specify) | |

* What is the size of the community you live in?

- ☐ Small town (<2,500)
- ☐ Town/small city (2,500-50,000)
- ☐ City (50,000-500,000)
- ☐ Metropolitan area (>500,000)

* What is your total family income in an average year?

- | | |
|---|---|
| <input type="radio"/> \$0 – \$9,999 | <input type="radio"/> \$60,000 – \$69,999 |
| <input type="radio"/> \$10,000 – \$19,999 | <input type="radio"/> \$70,000 – \$79,999 |
| <input type="radio"/> \$20,000 – \$29,999 | <input type="radio"/> \$80,000 – \$89,999 |
| <input type="radio"/> \$30,000 – \$39,999 | <input type="radio"/> \$90,000 – \$99,999 |
| <input type="radio"/> \$40,000 – \$49,999 | <input type="radio"/> \$100,000 or more |
| <input type="radio"/> \$50,000 – \$59,999 | <input type="radio"/> Prefer not to say |

* How much value do you place on having straight teeth / a beautiful smile?

	Not important at all		Somewhat important		Very important
Value	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* How many times a day do you brush your teeth?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3+

* If you were going to have orthodontic tooth straightening, which option would you prefer?

- ☐ Metal braces
- ☐ Clear braces
- ☐ Clear aligners / retainers
- ☐ I am not currently interested in tooth straightening

* If you are currently interested in having braces or clear retainers, what created that interest? (Select all that apply)

- | | |
|--|--|
| <input type="checkbox"/> Friend or family member had treatment | <input type="checkbox"/> TV |
| <input type="checkbox"/> Magazine/Newspaper | <input type="checkbox"/> Recommended by my dentist or hygienist |
| <input type="checkbox"/> Internet | <input type="checkbox"/> I previously had tooth straightening or am not currently interested |
| <input type="checkbox"/> Social media | |
| <input type="checkbox"/> Other (please specify) | |

* What about your teeth or bite (way teeth fit together) do you want to fix? (Select all that apply)

- | | |
|--|--|
| <input type="checkbox"/> I do not want to fix anything about my teeth | <input type="checkbox"/> Teeth stick out |
| <input type="checkbox"/> Teeth are crowded | <input type="checkbox"/> Jaw joint problems |
| <input type="checkbox"/> Teeth have space between them | <input type="checkbox"/> Uneven bite |
| <input type="checkbox"/> Teeth are difficult to clean in current position | <input type="checkbox"/> Difficulty chewing |
| <input type="checkbox"/> Top front teeth overlap over my bottom front teeth too much | <input type="checkbox"/> Wear on teeth due to bite |
| <input type="checkbox"/> Space between top and bottom teeth | <input type="checkbox"/> Speech problems |
| <input type="checkbox"/> Show too much gum when smiling | |
| <input type="checkbox"/> Other (please specify) | |

* Why would you straighten your teeth? (Select all that apply)

- | | |
|--|--|
| <input type="checkbox"/> I don't want to change anything about my teeth / I am happy with my smile | <input type="checkbox"/> A friend/family member had their teeth straightened |
| <input type="checkbox"/> To have a more attractive smile | <input type="checkbox"/> To improve bite / chewing |
| <input type="checkbox"/> To improve confidence / self-esteem | <input type="checkbox"/> To improve jaw alignment |
| <input type="checkbox"/> To make cleaning my teeth easier | <input type="checkbox"/> To prevent injuries (fractures, chips, etc.) |
| <input type="checkbox"/> Other (please specify) | |

* Which of the following options would you choose for your orthodontic treatment?

- ☐ Tooth straightening by an orthodontist (specialist)
- ☐ Tooth straightening by a family dentist
- ☐ Clear aligner companies / online orthodontic companies (ex: aligners mailed to you)
- ☐ Whichever is recommended by my dentist
- ☐ Other (please specify)

* What makes the option you choose in the previous question most attractive to you?

- | | |
|---|--|
| <input type="radio"/> Expertise and training of the doctor / provider | <input type="radio"/> Being treated outside of a professional office / at home |
| <input type="radio"/> Testimonials from friends / family | <input type="radio"/> Convenience of aligner delivery to my home |
| <input type="radio"/> Successful treatment outcomes | <input type="radio"/> Cost of treatment |
| <input type="radio"/> Interaction with person providing treatment | <input type="radio"/> Location (close to work or home) |
| <input type="radio"/> Being treated in a professional office | |
| <input type="radio"/> Other (please specify) | |

Thank you for taking the time to complete this survey. If you wish to receive a summary report of this study, please email a request to: brownm4@myumanitoba.ca

Appendix 3 – Survey of Orthodontists

The influence of the changing external environment and demographics on orthodontic practices

How long have you been in practice as a provider of orthodontic services?

- ☐ < 5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ 15-20 years
- ☐ 20-25 years
- ☐ 25-30 years
- ☐ 30-35 years
- ☐ 35-40 years
- ☐ > 40 years

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Prefer not to say
- ☐ Other (please specify)

How would you describe the area where your practice is located?

- ☐ City: metropolitan area and inside principal city
- ☐ Suburban: metropolitan area and outside a principal city
- ☐ Small city or town: population of less than 50,000
- ☐ Rural: population less than 5000

Which country do you practice in?

- ☐ Canada
- ☐ United States

What is the patient population number you have in your practice?

- ☐ < 1000
- ☐ 1000-2000
- ☐ 2000-3000
- ☐ 3000-4000
- ☐ 4000-5000
- ☒ >5000

Do you perceive that your practice been impacted by general dentists providing orthodontic treatment?

- ☐ Yes
- ☐ No
- ☐ Unsure

Do you perceive that your practice been impacted by direct-to-consumer orthodontic products?

- ☐ Yes
- ☐ No
- ☐ Unsure

Has the number of referrals you receive from general dentists decreased in the past 10 years?

