How Does Competition Affect the Clinical Decision-Making of Dentists in Ontario?

by

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A thesis submitted in conformity with the requirements for the degree of Master of Science Dental Public Health

Faculty of Dentistry University of Toronto

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Abstract

Clinical decision-making is influenced by various factors, including patients' disease risk and dentists' age. We investigated these and other factors, including competition and their association with clinical decision-making. We gathered data through a cross-sectional survey of a random sample of general dentists in Ontario, Canada (n=3,201), which queried demographic, professional, and practice information. Competition was quantified as dentist geographic density via spatial analysis and through self-perceptions of competition. The outcome (treatment intensity or aggressiveness) was measured using clinical scenarios. One thousand and seventy-five dentists responded (33.6% response rate). Dentists who owned their practice, were <40-years old, American-trained, dissatisfied with their practice busyness, and who had large practice loans, were more likely to be aggressive in treatment decisions. Dentists located in low dentist density areas were also more like to be aggressive in treatment decisions. This study is the first to explore competition and other factors on Canadian dentists' clinical decision-making.

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List of Abbreviations

CAPRICORN: Capital Area Primary Care Research Network

CDA: Canadian Dental Association

CHASS: Computing in the Humanities and Social Sciences

DA: Dissemination Area

FFS: Fee-for-service

FSA: Forward Sortation Area

GDP: Dental practitioners without postgraduate implant qualifications

GDPP: Dental practitioners with postgraduate implant qualifications

GDPT: Practitioners undergoing training for postgraduate implant qualifications

GIS: Geographic Information System

HI: Herfindahl Index

HHI: Herfindahl-Hirschman Index

NHI: National Health Insurance

NHS: National Health Service

ODA: Ontario Dental Association

OOP: Out-of-pocket

RCDSO: Royal College of Dental Surgeons of Ontario

REB: Research ethics board

SID: Supplier-induced-demand

Chapter 1: Introduction

1.0 Introduction

Clinical decision-making is defined as "the contextual, continuous, and evolving process, where data are gathered, interpreted, and evaluated in order to select an evidence-based choice of action." (1, p.2) It is a process utilized similarity between different healthcare professionals such as physicians, nurses, and dentists. Variation in clinical decision-making among dentists is well recognized and documented. (2–4) In this regard, clinical decision-making is a complex phenomenon, and is not only influenced by "clinical factors" such as a patient's oral health status or disease risk, but also "non-clinical factors" such as a patient's insurance status, the clinician's age, place of initial training, and clinical beliefs. (3,5)

1.1 Statement of the problem

Variation in clinical decisions is ubiquitous and generally accepted in dentistry since the majority of services lie in a 'grey zone' and lack a distinct or clear-cut position in terms of what is right or wrong. The question of "Which clinical decision serves the best interest of my patient?" emerges in each clinical scenario faced by dentists on a daily basis. To guard patients' well-being from being exploited by the asymmetry of knowledge between dentists and patients, the ethics of the profession are to guide such decisions. In general, it is believed that incentives and professional values play different roles in dentists' decisions. For instance, when the right decision is obvious, dentists are believed to act in the patient's best -interest. However, when the appropriateness of clinical decisions is unclear, financial incentives and professional ethics start playing a bigger role in decisions. (6) It is thus important to understand the: 1) types of financial

pressures/incentives dentists face; and 2) the extent to how these pressures/incentives influence treatment decisions.

Unfortunately, the current situation in dentistry does not paint the most optimistic picture of the dental profession. The cost of dental education has increased from 1982 to 2002, with an estimated 314% increase in tuition fees. (7) This is accompanied by an increase in the private loans of dental students to fund their education, as federal and provincial assistance programs were terminated or scaled back during the 1990s. (8) It is estimated that on average, the total accrued debt of a Canadian dental student ranges from \$24,000-\$26,000 per year. (9) A study conducted among dental students in Canada found that approximately one-third of graduating students are likely to graduate with significant debt, which affects their career choices.

After graduation, financial challenges can continue, as the cost of initiating and operating dental clinics in the last 15 years is estimated to have increased by 76.5%. (10) The cost of purchasing an established clinic is also estimated at around \$1-million in large cities like Toronto, Calgary, and Vancouver. (11) In addition, large corporations are buying more clinics with a higher capacity to compete for patients, thanks to their purchasing power, which allows them to offset their operating costs. (12)

According to a report published by the Ontario Dental Association (ODA) in 2014 (10), the ratio of population-to-dentists in Ontario has also decreased, and the consequences are worrying for practicing dentists. The population-to-dentist ratio has fallen from 1052 in 2001 to 675 in 2014 and could be as low as 551 by 2024, with a majority of dentists practicing in big cities and urban settings. (13) The report outlines that, in the last decade, the number of dentists who claimed to be "busy" has declined from 30% to 15%. Similarly, the number of dentists who claimed to be "slow" also rose from 30% to 45%. Some attribute these effects to the influx of

internationally-trained dentists and the high rate of admissions into Canadian dental schools, which results in dentists facing more competition. (12,14)

The reported oversupply of dentists has caused leaders within the profession to express their concerns about the consequences of these changes on patient outcomes. (15) Some of the communicated concerns are the development of supplier-induced demand (SID) and overtreatment, for financial gain, as well as reduced quality of care since patients will become more attracted to the better marketer and not necessarily those with better skills. (14) In Ontario, the advertising and promotion expenses among dental clinics over the last 15 years have increased by 205% in worry of losing patients to competitors. (10) All are reasons for which dentists fear the undermining of the integrity of dental practitioners in the eyes of the public; consequences that will have detrimental implications for the profession of dentistry. With the increased competition between dentists and the financial burdens facing young professionals, ethical reasoning is believed to play an even more decisive role in clinical decision-making and maintaining the status of the profession. (16,17)

Collectively, it has become obvious that dentists are facing various financial and market challenges. From increased school debt to increased competition, the dental market in Canada is changing. However, very little is known about the influence of these changes on clinical decision-making and patient outcomes.

1.2 Literature review

1.2.1 Electronic search and selection of studies

The medical and dental literature were searched using the following electronic databases: PubMed, Google Scholar, Cochrane Library, Scopus, Medline/Embase. Titles and abstracts were screened for relevance. In the case of the absence of an abstract or other uncertainty, the full article was reviewed to judge for relevance and eligibility. Relevant articles published in English after 1988 were included in the review. Keywords included: supplier-induced demand, clinical decision-making, competition, dentist density, and physician density.