- ☐ Yes
- ☐ No
- ☐ Unsure

Has the case difficulty referred by general dentists become more difficult in the past 10 years?

- ☐ Yes
- ☐ No
- ☐ Unsure

What do you think the role(s) of a general dentist should encompass in modern orthodontics? (Select all that apply)

- ☐ Provider of interceptive orthodontics for children
- ☐ Provider of limited full fixed orthodontic treatment
- ☐ Provider of comprehensive full fixed orthodontic treatment
- ☐ Provider of limited clear aligner therapy
- ☐ Provider of comprehensive clear aligner therapy
- ☐ Referrer of difficult orthodontic case
- ☐ Should refer all orthodontic cases

Do you provide clear aligner therapy in your practice?

- ☐ Yes
- ☐ No

If you do provide clear aligner therapy in your practice, how many years have you been providing this service?

- ☐ <5 years
- ☐ 5-10 years
- ☐ >10 years

If you do provide clear aligner therapy in your practice, do you fabricate aligners in-office?

- ☐ Yes
- ☐ No

If you do not provide clear aligner therapy in your practice, are you considering adding this to your services?

- ☐ Yes
- ☐ No

In the past 10 years, has the percentage of clear aligner therapy cases in your practice increased?

- ☐ Yes
- ☐ No
- ☐ Unsure

Have you re-treated orthodontic patient's who have previously been treated by a general dentist or via direct-to-consumer orthodontic products? (Select all that apply).

- ☐ Yes (general dentist)
- ☐ Yes (direct-to-consumer)
- ☐ No

If you have treated or seen patients who have previously been treated by a general dentist or via direct-to-consumer orthodontic products, have you encountered any of the following negative dental outcomes?

- ☐ Root resorption
- ☐ Gingival recession
- ☐ Periodontally involved teeth
- ☐ TMJ issues
- ☐ Increased overjet
- ☐ CR-CO discrepancy
- ☐ Posterior open bite
- ☐ Anterior open bite
- ☐ Traumatic occlusion
- ☐ Tooth mobility
- ☐ Deep bite
- ☐ Crossbite
- ☐ Other (please specify)

Do you currently feel the need to make your practice more competitive? (to provide accessible, qualified, and high level of care to your community)

- ☐ Yes
- ☐ No

What mode of advertisement do you employ in your practice? (Select all that apply)

- ☐ Radio
- ☐ Television
- ☐ Internet ads
- ☐ Practice website
- ☐ Online videos (ex: Youtube)
- ☐ Billboard
- ☐ Newspaper
- ☐ Magazine
- ☐ Social media
- ☐ Mail
- ☐ Event marketing
- ☐ Other (please specify)

Patient centered Practices

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Referral reward program – reward existing patients for referring new patient's to you	<input type="radio"/>	<input type="radio"/>
Discount for family members of existing patients	<input type="radio"/>	<input type="radio"/>
Free initial consult	<input type="radio"/>	<input type="radio"/>
Lowering cost of clear aligner therapy	<input type="radio"/>	<input type="radio"/>
Implementing new patient incentives (discount off records/diagnosis)	<input type="radio"/>	<input type="radio"/>

Community Outreach

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Sponsoring local events (ex: sports teams, community festivals, etc.)	<input type="radio"/>	<input type="radio"/>
Submitting press releases to media outlets regarding current trends in orthodontics	<input type="radio"/>	<input type="radio"/>
Seeking business referrals from other specialists (oral surgery, perio, pros, etc.)	<input type="radio"/>	<input type="radio"/>

Online Presence

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Professional redesign/update of practice	<input type="radio"/>	<input type="radio"/>
Search Engine Optimization (SEO)	<input type="radio"/>	<input type="radio"/>
Pay-Per-Click Advertising (PPC)	<input type="radio"/>	<input type="radio"/>
Increasing the number of online directory listings for your practice	<input type="radio"/>	<input type="radio"/>
Ensuring consistency among all online directory listings (ex: practice name and contact always the same on all databases)	<input type="radio"/>	<input type="radio"/>
Increasing practice social media presence (ex: adding practice Facebook, Twitter, Instagram pages)	<input type="radio"/>	<input type="radio"/>
Ad retargeting (adding cookies to practice website)	<input type="radio"/>	<input type="radio"/>
Encouraging patient's to write online reviews of your practice (ex: Yelp and Google)	<input type="radio"/>	<input type="radio"/>
Devoting resources to addressing bad online reviews	<input type="radio"/>	<input type="radio"/>

Staffing Practices

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Hiring a part-time or full-time market coordinator to manage patient referral programs	<input type="radio"/>	<input type="radio"/>
Setting goals for staff performance	<input type="radio"/>	<input type="radio"/>
Implementing a staff bonus system	<input type="radio"/>	<input type="radio"/>
Assigning a staff member (treatment coordinator) to promote patient education to improve case acceptance	<input type="radio"/>	<input type="radio"/>
Planning of staff team-building activities/outings	<input type="radio"/>	<input type="radio"/>
Cross train staff on various duties	<input type="radio"/>	<input type="radio"/>
Delegate increased responsibilities to auxiliary staff	<input type="radio"/>	<input type="radio"/>
Paying for staff conference attendance	<input type="radio"/>	<input type="radio"/>
Hiring additional Dental Assistants	<input type="radio"/>	<input type="radio"/>
Hiring additional Dental Hygienists	<input type="radio"/>	<input type="radio"/>

Office Technology

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Purchased new office technology (intra-oral scanner, 3D printer, etc.)	<input type="radio"/>	<input type="radio"/>
Updating or replacing office technology with newer models (intra-oral scanner, 3D printer, etc.)	<input type="radio"/>	<input type="radio"/>
Added automation to patient correspondence (appointment cycle reminders, appointment confirmation, etc.)	<input type="radio"/>	<input type="radio"/>
Purchase new or update existing practice management software	<input type="radio"/>	<input type="radio"/>
App related practices – (reminders to patients for elastics, monitor hygiene habits, request appointments)	<input type="radio"/>	<input type="radio"/>
Biometric scanner (ex: fingerprint check-in)	<input type="radio"/>	<input type="radio"/>

Clinic Centric Practices

During the past few years (≤ 10), have you made any of the following changes to your business? Please select all that apply. Please indicate if the change was made within the past 10 years, or over 10 years ago by checking the appropriate box.

	≤ 10 years	> 10 years
Expanding office hours (evening, early mornings, etc.)	<input type="radio"/>	<input type="radio"/>
Adding new days for practice to be open (ex: weekends)	<input type="radio"/>	<input type="radio"/>
Redesigning practice reception areas	<input type="radio"/>	<input type="radio"/>
Redesigning operator areas	<input type="radio"/>	<input type="radio"/>
Changing supply provider for significant purchases (ex: after receiving a discount)	<input type="radio"/>	<input type="radio"/>
Purchasing the practice of a competitor	<input type="radio"/>	<input type="radio"/>
Opening a satellite clinic	<input type="radio"/>	<input type="radio"/>
Having a lab / technician on-site	<input type="radio"/>	<input type="radio"/>
Working in a multidisciplinary clinic (ex: ortho, pedo, perio in one clinic)	<input type="radio"/>	<input type="radio"/>

Please list the three answers from the preceding questions on this page that you found have been most helpful in growing your practice.

Response 1

Response 2

Response 3

Of the changes that you indicated implementing in the past 10 years, do you think those provisions helped the administration and functioning of your practice?

☐ Yes

☐ No

☐ Unsure

This is the last page and final question. Thank you for your valued time. If you are interested in receiving an executive summary of this research project, please send an email directly to: brownm4@myumanitoba.ca

Appendix 4 – Survey of Canadian Public Consent Form



**University
of Manitoba**

FACULTY OF ORTHODONTICS
DR. GERALD NIZNICK COLLEGE OF DENTISTRY

Patient Preference for Mode of Orthodontic Treatment

PARTICIPANT INFORMATION AND CONSENT FORM

This survey is being conducted by Dr. Matthew Brown, a graduate orthodontic resident at the University of Manitoba. You are being asked to consider participation in a survey study because you are a member of the public.

This survey is being conducted to determine what factors influence a potential orthodontic patient's choice of treatment provider.

Your feedback will be collected through completion of a survey, which will ask you a series of questions and should less than 5 minutes to complete.

Your participation is completely voluntary. You may only answer the questions you feel comfortable answering.

The risks of participating are low. The potential risks are feelings of embarrassment or anxiety concerning demographic questions. You do not have to answer any question that makes you uncomfortable.

You are not required to provide any personal information such as your name, address or telephone number. Your responses will be anonymous as we will not know who has completed the survey and it will not be linked to any other information about you.

Your participation is important to us and may help us determine what factors influence a person's choice of mode of orthodontic treatment.

If you have any questions about this survey study, please do not hesitate to contact Dr. Matthew Brown at brownm4@myumanitoba.ca

This study and survey has been approved by the University of Manitoba Health Research Ethics Board.

By continuing on and completing the questions you are consenting to participate in this survey.

Appendix 5 – Survey of Orthodontists Consent Form



University
of Manitoba

FACULTY OF ORTHODONTICS
DR. GERALD NIZNICK COLLEGE OF DENTISTRY

The influence of the changing external environment and demographics on orthodontic practices

PARTICIPANT INFORMATION AND CONSENT FORM

Thank-you for accessing “The influence of the changing external environment and demographics on orthodontic practices” internet survey. This survey is being conducted by Matthew Brown, a graduate orthodontic resident at the University of Manitoba.

This survey is being conducted to determine the changes to the face of Canadian and US orthodontic business practices over the previous 10-year period.

Your feedback will be collected through an online survey that will ask you a series of questions and should take about 5-10 minutes to complete.

Your participation on this online survey is completely voluntary. You are not required to provide any personal information such as your name, address or telephone number, and you don’t have to answer any questions you don’t want to. The survey system will not record your e-mail address or IP (Internet protocol) address.

The risks of participating are low. The investigator has not identified any possible risks to respondents.

If you agree to participate in the survey, please note that you must complete the survey in one sitting (in other words, the system won’t let you save your survey responses and return to complete them later.

Also, please note that when you submit your response, you will not be able to withdraw them, as we cannot link the survey responses back to you.

Your participation is important to us and will help us analyze the changes North American orthodontists have made to their business practices in the previous 10-year period. If you have any questions about this survey study, please do not hesitate to contact Dr. Matthew Brown at brownm4@myumanitoba.ca.

This study has been approved by the University of Manitoba Health Research Ethics Board.

By continuing on and completing the questions you are consenting to participate in this survey.