1.2.1 Geographic location

Brennan and Spencer (2002) (18) conducted a study to explore the different factors influencing the choice of dental treatment by private general practitioners. The authors surveyed 1,202 dentists from across Australia to examine the factors considered in choosing treatments for their patients through case scenarios. Given that the geographic location of the dentists is the exposure, and the clinical services provided is the outcome, dentists practicing in the capital city and dentists practicing in cities other than the capital city were compared. Although the results did not demonstrate a significant difference in the services provided, geographic location was still recognized as a potential influence on clinical decision-making of dental practitioners.

1.2.3 Remuneration system

Shen et al. (2004) (19) conducted a cross-sectional survey among a sample of 601 family physicians practicing in California. The purpose of the study was to test whether the clinical decisions of physicians were affected by payment incentives through a series of case scenarios. The study found that physicians working under a fee-for-service (FFS) system tended to utilize more discretionary (optional) care in comparison to physicians under capitated agreements. The authors concluded that payment mechanisms have a potential effect on the clinical decision-making of physicians.

A retrospective cohort study was conducted by Naegele et al. (2010) (20) by reviewing dental insurance claims records of 3,818 employees of a large company in the city of Rio de Janeiro, Brazil. The aim of the study was to investigate differences between the number of teeth with treatment need as determined by dentists working under a salaried system and the number of teeth treated by dentists working under a FFS system. Assessments were completed by dentists working under the salaried system and treatment was delivered by dentists operating under the FFS system six months later. The authors hypothesized that FFS dentists would deliver more treatments due to financial considerations. Their hypothesis was supported by a finding of a difference between the dental needs assessed by dentists under a salary cap and the services rendered by dentists under the FFS system.

This research was later corroborated by Brocklehurst et al.'s (2013) (21) systematic review. The objective of the review was to evaluate the effects of different methods of remuneration on primary care dentists and its consequences on patients in the United Kingdom (UK). Only two studies matched the author's inclusion criteria and were assessed to be at an overall high risk of bias. In one study, the authors reported that there was a significant increase in clinical activity in FFS dentists compared to dentists under a capitation system. In the second study, dentists under a capitation system tended to restore teeth at later stages of the disease process and provided more preventive services compared to their FFS counterparts. Based on the findings from both studies, the authors concluded that dentists with more financial incentives (FFS system) may tend to be more aggressive in treating patients than their salaried counterparts.

Tickle et al. (2011) (22) performed a longitudinal prospective study to investigate changes in dental treatment trends in response to one reform in the National Health Service (NHS) system in the UK, using an observational period between 1992 and 2009. The reform was introduced in 2006 and changed the remuneration method of dentists from FFS to a fixed annual salary. Using the types of treatments rendered to patients and comparing it over time, the authors were able to test whether financial incentives played a role in dentists' clinical decision-making. Following the introduction of the new remuneration system, a decline in the overall number of treatments was observed, yet there were relative increases in those treatments that could be provided in the least amount of time such as extractions. Simultaneously though, there was also an increase in treatments that were time-consuming such as bridgework, crowns, and root fillings. Based on the findings, the authors concluded that abrupt changes in professional behaviors could be a consequence of changes in the financial incentive structure of a remuneration system.

Finally, Walker et al. (2015) (23) investigated differences in the decisions of experienced NHS dentists (20 years post-qualification) through a series of vignettes and a decision-making questionnaire. Dentists were provided with hypothetical scenarios for patients under three insurance schemes, NHS funded, privately funded or undisclosed. In the clinical scenario, they were asked to choose whether to provide an extraction or root canal treatment. No strong evidence was found to suggest that experienced dentists would be influenced by the patient's feestatus. The finding from this study contradicts the previous findings in the literature that remuneration changes can impact dentist's decision-making. The results led the authors to suggest that experienced dentists in the UK might be practicing in an entirely ethical way.

1.2.4 Competition

In a retrospective descriptive study conducted in Ontario, Canada by Yuen and Quiñonez (2015) (24), the association between financially-related misconduct findings by the provincial dental regulator and the competition between dental practitioners was explored. The number of dental

professionals per forward sortation area (FSA) was used as a proxy to measure competition. The study found a positive correlation between competition and financially-related misconduct. The finding may suggest that dentists who perceive high competition from neighbour peers may become financially driven in making their clinical decisions and thus at a higher risk of engaging in professional misconduct.

Similarly, a systematic review conducted by Léonard et al. (2009) (25) investigated the correlation between physician density and health care consumption. The authors reviewed 25 eligible studies. Most studies (n=20) focused on general practitioners, but medical specialists were also analyzed in five studies. The primary studies were heterogeneous and classified as having intermediate methodological quality. The majority of the studies demonstrated variable strengths of evidence that an increase in health care consumption was associated with an increase in physician density. Those results led the authors to conclude that there might be a positive correlation between physician density and physician-induced demand. However, they stated that the exact dynamics of this relationship and the underlying motivations were still poorly understood and called for more research in this area.

Supplier-induced demand (SID) is described as the "notion that doctors can manipulate their patients' demand for medical services to create additional demand for these services [and] can arise from actions by doctors linked to self-interest or attempts to promote the well-being of their patients." (26, p.5) Although the evidence around SID is inconclusive, it is viewed as a negative phenomenon as it exploits the imbalance between the practitioner's knowledge to serve one's own financial goals rather than seeking the patient's well-being. One can argue, however, that the most prominent long-term consequences of SID are the increase in health expenditure

with no tangible improvement in patient outcomes, along with increased patients' dissatisfaction and distrust. (26)

Xirasagar and Lin (2006) (27) examined the earnings of 8,106 physician offices in Taiwan for evidence of SID. The healthcare system in Taiwan is categorized as a universal, comprehensive health benefit, single payer system, with a mix of public, private and not-forprofit hospitals and physician practices competing for patients. Since all claims are logged into the National Health Insurance (NHI) database, the authors were able to explore SID and its relationship to competition, based on practice income data. Physician density was used as a proxy measure of competition. The study showed that increased physician density was associated with a corresponding increase in earnings. According to the authors, the SID effect was very prominent in Taiwan since there is no financial barrier for the population to use care, due to universal coverage, a generous benefit package, and a single payer. Coupled to this, the authors attributed the over-consumption of services to physicians' economic self-interest.