Appendix 6 – Supplementary Tables

Supplementary Table 1. Orthodontic treatment provider preference based on demographic characteristics						
Demographic characteristics	Orthodontist n (%)	General Dentist n (%)	DTC aligners n (%)	Recommended by Dentist n (%)	df	p
Age						
16-29	36 (56.3)	9 (14.1)	11 (17.2)	8 (12.5)	9	0.037*
30-39	75 (52.1)	33 (22.9)	17 (11.8)	19 (13.2)		
40-49	37 (43.5)	13 (15.3)	10 (11.8)	25 (29.4)		
50+	14 (40.0)	7 (20.0)	3 (8.6)	11 (31.4)		
Gender						
Male	87 (50.9)	34 (19.9)	26 (15.4)	24 (14.0)	3	0.060
Female	75 (47.8)	28 (17.8)	15 (9.6)	39 (24.8)		
Ethnic Group						
White	90 (48.9)	38 (20.7)	22 (12.0)	34 (18.5)	12	0.822
Black	8 (53.3)	3 (20.0)	3 (20.0)	1 (6.7)		
Hispanic	5 (71.4)	0 (0.0)	2 (28.6)	0 (0.0)		
Asian	50 (50.0)	17 (17.0)	13 (13.0)	20 (20.0)		
Mixed Race	3 (37.5)	2 (25.0)	0 (0.0)	3 (37.5)		
Marital Status						
Single/Divorced/Separated/Widowed	57 (54.8)	18 (17.3)	12 (11.5)	17 (16.3)	3	0.577
Married/Domestic Partnership	104 (46.6)	44 (19.7)	29 (13.0)	46 (20.6)		
Household Size						
1	26 (53.1)	10 (20.4)	6 (12.2)	7 (14.3)	15	0.843
2	34 (43.0)	17 (21.5)	12 (15.2)	16 (20.3)		
3	39 (46.4)	14 (16.7)	10 (11.9)	21 (25.0)		
4	49 (53.3)	18 (19.8)	9 (9.8)	16 (17.4)		
5	10 (52.6)	2 (10.5)	4 (21.1)	3 (15.8)		
6+	4 (80.0)	1 (20.0)	0 (0.0)	0 (0.0)		
Education						
High School	10 (30.3)	11 (33.3)	5 (15.2)	7 (21.2)	9	0.357
College or Technical Diploma	41 (52.6)	13 (16.7)	10 (12.8)	3 (17.9)		
Bachelor's Degree	72 (51.4)	24 (17.1)	14 (10.0)	30 (21.4)		
Master's Degree or Higher	39 (52)	13 (17.3)	12 (16.0)	11 (14.7)		
Employment Status						
Employed Part Time	42 (41.2)	23 (22.5)	18 (17.6)	19 (18.6)	9	0.101
Employed Full Time	113 (55.7)	38 (18.7)	21 (10.3)	31 (15.3)		
Unemployed	5 (35.7)	2 (14.3)	1 (7.1)	6 (42.9)		
Post-Secondary Student	5 (62.5)	0 (0.0)	1 (12.5)	2 (25.0)		
Community Size						
Small City/Town (<50,000)	17 (50.0)	10 (29.4)	6 (17.6)	1 (2.9)	6	0.0005*
City (50,000-500,000)	59 (39.6)	33 (22.1)	15 (10.1)	42 (28.2)		
Metropolitan Area (>500,000)	85 (59.0)	19 (13.2)	20 (13.9)	20 (13.9)		
Income (\$)						
<49,000	5 (45.5)	4 (36.4)	1 (9.1)	1 (9.1)	18	0.520
50,000-59,999	14 (45.2)	6 (19.4)	3 (9.7)	8 (25.8)		
60,000-69,999	12 (34.3)	8 (23.9)	5 (14.3)	10 (28.6)		
70,000-79,999	15 (38.5)	7 (17.9)	6 (15.4)	11 (28.2)		
80,000-89,999	16 (44.4)	9 (25.0)	4 (11.1)	7 (19.4)		
90,000-99,999	24 (60.0)	5 (12.5)	4 (10.0)	7 (17.5)		
>100,000	75 (56.4)	22 (16.5)	18 (13.5)	18 (13.5)		

*Chi-square p-value statistically significant if ≤ 0.05
df = degrees of freedom

Supplementary Table 2. Orthodontic appliance type preference based on demographic characteristics						
Demographic characteristics	Metal Braces n (%)	Clear Braces n (%)	Clear Aligners n (%)	Not Currently Interested n (%)	df	p
Age						
16-29	18 (28.1)	26 (40.6)	20 (31.3)	0 (0.0)	9	0.0005*
30-39	21 (14.6)	62 (43.1)	56 (38.9)	5 (3.5)		
40-49	7 (8.2)	37 (43.5)	29 (34.1)	12 (14.1)		
50+	1 (2.1)	24 (68.6)	7 (20.0)	3 (8.6)		
Gender						
Male	23 (13.5)	82 (48.0)	54 (31.6)	12 (7.0)	3	0.598
Female	24 (15.3)	67 (42.7)	58 (36.9)	8 (5.1)		
Ethnic Group						
White	22 (12.0)	83 (45.1)	67 (36.4)	12 (6.5)	12	0.492
Black	4 (26.7)	7 (46.7)	2 (13.3)	2 (13.3)		
Hispanic	0 (0.0)	4 (57.1)	3 (42.9)	0 (0.0)		
Asian	17 (17.0)	45 (45.0)	34 (34.0)	4 (4.0)		
Mixed Race	2 (25.0)	3 (37.5)	2 (25.0)	1 (12.5)		
Marital Status						
Single/Divorced/Separated/Widowed	15 (14.4)	48 (46.2)	38 (36.5)	3 (2.9)	3	0.404
Married/Domestic Partnership	32 (14.3)	101 (45.3)	73 (32.7)	17 (7.6)		
Household Size						
1	8 (16.3)	18 (36.7)	21 (42.9)	2 (4.1)	15	0.057
2	7 (8.9)	39 (49.4)	32 (40.5)	1 (1.3)		
3	12 (14.3)	44 (52.4)	20 (23.8)	8 (9.5)		
4	12 (13.0)	40 (43.5)	41 (33.7)	9 (9.8)		
5	6 (31.6)	6 (31.6)	7 (36.8)	0 (0.0)		
6+	2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)		
Education						
High School	4 (12.1)	16 (48.5)	11 (33.3)	2 (6.1)	9	0.934
College or Technical Diploma	11 (14.1)	38 (48.7)	25 (32.1)	4 (5.1)		
Bachelor's Degree	17 (12.1)	60 (42.9)	54 (38.6)	9 (6.4)		
Master's Degree or Higher	14 (18.7)	34 (45.3)	22 (29.3)	5 (6.7)		
Employment Status						
Employed Part Time	18 (17.6)	50 (49.0)	30 (29.4)	4 (3.9)	9	0.298
Employed Full Time	27 (13.3)	88 (43.3)	75 (36.9)	13 (6.4)		
Unemployed	0 (0.0)	10 (71.4)	3 (21.4)	1 (7.1)		
Post-Secondary Student	3 (37.5)	3 (37.5)	2 (25.0)	0 (0.0)		
Community Size						
Small City/Town (<50,000)	10 (29.4)	17 (50.0)	6 (17.6)	1 (2.9)	6	0.001*
City (50,000-500,000)	18 (12.1)	73 (49.0)	43 (28.9)	15 (10.1)		
Metropolitan Area (>500,000)	18 (12.5)	59 (41.0)	63 (43.8)	4 (2.8)		
Income (\$)						
<49,000	4 (36.4)	7 (63.6)	0 (0.0)	0 (0.0)	18	0.055
50,000-59,999	5 (16.1)	12 (38.7)	9 (29.0)	5 (16.1)		
60,000-69,999	9 (25.7)	16 (45.7)	9 (25.7)	1 (2.9)		
70,000-79,999	6 (15.4)	16 (41.0)	16 (41.0)	1 (2.6)		
80,000-89,999	4 (11.1)	20 (55.6)	9 (25.0)	3 (8.3)		
90,000-99,999	5 (12.5)	19 (47.5)	15 (37.5)	1 (2.5)		
>100,000	13 (9.8)	59 (44.4)	54 (40.6)	7 (5.3)		