Birch (1988) (28) tested the presence of SID in the UK dental care market using data on service provision in the NHS. At the time, the majority of the dental services provided in the UK were through general practitioners on a fee-for-service basis. This remuneration system was introduced by the government in an effort to increase dentist's efficiency. However, it may have provided an incentive for SID. The author hypothesized that fixed fees offer no incentive for suppliers to change their behavior and that FFS would induce it. A predictive analysis was done to test supplier's behavior as a response to that change. The author found considerable support for his hypothesis. The analysis revealed that, on average, patients in districts with a plentiful supply of dentists receive considerably more services per treatment-course than patients in districts with fewer dentists.

Tsai et al. (2007) (29) conducted a study to explore the influence of market competition on the dental care utilization among dentists in Taiwan from the period of 1999 to 2002. Using the Herfindahl Index (HI) (also known as Herfindahl-Hirschman Index (HHI)) to measure competition, and the NHI dental care claims data, the authors were able to probe the relationship between the two variables. HI is an index used to measure competition through the measure of market concentration by calculating market shares of firms. In response to the annual increase in the competition index, annual frequencies of dental visits and frequencies of tooth-filling per person increased after controlling for all other variables (age, average household income, the proportion of agricultural population and the proportion of highly educated population). The authors suggest that study confirmed the existence of SID in a competitive dental care market. Further interpretation of this study also led them to hypothesize that when dentists perceive higher competition, they tend to be more aggressive and deliver more unnecessary treatments.

Austin & Baker (2015) (30) assessed the influence of physician practice competition in California on the prices paid for 15 common procedures. The authors used county-level measures of the concentration of physician practices and Herfindahl-Hirschman Index (HHI) as proxies to measure competition and the county average prices to measure price changes. After controlling for regional characteristics, a positive association between competition and charged prices was found, and the authors concluded that physician competition is associated with prices.

To examine whether SID exists in the Norwegian healthcare system as a response to increased competition, Grytten & Sørensen (2001) (31) compared data sets of 1,818 physicians under FFS payments to 564 physicians under salaried payment. Physician density was used to assess competition while the amount of service provided, extent and the number of consultations were used to track healthcare consumption by patients. Despite having the incentive to induce

demand for services, neither of the physician groups responded to increased competition by increasing their output. However, the reasons for these results were not identified in the study.

In response to the health care reform which took place in the public sector in Ireland in 1989, Madden et al. (2005) (32) conducted a comparative study to monitor the effect of the shift of the remuneration system from FFS to capitation on physician visits. The authors compared the rates of visits post-reform to the private sector, which was initially under the FFS system. The hypothesis was that the gap between the numbers of visits to physicians in both sectors would narrow if the Irish medical market was suffering from SID. However, the results contradicted the hypothesis, which led the authors to conclude that SID did not play a major role in the Irish health care system.

Carlsen and Grytten (1998) (33) applied a theoretical model to a cross-sectional set of data on information about patient visits and laboratory tests for all FFS primary care physicians in Norway. The purpose of the study was to investigate if the correlation between utilization and physician/population ratio is due to SID or an availability effect. Despite the prominence of an unequal distribution of primary care physicians in Norway, it did not appear to lead the physicians to over-prescribe lab work to maintain their incomes. These results suggested that SID is not evident in the Norwegian medical care market.

Based on this research, one can conclude that physician and dentist responses to increased competition varies based on the health care system in place, policies, provider characteristics and the role of self-interest. Depending on these factors, and others, the outcome can be an increase in prices, a demand inducement or no effect.

1.2.5 Age/Experience

To investigate the influence of the clinical experience of Brazilian dentists on their clinical decisions, Traebert et al. (2005) (34) performed a cross-sectional survey among 840 dentists in three Southern Brazilian cities. The aim was to explore the pattern of decision-making of Brazilian dentists in regards to restoring caries. The authors found that dentists who graduated less than ten years ago and attended fewer postgraduate courses gravitated more towards interventionist approaches compared to their peers who graduated more than ten years ago and attended success.

Grembowski et al. (1997) (35) conducted an analysis of an American cohort of 681 employees with dental insurance to identify dentist factors influencing over- and under-treatment in terms of restorative services. The authors found that younger dentists with busier practices and fewer continuing education courses tended to provide more unnecessary services. In addition, it was suggested that dentist advertising may have had a role in the unnecessary treatments received by patients. They concluded that age of the practitioner along with other characteristics (busyness of the practice, continuing educational course, and advertisement) played a role in altering dentists' decision-making towards overtreating or undertreating patients.

Sundberg et al. (2000) (36) surveyed 923 Swedish dentists to explore their choices of restorative material and technique. The study revealed different diagnostic thresholds between dentists graduated from different cities in Sweden. Variations in the restorative materials used were also found in different age groups of dentists. The findings from this study suggest that both location and age may play a role in the choice of the restorative material by dentists. For various possible reasons, younger dentists preferred to use composite over amalgam when restoring occlusal and interproximal carious lesions.

1.2.6 Place of graduation

Zadik and Levin (2007) (37) conducted a survey of 98 general dental practitioners who graduated from different locations globally regarding their demographics and work habits. The purpose of the study was to evaluate the influence of location of graduation on decision-making regarding the management of dental caries, periapical lesions, and antibiotic prescribing routines. The findings of the study revealed that East European graduates tended to recommend endodontic retreatment when it was unnecessary, and more Latin American graduates tended to prescribe unnecessary postoperative antibiotics. The authors concluded that overmedication and overtreatment were more common in younger practitioners compared to their older peers despite graduating an era in which treatment philosophy tends to emphasize less intervention.

Espleid et al. (2001) (38) conducted a survey among 759 dentists in Norway, 923 in Sweden, and 173 in Denmark inquiring about caries and treatment strategies. The purpose of the study was to map variations in the operative treatment threshold for occlusal caries among a representative sample of dentists from three different Scandinavian countries. The results showed little variation between the dentists from the three countries towards restoring occlusal carious lesions. In general, it was concluded that the leading strategy in Scandinavia concerning occlusal caries seems to be to postpone operative treatment until a definite cavity or radiolucency in the outer third of dentin can be observed.

Tubert-Jeannin et al. (2004) (39) conducted a cross-sectional survey among 180 dental teachers of operative dentistry in France. The aim of the study was to assess caries management strategies taught in French dental schools. Dental teachers were asked to choose when to intervene surgically on occlusal and interproximal caries. Since the survey was completed two years before this study by a cohort of private practitioners, the authors were also able to compare the two outcomes. The findings revealed that university teachers tended to intervene operatively

at a later stage than did private dentists. The authors also suggested that French dental teachers would intervene earlier in the carious process than would Scandinavian dentists.

Kay and Locker (1996) (40) compared dentists' restorative thresholds and treatment decisions based on radiographic evidence between 20 randomly selected Scottish general practitioners working in the NHS and 17 Canadian dentists who were employed by a public health department. The findings indicated similar abilities to detect caries lesions. However, Canadian dentists had a greater propensity to restore in contrast to Scottish dentists who were more certain about their decision not to restore. However, due to the small sample size, the generalizability of the results was considered questionable.

Gordan et al. (2009) (41) performed a survey to identify characteristics of dentists that were associated with restorative intervention in lesions that penetrated only the enamel surface. The authors conducted the survey among 901 dentists from different Scandinavian countries (Denmark, Norway, and Sweden) and the United States. It was concluded that dentists from Scandinavian countries tended not to restore enamel carious lesions while the US dentists would intervene on an enamel lesion. The authors suggested that this difference may be attributed to the subsidized public health care system in Scandinavia where prevention is promoted extensively to the public at-large and access to care is easier. This study adds to the general finding in the literature which indicates that Scandinavian dentists tend to be more conservative in their clinical approaches compared to dentists in other countries.

Wang et al. (2012) (42) conducted a cohort study to compare the treatments rendered by 83 UK trained dentists, and 199 non-UK trained dentists in the Scottish NHS by reviewing data on patients treated. The authors hypothesized that the variation between the two dentist cohorts would be insignificant. The results revealed, however, that, initially, the internationally trained

dentists had a higher number of treatments compared to their peers. This difference tended to diminish over approximately two years of practice in the UK. This article supports the hypothesis that the place of initial training might influence the way dentists practice. Also, it suggests that dentists might alter their treatment protocols over time, as they become more familiar with the health needs of local populations and locally preferred practices.

1.2.7 Gender

Kakudate et al. (2012) (43) conducted a survey among 189 Japanese dentists to identify characteristics associated with their decision to intervene surgically in proximal caries lesions within the enamel. The authors found that male dentists would intervene in enamel surfaces significantly more often compared to their female counterparts in a high-risk caries model.

In their review of the literature about professional demographic changes, McKay and Quiñonez (2012) (44) found that gender may influence the decision-making of a dental practitioner. The findings from the studies can be summarized as follows; female dentists favour preventive strategies in the early disease stages, as compared to men who have been reported to be more interventionist.

1.2.8 Continuing education

Suga et al. (2014) (45), in a systematic review, discussed several factors that might drive dentists away from or towards embracing a preventive approach. Despite the questionable quality of the primary studies, the authors concluded that dentists with fewer continuing education courses were more likely to be less prevention-oriented in their treatments.

Lang-Hau et al. (2014) (46) conducted a cross-sectional study to evaluate treatment decision-making with respect to maintaining periodontally compromised teeth among dentists

with or without postgraduate qualifications in implant dentistry. The authors used clinical scenarios of patients with varying periodontal disease levels to test the variation of the clinical decisions among 30 dental practitioners with postgraduate implant qualifications (GDPP), 33 dental practitioners without postgraduate implant qualifications (GDP), and 27 practitioners undergoing training for postgraduate implant qualifications (GDPT). The study concluded that GDPP/GDPT dentists were three times more likely to retain periodontally compromised teeth compared to their GDP peers. The results from this study suggest that continuing education courses tend to shift dentist's mentality towards more conservative approaches.

1.2.9 School debt

Walton et al. (2006, 2007) (9,47) investigated the influence of school debt on the future decisions and career options of Canadian dental students. The authors surveyed dental students from across Canada's ten dental schools to examine the effect of the increased cost of attending school on their perspectives on future careers. The results showed that the sharp increase in the cost of dental school imposes a significant burden on the students. As a result, this may adversely influence their future choices or decrease the rate of applications to dental schools.

Similarly, Nicholson et al. (2015) (48) surveyed 1,842 practicing dentists in the US who completed dental school between 1996 and 2011 to determine whether there is an association between the amount of the initial debt (education debt on completing dental school) and career decisions. The authors concluded that despite having an effect, the more powerful influence was the demographic characteristics of the students.

Despite not being mentioned in these articles, one can hypothesize that students graduating with substantial school loans might tend to be more financially-driven when

practicing. As a consequence, we hypothesize that they might develop an aggressive approach when treating patients.

1.2.10 Rate of referrals

Iverson and Ma (2011) (49) conducted a study to explore how market conditions influence referrals of patients by physicians in the Norwegian health care system. A model of physician referral was set in a system where the practioner receives a capitation payment based on the number of patients in his/her practice, as well as FFS reimbursements. The study found that the rates of referrals, radiology referrals, in particular, were positively associated with competition. It was suggested that in a competitive market, physicians tend to care more about patient's satisfaction in order to retain them.

Zitzmann et al. (2011) (50) conducted a clinical case questionnaire to investigate the influence of gender differences on clinicians' treatment preferences and decision-making in a complex treatment situation. The authors conducted the survey among 340 dentists in Switzerland to assess their opinions on the treatment of periodontally-involved maxillary molars and implant therapy with sinus grafting. The results showed that the treatments suggested did not differ between genders. However, female clinicians referred more patients to specialists while male care providers tended to provide the care themselves.

1.2.11 Practice setting

To determine how clinical decisions are associated with individual characteristics, practice setting, and organizational characteristics, Landon et al. (2001) (51) conducted a cross-sectional, telephone survey of 4,825 physicians who work at least 20 hours/week through a series of vignettes. Many variables were tested in the study such as gender, average years in practice,

practice setting (solo practice, small practice, large practice, group practice, medical school, and hospital based), compensation factors, and percentage of patients covered by insurance. It was concluded that physicians in solo practices were more likely to refer and request a test in order to pursue treatment in comparison to other practice settings. Apart from the practice setting, the other variables did not show consistent variation in the clinical decision-making of these physicians.