*Chi-square p-value statistically significant if ≤ 0.05
df = degrees of freedom

For additional data, please see attached disc of supplementary tables. Summaries of each question for both surveys can be found within.

Appendix 7 - Journal Article

Title

Adult Patient Preference for Orthodontic Care Provider in Canada

Abstract

Introduction: This study evaluated the factors that influence potential orthodontic patients' choice between an orthodontist, general dentist (GD), and direct to consumer (DTC) aligners for their treatment and their choice of orthodontic appliance type as well as explore their motivating factors to seek orthodontic treatment and preference for appliance type.

Methods: An electronic survey was administered to 330 Canadian adults to determine demographic background, choice of orthodontic treatment provider, preferred mode of treatment, orthodontic issues they wished to address, and motivation for treatment.

Results: When participants were asked their preference in provider type, 49.4% of participants selected an orthodontist, 19.2% would follow the recommendation of their GD, 18.9% selected a GD, and 12.5% selected DTC aligners. Younger participants ($p = 0.037$) and those living in metropolitan areas ($p = 0.0005$) were significantly more likely to select an orthodontist compared with a GD or DTC aligners. When asked their preference in mode of orthodontic treatment, 45.4% selected clear braces, 34.1% selected clear aligners, 14.3% selected metal braces, and 6.1% indicated they currently have no interest in orthodontic treatment. Older participants ($p = 0.0005$) and those in moderate sized population centers ($p = 0.001$) were significantly more likely to select clear braces or aligners.

Conclusions: Adults in Canada have a high preference for orthodontic treatment performed by orthodontists, especially among younger persons and those in metropolitan areas. Younger

respondents tend to prefer metal braces, while older respondents tend to prefer clear braces.

Preference for clear aligners is positively correlated to increased community size.

Introduction

The traction being gained by clear aligner orthodontic therapy and introduction of direct-to-consumer (DTC) orthodontics have changed consumer choices in the marketplace. In the early 2000s, clear aligner therapy was popularized by Align Technology with their Invisalign system. GDs were provided with another treatment option to keep their orthodontic patients “in house”.¹ The rise in popularity of clear aligner therapy has had two significant effects on orthodontists: (1) an increased number in GDs providing orthodontic treatment, and (2) DTC providers are enabling patients to treat themselves at home.

The advent of clear aligner therapy popularity was accompanied by an increased number of GDs providing orthodontic treatment. A study by Wolsky and MacNamara² surveying GDs showed that 19.3% performed comprehensive orthodontic services, 57.0% provided limited orthodontic services, and 23.7% provided no orthodontic services. The number of GDs who utilize clear aligner therapy has also increased in the past two decades.^{3,4} Current reports suggest an expected increase in the future.^{5,6}

In the past decade, the thriving clear aligner sector has also spawned new orthodontic product companies that utilize DTC advertising.^{1,7,8} The relatively new DTC providers have gained attention from the dental community in recent years.^{9,10} Their main advertised advantages are reduced cost and increased convenience. The principle argument from DTC providers justifying their approach is that their DTC aligner system is not do-it-yourself, but rather doctor-directed and that they increase access to care for patients.¹¹

There are legal concerns about provider liability and licensure across jurisdictional boundaries in regards to this treatment modality.¹ Furthermore, there are other concerns such as reduced patient interaction and the lack of direct monitoring.⁸ Previous studies have compared the efficacy of orthodontic treatment executed by orthodontists and GDs,^{4,12,13} but there is currently no literature comparing the outcomes of orthodontic treatment delivered by a specialist and treatment delivered via DTC providers, with the only evidence being media reports and testimonials.^{14,15}

There is a paucity of literature examining the effects of DTC aligners on patient behaviours. There are only two articles to date that examine factors that influence patients' choice of orthodontic treatment provider.^{9,10} Both found that the highest level of interest in an orthodontist as a treatment provider and while the interest in DTC providers was noteworthy, parents who choose DTC for themselves would still prefer an orthodontist for their children.

The purpose of this study was twofold: 1. to determine the relative influence of patient demographic factors on their choice of provider type (orthodontist, GD, and DTC provider), and 2. to determine the preferred mode of orthodontic treatment. This will provide additional clarity on choices patients will make regarding their orthodontic treatment. The null hypothesis was that the participants' choice of provider and mode of treatment would not differ in relation to their different demographic factors under study. In addition, supplementary descriptive data on participant source of interest in orthodontic therapy, occlusal issues they wished to address, and motivation for treatment will also be presented. The information herein may provide a foundation from which future more focussed research questions may be posed, as well as future marketing strategies which could be beneficial to the orthodontic profession.