Grembowski et al. (1991) (52) attempted to understand the wide variation in service rates among dentists in a small geographic area. The authors collected the dentist service rates (the average number of services provided per patient) through insurance claims for their population between 1984 and 1985. Along with the clinical (technical) status of the patients, different practice and environmental characteristics were extracted. Using a regression model, the authors found that technical reasons alone do not fully shape dentists' clinical decision-making. Rather, it depends on many other factors. Some of the variables explored in this study to measure the extent of influence of practice characteristics on the decision making of dentists include the age of the practice, patient preferences, community water fluoridation and insurance type. The authors found that practices with more dentists, hygienists and operatories tended to adopt more preventive-oriented treatments after controlling for all other variables.

1.2.12 Busyness

Gordan et al. (2009) (41) found that dentists who belong to busier practices and practices with higher percentages of time spent doing aesthetic procedures recommended restorative treatment more often on enamel surfaces. Dentists in practices that are "not busy enough" also intervened significantly more often in the treatment of enamel surfaces. Similar findings were presented by

Grembowski et al. (1991) (52). These authors suggested that less busy practices tended to offer a higher number of services per patient after controlling for all other factors.

1.2.13 Patient race/ethnicity and gender

Natale et al. (2015) (53) investigated the influence of children's race or ethnicity on receiving an abdominal CT after a blunt torso trauma through a secondary analysis of a prospective observational study. The study involved reviewing the charts of 12,044 children under the age of 18 with their ethnic identification and correlating it to the treatment received. Children identified as white non-Hispanic were more likely to receive an abdominal CT than those identified as black non-Hispanic after controlling for all other variables (e.g. age, sex, abdominal ultrasound use). The authors suggest that non-clinical factors (e.g. race/ethnicity) influenced the clinical decision making of physicians.

Boissoneault et al. (2016) (54) conducted a study among 76 physicians and 76 dentists in Florida to identify provider characteristics when making clinical judgments (administering analgesics). The study used a virtual human (VH) technology to present hypothetical patients with varying characteristics such as race (white/black), age (old/young) and gender (male/female). Vignettes tailored to each profession (tooth pain for dentists and low back pain for physicians) were used to capture the patient's presentation of pain and correlate it to the physicians' and dentists' likelihood of administering non-opioid and opioid analgesics. The study found disparities among the clinical decisions, which were attributed to patient characteristics.

Green et al. (2003) (55) conducted a survey among 368 physicians from Michigan to explore the physician and patient characteristics that lead to variation in decision-making. The survey contained nine vignettes, which varied on the type of pain and gender of the patient. The results indicated that physicians tended to provide optimal pain treatment for men with acute postoperative pain or cancer pain compared to females and patients with chronic pain after controlling for other variables. The authors did not explain why this might occur and encouraged future research in this field to further investigate these findings.

1.2.14 Neighbourhood status

Meyer (2014) (37) performed a spatial analysis mapping dental clinics across Ontario. The purpose of the study was to classify Ontario's municipalities into high and low density in regards to the number of dentists serving the district. The author then correlated this classification with the population characteristics within the districts (average age and annual income). The findings suggest that despite the existence of unserved municipalities, dentists tend to cluster around metropolitan areas where the population has lower age and higher annual income. Ahmad and Quiñonez (2014) (36) mapped dentist density and average annual household income by FSA as well. The purpose of their study was to explore whether distributional disparities were associated with underlying factors, such as affordability as measured by average household income. The authors concluded that dentists usually gravitate towards areas with higher average annual household income. This study in conjunction with Meyer (2014) (37) suggested that dentists target younger populations with higher family annual incomes as a part of their positioning strategy. The clustering of dentists around certain subdivisions and municipalities may thus predict high competition for patients. As a consequence, this might contribute to the development of SID and/or variation in clinical decision-making.

1.2.15 Patient insurance status

With a sample of 25 physician members of CAPRICORN (Capital Area Primary Care Research Network), Meyers et al. (2006) (56) conducted a survey to examine the effect of patients' insurance status on physicians' clinical decisions. It was concluded that the vast majority of the surveyed physicians (85%) made alterations to their treatment plans as a result of a patient's insurance status. Even though the study highlighted this association, the authors did not study the effect of clinical modifications on the quality of care delivered.

1.3 Conceptual framework

In the light of the research reviewed, it is clear that, in the medical and dental field, various clinical and non-clinical factors influence clinical decisions. Figure 1 presents the conceptual framework of this research. Based on empirical evidence and anecdotal reports, the factors were grouped and classified in our conceptual framework into four categories: environmental, practice, provider, and patient factors. Environmental factors can be described as the factors where dentists practice and in which they have relatively little to no influence, such as the health care system in place, the geographic location of the practice, and dentists' density. Practice factors are the factors that pertain to the dental clinic in which he/she practice such as the age of the clinic, the number of dentists and hygienists employed and the type of practice (general vs. speciality). Provider factors are factors that describe the dentist such as their gender, age, place of initial dental training, years of experience, amount of personal debt, etc. Finally, patient factors include their socioeconomic status, oral health literacy, alongside beliefs and preferences in regard to oral health and dental care. It is believed that dentists' decisions in clinical practice are influenced by a combination of one or more of those factors.

Figure 1.The conceptual framework of factors affecting dentists' clinical decision-making

Environmental	Provider	Practice	Patient	Clinical
characteristics	characteristics	characteristics	characteristics	decision-making
 Health care system - organization, financing, delivery Geographic location- urban, rural, downtown Community water fluoridation Policies and regulations Dentist Density, Competition 	 Age Gender Ethnicity Years of practice Place of graduation Number of dependents Debt - student, practice, personal loans Practice ownership owner, associate, partner Number of hours worked Income Perception of competition Perception of busyness Ethics, Professionalism, Moral community Perceived professional role - business, health care profession 	 Practice setting - solo practice, small practice, large practice Number of dentists Number of hours worked Practice philosophy Type of practice - general practice, specialicty practice Age of practice Busyness of practice 	 Age Gender Ethnicity Socioeconomic status Socioeconomic status Insurance status General and oral health Oral health literacy Patient preferences Number of dependents Previous dental experience Accessibility - physical and financial 	• Aggressive Approach

1.4 Central research question

To inform this research area, as presented in the literature reviewed above, the question that this thesis addresses is: How does competition affect the clinical decision-making of dentists in Ontario?