Materials and Methods

Health Research Ethics Board approval was obtained to conduct this study by the relevant university ethics board. An original 19-question survey (Appendix 1) was consensually developed by two orthodontists (F.P, W.W) and one orthodontic resident (M.B.) and tested for construct validity by a psychometrician (DJS). The questionnaire was distributed to ten laypersons as a pilot test to identify confusing terminology and assess question comprehension after which it was administered to the general population using a commercial polling company (Dynata, Shelton, CT; July 2020) that had existing databases of reliable participants. Potential participants were screened by the polling company by receiving an initial question asking if they had interest in or placed value on orthodontic treatment. Following affirmation, an invitation would be extended. A total of 330 individuals received electronic invitations to participate in the survey from July 2020 through August 2020 with weekly reminders. The target population included Canadian adults aged 25-65 years.

The survey was designed so participants could not return to previous questions. This approach prohibited participants from altering answers to earlier questions after progressing throughout the survey. Additionally, responses from individuals who selected the same answer choice continually were excluded according to a norm established by the polling company.

The survey questions were designed to (1) determine the participant's demographic background; (2) assess if the participant valued his/her oral health; (3) evaluate the value participants placed on orthodontic treatment and its appliance types; (4) evaluate if the participant was interested in improving their dentition through orthodontic treatment, and their motivation; and (5) determine the participant's preference in each of the three provider options, as well as their rationale.

Statistical Analysis

Pearson chi-square test was used to identify and evaluate demographic factors that influenced value placed on orthodontic treatment, rationale for treatment, and provider type selection. Analysis was performed using IBM SPSS Statistics for Windows (2020), Version 27.0. Armonk, NY: IBM Corp. The significance level was set at 0.05. When suitable, linear-by-linear and likelihood ratio testing were undertaken to aid with interpretation of significance.

Results

A total of 330 Canadian adult laypersons completed the questionnaire. The survey of the general public was distributed by a data collection company to their members who normally agree to participate in surveys. Regarding the participants' demographics, 171 (51.8%) were male and 159 (48.2%) were female. Most participants identified as Caucasian 185 (56.0%), followed by Asians 100 (30.3%), while the remaining ethnic categories had frequencies of less than 5%. Age and household size followed a normal distribution, with an age range selection being 30-39 and a mean household size of 4. A total of 295 (89.4%) participants reported education beyond a high school diploma. Most participants 203 (61.5%) were employed full-time and either married or in a domestic partnership 224 (67.9%). Most participants lived in metropolitan areas 144 (43.8%) or cities / suburban areas 150 (45.6%). Mean household income followed an asymmetric distribution skewed towards higher income levels, with the median being \$100,000 or more.

Participants were asked to select an orthodontist, GD, DTC aligner company, or to follow the recommendation of their GD if they were interested in pursuing orthodontic treatment (Figure 1). Most participants 162 (49.4%) selected an orthodontist, 63 (19.2%) would follow the recommendation of their GD, 62 (18.9%) selected a GD, and 41(12.5%) selected DTC aligners.

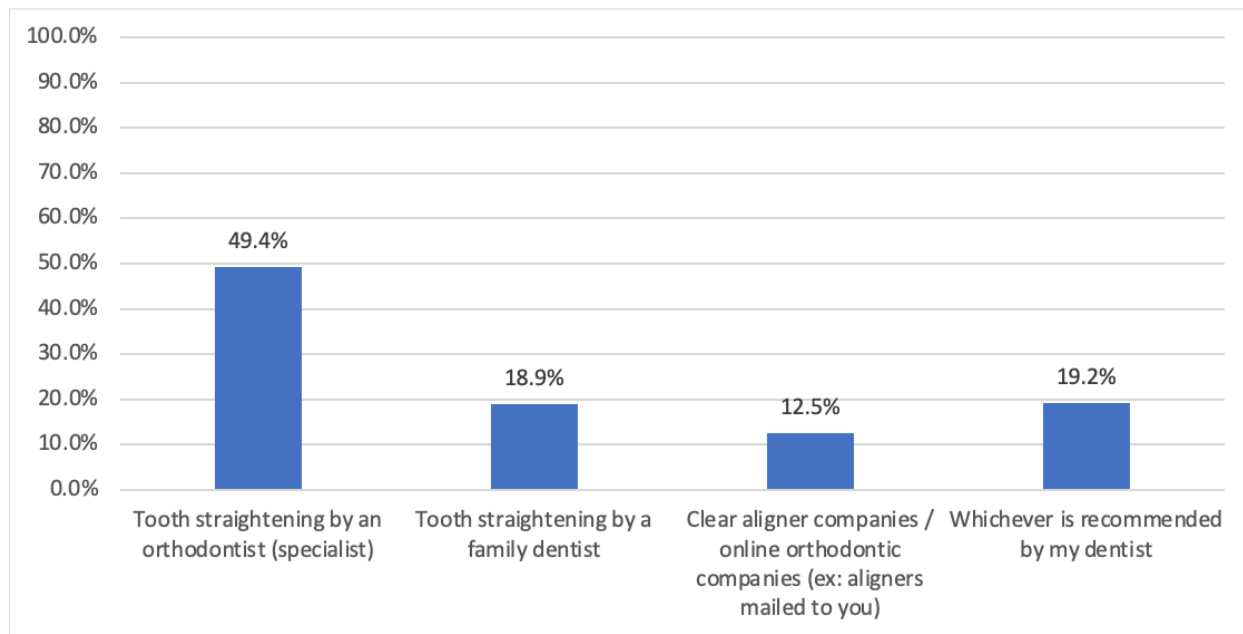


Figure 1. Participants choice for provider of orthodontic treatment.