1.5 Objectives

Our research has two specific objectives:

- To investigate the association between various non-clinical factors with clinical decisionmaking.
- 2. To investigate the association between dentists' geographic density and perceptions of competition with clinical decision-making.

1.6 Thesis Outline

Now that all background information has been reviewed, this thesis is organized as follows. Chapter 2 will broadly describe the methods used in this thesis. Chapters 3 and 4 then present papers to be submitted to journals for publication; specifically, Chapter 3 investigates the association between provider, patient, and practice factors with clinical decision-making among a representative sample of general dentists in Ontario, and Chapter 4 investigates the association between dentists' geographic density and dentists' perception of competition with clinical decision-making. Finally, Chapter 5 presents the main conclusions of this research, and describes future policy implications and research directions.

Chapter 2: Methods

This chapter represents a general methods section, describing the methods used in this study in broad terms. More detailed methods appear in the two papers presented in chapters 3 and 4.

2.0 Study design

This is a cross-sectional study conducted among general practitioners in Ontario, Canada's most populated province. The purpose of the study was to explore dentists' clinical decision-making and the putative factors influencing it, such as dentists' sociodemographic factors, practicerelated factors, and their perceptions of various financial issues.

2.1 Survey development

A 46-item survey was developed based on the conceptual framework outlined in the literature review. Survey participants were queried on their sociodemographic and professional characteristics, practice characteristics, and self-perceptions of competition and financial pressures (e.g. student loans, practice loans). The questions were either reproduced from previous surveys that explored similar issues or were developed de novo based on anecdotal reports of their influence on clinical decision-making.

Appendix 1 outlines the sources of the questions utilized in the survey. The outcome or dependent variable, a treatment intensity score, was assessed using ten-case scenarios with four recommended treatment options. The case scenarios were developed based on common clinical situations (e.g. decisions about restorations, extractions of asymptomatic third molars, replacing restorations with crowns, recommending veneers) and used to quantify the treatment decision-making of dentists. The recommended treatment options ranged from very conservative to very aggressive approaches. Each option was assigned a number, with '1', '2', '3', '4' representing

very conservative, conservative, aggressive, and very aggressive options, respectively. The questions and the treatment options were developed from the literature and with the help of experts from the Faculty of Dentistry at the University of Toronto. All the scores from the tencase scenarios were summed and were assumed to reflect the general clinical approach of the respondent. The higher the score, the more aggressive treatment approaches dentists would assumedly adopt. Appendix 2 presents the survey instrument.

2.2 Sampling

The sampling frame for the study was obtained from the Royal College of Dental Surgeons of Ontario (RCDSO), the provincial regulatory body for dentists. The 2016 register of the RCDSO contains the registration number, first and last name, name and address of their primary practice, as well as the postal code/P.O. box of the 9,303 dentists registered in the province for that year. We were only interested in studying clinical decision-making among general dentists who operate within private practices. As such, specialists, dentists working in public health units, military bases, institutional and correctional facilities were excluded from the sampling frame. The final sampling frame (N=7,067) was imported into an Excel spreadsheet for sampling purposes.

The sample size calculation was based on Dillman:
$$n = \frac{((P)(1-P))}{\left(\frac{C}{Z}\right)^2}$$
, where P is the

proportion of the population expected to choose one of two responses, C the assumed sampling error, and Z the zed statistic of the confidence interval. For this sample size calculation, two assumptions were made. The first involves an 80/20 split (minimal variation) which means 80% of the population will choose one answer, along with a 95% confidence interval and 3% sample error. The second assumption is a 50/50 split (maximal variation) which means that 50% of the

population will choose one answer, along with a 95% confidence interval and 3% sample error. When inserting these values into the equation above, a representative sample size ranges between a minimum of 683 to a maximum of 1,067. To be cautious, we picked the larger sample size (n=1,067). To account for the general low response rate to surveys among dental professionals (57), this number was tripled, and the survey was sent to 3,201 general dentists across the province. Using a random start, systematic sampling technique, the sample was selected from the sampling frame. To ensure respondents' confidentiality, each respondent was assigned a unique ID, and no personal identifiers appear in the dataset used for analysis.

2.3 Mailing

A modified Total Dillman's method was used to mail out the survey (48,49). Three waves of mailing were sent with a gap of a month between each mailing. The mailing breakdown was as follows:

- First mailing: initial invitation letter, the questionnaire, and a postage-paid return envelope.
- Second mailing: reminder letter, the questionnaire, and a postage-paid return envelope.
- Third mailing: final letter, the questionnaire, and a postage-paid return envelope.

The initial letter included a greeting, the purpose of the survey and instructions on how to complete it and mail it back. The second letter reminded dentists of the survey in case it was forgotten. The final letter was an announcement that this was the last chance to complete the survey. The initial, reminder, and final letters are presented in Appendix 3.

One thousand seventy-five letters were completed and returned (33.6% response rate), eleven respondents reported that they had retired (0.3%), and eighty-one letters were returned

showing that the addressee had moved to a new location (2.5%). Figure 1 outlines the response pace within the window of accepting returned surveys.

2.4 Data entry and coding

All data entry was performed using Microsoft Excel, and was conducted by the lead author, another graduate student, and two undergraduate dental students. A quality check using a random sample of 50 surveys was conducted to ensure the data entry spreadsheet was free from errors.

For ease of data analysis and interpretation, continuous variables were dichotomized based on their respective median values. The data dictionary containing the list of variables explored along with the Excel codes, the variable name, and their respective recategorized variables are outlined in Appendix 4.

2.5 Data analysis

All data analyses were performed using SPSS v.23. Descriptive analysis was performed followed by bivariate, binary, and multivariate logistic regressions. During the bivariate analysis, Pearson Chi-square and Spearman's rho were performed to correlate the categorical and continuous variables with the outcome, respectively. Given the exploratory nature of this study, the significance level was set at the p<0.1 level. Variables that were significant at the bivariate level were then carried forward to the binary and multivariable logistic analysis. Binary logistic regressions were performed to calculate unadjusted odds ratios. Multivariable logistic regression was then performed by entering all the statistically significant variables simultaneously to generate fully adjusted odds ratios.