The participants' selection of provider type was significantly associated with two demographic variables. Younger participants ($p = 0.037$) and those living in metropolitan areas ($p = 0.0005$) were significantly more likely to select an orthodontist compared with a GD or DTC aligners (Supplementary Table 1). Participants in smaller community sizes were significantly more likely to select a GD or follow the advice of their general dentist relative to an orthodontist or DTC aligners ($p = 0.0005$).

Participants were asked to select metal braces, clear braces, or clear aligners for type of orthodontic appliance (Figure 2). Most participants 149 (45.4%) selected clear braces, 112 (34.1%) selected clear aligners, 47 (14.3%) selected metal braces, and 20 (6.1%) indicated they currently have no interest in orthodontic treatment.

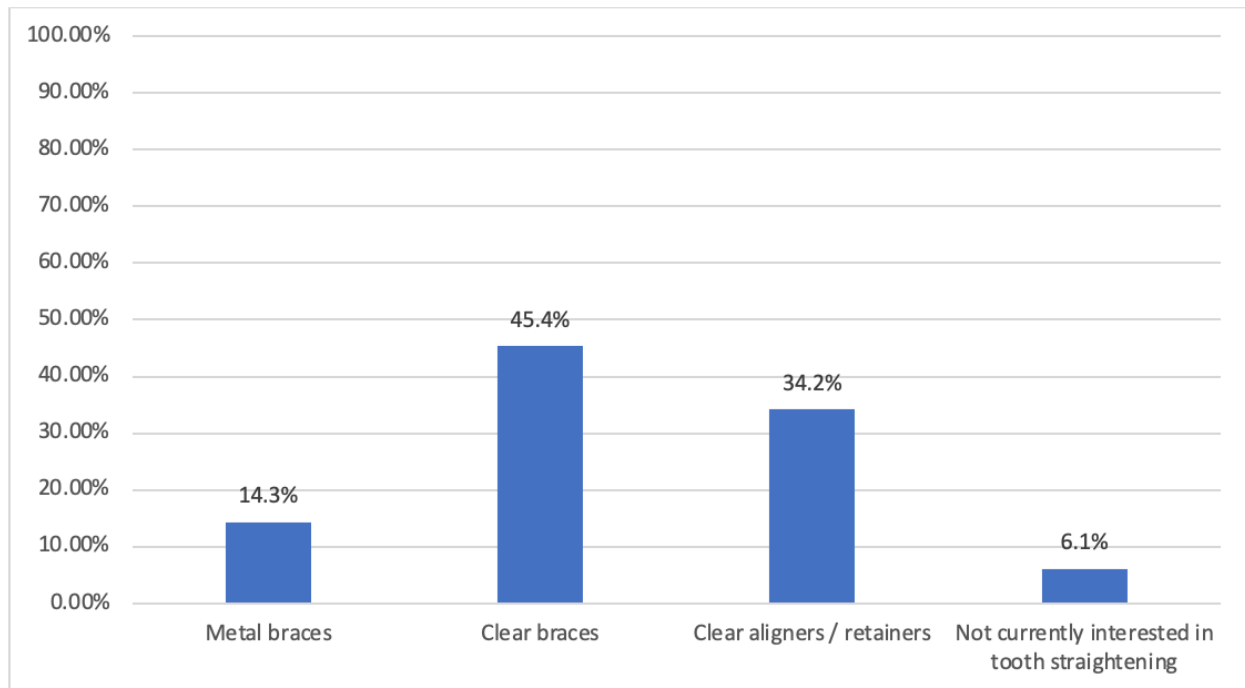


Figure 2. Participants self-reported preference for type of orthodontic appliance.

The participants' selection of appliance type was significantly associated with two demographic variables (Supplementary Table 2). Specifically, younger participants ($p = 0.0005$) and those in smaller population centers ($p = 0.001$) were significantly more likely to select metal braces. Additionally, older participants ($p = 0.0005$) and those in moderate sized population centres ($p = 0.001$) were significantly more likely to select clear braces or aligners.

Participants were asked what source created their current interest in orthodontic treatment and select all options that applied from a list. Most participants 138 (42.1%) selected family and social circle, 106 (32.3%) received a recommendation from their dentist, 88 (26.8%) selected the internet, 61 (18.6%) selected social media 49 (14.9%) cited television, 41 (12.5%) chose magazines and newspapers, and 28 (14.9%) indicated they are not currently interested in orthodontic treatment.

Participants were asked the issues with their occlusion that they would like to address and select all options that applied. Most participants 91 (27.7%) noted they would like to eliminate

crowding, 80 (24.4%) reported spacing, 73 (22.3%) stated an increased overbite, 69 (21.0%) signified a cant, 58 (17.7%) specified desire for ease of performing oral hygiene, 44 (13.4%) wanted to address attrition, 33 (10.1%) selected openbite, 28 (8.5%) noted TMJ issues, 28 (8.5%) reported increased overjet, and 28 (8.5%) indicated they had no concerns. All remaining categories of gingival display, speech difficulties, and mastication difficulties were not selected with an incidence above 5%.

Participants were asked their motivation from orthodontic treatment and to select all options that applied. Most participants 206 (62.8%) indicated they wanted a more attractive smile, 134 (40.9%) wanted to improve confidence and self-esteem, 80 (24.4%) desired to improve ease of performing oral hygiene, 75 (22.9%) wanted to improve mastication ability, 61 (18.6%) sought to improve jaw alignment, 33 (10.1%) aspired to prevent future occlusal trauma/injuries, 26 (7.9%) wanted to have treatment because a family member or friend had treatment, and 26 (7.9%) did not want treatment.