To assess the role of competition and clinical decision-making, two proxies for competition were utilized. First, the perception of competition was assessed based on dentists' self-reports of competitive pressure from other dental clinics. The levels of perceived competition were noted on an ordinal scale with the options of no pressure, small, medium, and large amounts of pressure.

The second proxy was calculated using the spatial buffer tools in the geographic information system software, ArcGIS v.10.5. First, the cartographic boundary files (provincial and Dissemination Area (DA) boundaries) and the road network files were downloaded from the Statistics Canada website. The Excel spreadsheet containing the dentists' unique ID numbers, street addresses and postal codes was then imported to ArcGIS. Using the composite address locator, the clinics were geocoded onto the map. A ring model was then used to define the trade area of each respondent by creating a circular buffer with radii of 0.5 km, 1 km and 3 km around their geocoded location. The number of dentists within the buffers were then counted, as they were considered competitors. The Census files of the 2016 population count obtained from the Computing in the Humanities and Social Sciences (CHASS) website were used to adjust for the population density. Finally, the 'Intersect' and 'Join' features in ArcGIS were used to interpolate the number of population residing within each respective buffer. This was performed by using the following equation: $\frac{DA covered by the buffer}{Total area of the DA} \times population of the DA$

The interpolation assumes an even distribution of people over the entire area of the DA. This means that, if the buffer covers half the DA, the number of population residing with the buffer is half of the total population within the DA. Following that, dentist density was calculated using the following equation: $\frac{The \ count \ of \ dentists \ within \ the \ buffer}{Interpolated \ population \ within \ the \ buffer} \times 1000$, yielding the dentist density/1000 population. The resultant continuous scale was then recategorized into quartiles (very low, low, high, and very high dentist densities). The dentist densities were then linked to their respective survey responses using the dentists' unique ID numbers. Ethical approval (protocol number 00033950) was obtained from the University of Toronto Health Science Ethics Research Ethics Board (REB) in February 2017.




Chapter 3: Manuscript 1

What Influences the Clinical Decision-Making of Dentists?

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Abstract

Background: Clinical decision-making is a complex process that is influenced by clinical and non-clinical factors. Previous studies have explored associations with clinical decision-making and patients' oral health status and disease risk, as well as dentists' age, years of experience, and place of initial training. However, studies have only explored a limited number of variables, and there is little to no evidence for dentists in Canada. **Objectives:** To investigate the association between provider, patient, and practice factors with clinical decision-making among a representative sample of general dentists in Ontario, Canada's most populated province. **Methods:** This was a cross-sectional, self-administered survey of a random sample of general dentists in Ontario, Canada (n=3,201). The 46-item survey collected demographic, professional, and practice information (e.g. age of practice, number of hours worked/week, number of hygienists employed, and the number of patients seen/day). The outcome (clinical decision-

making, or treatment-intensity) was measured using a set of clinical scenarios, which categorized dentists as either aggressive or conservative in their treatment decisions. Associations were assessed using bivariate analysis and logistic and linear regressions. **Results:** One thousand and seventy-five dentists responded (33.6% response rate). Age (p=0.001), place of initial training (p<0.001), number of dependents (p=0.001), number of hours worked/week (p=0.043), billings/hour needed to be profitable (p<0.001), number of hygienists employed (p=0.001), and perceptions of practice loans (p=0.020) were associated with treatment-intensity. Dentists who were <40-years old (OR=2.06, 95% CI:1.39-3.06), American-trained (OR=2.48, 95% CI:1.51-4.06), had outstanding student loans (OR=2.75,95% CI:1.47-5.14) and large practice loans (OR=1.57, 95% CI:1.02-2.42), were more likely to be aggressive in their treatment choices. **Conclusion:** This study is the first to explore the impact of various non-clinical factors on the clinical decision-making of dentists in a Canadian context and will serve as a foundation for future research in this area.

MeSH terms and Keywords:

MeSH terms: Clinical Decision-making, Decision-making, Conservative treatment

Key words: Non-clinical factors, clinical decision-making, treatment intensity, dentist characteristics, patient characteristics.

3.0 Introduction

Clinical decision-making is a part of a dentist's everyday practice. Dentists utilize their clinical judgement whenever they recommend treatments to patients. In fact, a substantial portion of dental care lies in the "gray zones" where the defining criteria for a right or wrong treatment is unclear.(60) Due to the imbalance of knowledge between dentist and patient, the latter also often

rely on their dentist to adequately inform them of the most appropriate procedure and clinical direction.(61,62) As a result, a dentist is ethically obligated to provide the recommendation that best guards a patient's well-being.

Many definitions of clinical decision-making exist, but in its simplest terms, it is the process of choosing between different alternatives or options.(63) Yet, such decisions are rarely simple, and involve a complex process that requires gathering and evaluating clinical and other information to formulate decisions. Hence, many factors are believed to influence clinicians' decisions.(64,65) Research has explored some of the factors in medicine, nursing, and dentistry, and putative factors can be classified into "clinical" (or sometimes referred to as "technical") and "non-clinical". In dentistry, clinical factors are described as the factors attributed to the patient's general and oral health, such as their current disease status, symptoms of disease, and their history and future risk of disease. Non-clinical factors are described as the factors that influence the clinician's behavior, yet are not exclusively related to the patient's clinical status, such as the patient's race, socioeconomic status, health insurance status, as well as other personal characteristics pertaining to the clinician and the patient.(3)

Previous studies have demonstrated associations between non-clinical factors such as provider age, years of experience and place of initial training with the clinical decisions of practitioners. Traebert et al. and Grembowski et al.,(34,35) for example, have found that younger dentists tend to adopt more aggressive approaches and perform more unnecessary treatments compared to their older peers. Gordan et al.(41) revealed that dentists from the United States are more prompt to intervene on carious enamel lesions, whereas dentists from various Scandinavian countries (Denmark, Norway, and Sweden) would rather intervene when the carious lesion is into dentin. Zadik and Levin (37) have found that unnecessary prescription of postoperative

antibiotics and endodontic treatments were more prevalent among Latin American and Eastern European graduates, respectively. Grembowski et al. and Gordan et al.(41,66) have also shown that dentists in practices that are "not busy enough" tend to intervene significantly more often in the treatment of enamel surface lesions and tend to offer a higher number of services per patient after controlling for all other factors. The same significant association has been found between the type of practice (solo or small vs. large practices) and dentists' decisions regarding restorative treatment. (41) To a lesser extent, factors such the reimbursement system in place or a patient's insurance status have also been found to be associated with dentists' treatment decisions.(20,66,67)

Ultimately, while this evidence clarifies some of this dynamic, it is still limited in scope, as it has tended to only explore some of the putative variables that might contribute to the decision-making of dentists, in addition to being limited by small samples of dentists. Also, despite the presence of this limited evidence in other countries, the dynamics of what influences clinical decision-making is yet to be studied within a Canadian context. To this end, this study aims to explore the association between provider, patient, and practice factors with clinical decision-making among a large and representative sample of general dentists in Ontario, Canada's most populated province.