Discussion

Traditionally, patients have sought orthodontic treatment from dental specialists. The rise of non-specialists providing orthodontic treatment and the advent of DTC aligner companies offer patients more choices of provider. This study reported patient preference for provider type and mode of treatment and analyzed the demographic factors affecting patients' selections. Descriptive data on motivation and source of interest in orthodontic treatment was also presented. The null hypothesis which stated that participants' choice of orthodontic treatment provider and mode of treatment was not associated with demographics was rejected as age and community size affected both variables.

The results demonstrated that there is a high preference among adults in Canada in pursuing orthodontic treatment with either an orthodontist or dentist. Orthodontists were selected significantly more than GDs and DTC aligners which parallels previous research.⁹ However, a notable difference is that the survey included an option to follow the recommendation of a GD and resulted in both GD and his/her recommended provider being selected more frequently than DTC providers. Olson found that participants chose DTC aligner companies more frequently than a GD.⁹ This disparity may be caused by a national difference as DTC aligner companies are more prevalent in the United States and thus Olson's survey population being more exposed to advertising of DTC providers.

The demographic factors that significantly affected participant choice for orthodontic treatment provider were age and community size. Younger participants were more likely they were to choose an orthodontist. This would suggest that in order to reach the audience with the most interest, orthodontists should focus advertisements to younger adults. Participants in smaller population centres were more likely to select a GD as a provider and least likely to choose whichever option was recommended by their GD. Additionally, the larger the population centre, the more likely the participant was to select an orthodontist. These phenomena are likely due to reduced access to orthodontic care in rural communities which could limit choice.^{16,17} Presently, the only literature that examined preferences for orthodontic treatment and community size surveyed an American population and did not find any predilection based on population centers.⁹ The current data suggests that as the availability of a specialist orthodontist increases, so does the likelihood that a person would choose that provider for their care.

The results suggest that there is a high level of interest among adults in Canada in pursuing orthodontic care with an aesthetic mode of treatment. Aesthetic brackets and clear aligners were

selected at a significantly higher rate than metal brackets. These results are not unexpected as it has been well established that patients have a clear preference for orthodontic appliances that are perceived to be more aesthetic.^{18,19}

The demographic factors that significantly affected choice of treatment mode were age and community size. Younger participants tended to prefer metal braces while older participants tended to prefer clear braces with a low affinity for clear aligners. This outcome conforms with the shift towards esthetic treatment options and the demonstrated predilection among adults for such modalities.²⁰ It has been demonstrated that adult patients show an increased affinity for appliances with reduced metal display.²¹ A possible explanation for aesthetic alternatives is the recent trend in Western culture of a preference for increasingly whiter teeth.²² As the participant's community size increased, their likelihood of indicating a preference for clear aligners as the favoured mode of orthodontic treatment increased. Currently, there is no data among the literature examining the association between community size with choice for mode of orthodontic treatment.

In general, the primary sources for creating participants' current interest appear to be social circle and the recommendation of a GD followed by online and subsequently traditional media. The traditional marketing model emphasized the specialist's reliance on GDs for referrals and building relationships with the family of patients.¹ The results appear to suggest that online media has notable potential in patient advertising.

When asked what occlusal issues they would like to address, the results were dispersed among all categories. The most prevalent responses were crowding, spacing, and an increased overbite. The presence of crowding, spacing, and an increased overbite have been shown to be occlusal issues of significant concern to orthodontic patients.^{23,24} These occlusal problems are

simple to identify, conceptualize, and describe for a layperson and therefore it is unsurprising they were most selected.

The primary motivations for orthodontic treatment among participants were aesthetic and psychosocial influences. Participants indicated that they wanted treatment to achieve a more attractive smile and improve self-esteem. This is in accordance with previous literature stating that dissatisfaction with dental esthetics is the prime motive for seeking orthodontic treatment.^{25,26} The two factors of smile esthetics and self-esteem are linked as dissatisfaction with dental appearance has a strong predictive effect on self-esteem.²⁷ The current data confirms two of the most common inspirations for orthodontic treatment.

Although this survey was designed with the challenges of survey-based research in mind, it is not always possible to control for all variables and limitations. The information provided in questions was neutral and explained in layman's terms to reduce bias. Surveys associated with orthodontic research are often limited to a sample size of current patients, participants within a restricted geographic area, and easily accessible mailing lists.²⁸⁻³⁰ Due to those restrictions and the challenges of COVID-19 in soliciting participant feedback, a commercial polling company (Dynata – <https://www.dynata.com/>) was hired to distribute the survey to Canadian participants. As the practices of the employed have evolved an estimation of response rate was not possible. Therefore, measures were taken to reduce bias by obtaining a higher sample size than previous research.⁹ Through such means, a large sample size was more easily obtained to reduce the bias associated with samples of convenience. A disadvantage of this survey was that it is unknown what province or region of the country participants are located in. Canada is a very large and diverse country and future research should be designed to provide insight on regional trends for greater utility.

This study provides insight regarding the motivators and selections by patients in the current environment. The data herein can be used by orthodontists to provide direction in meeting the needs of their patients. Additionally, it may serve as a foundation for more pointed research queries.

Conclusions

It was possible to draw the following conclusions in regard to Canadian patients' preferences and motivations. First, orthodontists were the treatment provider of choice, especially among younger persons and those in metropolitan areas, followed by GDs and DTC aligners. As the population became more rural, the preference for a GD increased. Second, younger participants tended to prefer metal braces while older respondents preferred clear braces. Preference for clear aligners was positively correlated to an increased community size. Family/social circle, a recommendation from their GD, and internet were the most frequent sources of interest, which appeared to be motivated mostly by the presence of crowding/spacing, and the aspiration of having an attractive smile and a higher self-esteem. In conclusion, despite the recent rise of adjunctive orthodontic treatment providers, orthodontists remain the provider of choice in the current equilibrium.

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Appendix 8 – Journal Receipt Confirmation



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