3.1 Methods

This is a cross-sectional study conducted through a self-administered survey sent to a random sample of general dentists practicing in Ontario. The sampling frame (N=7,067) was the 2016 register of the Royal College of Dental Surgeons of Ontario (RCDO), the regulatory body for dentists in Ontario. The sampling frame contained the names, addresses, and postal codes of dentists who hold a license to practice in Ontario. The inclusion criterion was general

practitioners in private practice with a RCDSO license, and the exclusion criteria were: 1) specialists; 2) those whose practice was not subject to the dental care market, such as public health dentists and university dental faculty members; and 3) those who participated in the pilot testing of the survey.

The sample size calculation was based on Dillman: $n = \frac{((P)(1-P))}{(C/Z)^2}$ where P is the proportion of the population expected to choose one of two responses, C the assumed sampling error, and Z the zed statistic of the confidence interval. Based on a maximal variation (50/50), which means 50% of the population will choose one answer, along with a 95% confidence interval and 3% sample error, the required sample size is 1,067.(68) However, due to the traditional low response rate from dental professionals, this number was tripled, and 3,201 surveys were sent out.(57) The sample was selected using a random start systematic sampling technique.

After reviewing the literature for potential predictors of clinical decision-making in health care with a specific focus on dentistry, a conceptual framework for this study was developed (Figure 1). The framework was partly based on similar models established by Bader and Shugars (1997) and Brennan and Spencer (2005).(69,70) It hypothesizes that dentists' clinical-decisions are a result of an interaction between different factors, which can be grouped into environmental, practice, provider, and patient factors. Also, putative factors where no empirical evidence was found were included based on anecdotal reports of their influence (e.g. amount required to bill/hour to be profitable, perception of other dentists, and the clinician's number of dependents). Using the framework, the 46-item survey was developed, which contained closed-ended questions to collect information on: a) provider characteristics (e.g. age, gender, place of initial training, number of dependents, perception of professional role and student loans); b) clinical characteristics (e.g. age of practice, number of hygienists employed, percentage breakdown of routine work, satisfaction with practice busyness, and perception of practice loans); and c) patient characteristics (e.g. insurance status). Some survey questions were sourced from previous literature and some were developed completely de novo (e.g. treatment intensity score).

To quantify the outcome, clinical decision-making, a "treatment intensity score" was assigned. Ten hypothetical vignettes were developed based on common clinical situations. The vignettes included questions about extraction of asymptomatic impacted third molars, recall intervals, the frequency of x-ray prescription, restorative decisions (restorative treatment vs. preventive treatment) based on radiographic images, replacing old fillings, crowns and bridges, as well as recommendations for cosmetic procedures (e.g. veneers). For each vignette, four treatment options were provided. The options spanned from a very conservative treatment approach, scored as '1', to a very aggressive treatment approach, scored as '4'. Adding up the scores for the ten vignettes yielded a continuous score. This allows for a range of values with the minimum and maximum scores of 10 and 40, respectively. The higher the treatment intensity score, the more aggressive the dentist's treatment decisions were deemed to be. The case scenarios and categorizing answers as conservative to more aggressive were developed from the literature and with the help of expert advice form three content experts at the University of Toronto's dental faculty.

Importantly, the results from three case scenarios showed very little variability in the responses. Subsequently, statistical analysis was completed excluding these three scenarios.

When these three case scenarios were removed, the minimum (and most conservative) score became '7' and the maximum (and most aggressive) score became '28.'

Also, to ensure a fair comparison, score proportioning was performed for participants who did not complete the full set of questions. Proportioning was performed using the following formula, $\frac{Score\ based\ on\ the\ completed\ questions}{Number\ of\ questions\ answered}} \times 7 \times 100$. For instance, if a participant completed five questions with a score of 16, then their adjusted score is $\frac{16}{5} \times 7 \times 100 = 22.4 \cong 22$. Importantly, only the scores of respondents who answered five questions or more were included in the data analysis. This resulted in the exclusion of the treatment scores of twenty-one respondents (2.0% of the sample size). The omission represented an insignificant proportion of our sample, which is unlikely to impact the overall result in any significant way.

The survey was also piloted with twenty dentists for face validity and ease of completion, and any proposed modifications were discussed with the main research team (AG, BY, CQ) and undertaken as needed. Approval for the study (protocol number 00033950) was obtained from the Health Sciences Research Ethics Board at the University of Toronto in February 2017.

Three mailing waves of the survey were completed. The first wave contained an invitation letter, the survey, and a postage-paid envelope to return the survey. Within the span of one month, a consecutive second and third waves were sent to all non-respondents. Each of the follow-up waves contained a reminder letter, the survey, and a postage-paid envelope.

In terms of data analysis, descriptive statistics were performed to describe respondents' demographic characteristics. Bivariate tests (Chi-square) and binary and multivariable logistic regressions were performed to explore associations. For the sake of consistency and ease of data analysis, all continuous variables (e.g. the percentage of patients' insurance coverage, the

percentage breakdown of routine work, and treatment intensity score) were dichotomized with the median score used as the cut-off point. Given the exploratory nature of this study, the level of significance was set at p<0.1. Binary logistic regressions (unadjusted odds ratios) were then performed on the significant variables from the bivariate analysis. Multivariable logistic regression (adjusted odds ratios) was then performed as a block model, adjusting for all significant variables simultaneously. All statistical analyses were performed using SPSS v.23.

3.2 Results

After excluding returned surveys for reasons such as the dentist had moved, retired or the survey was filled out twice by the same respondent, we had 1,075 usable surveys (33.6% response rate). Table 1 presents the descriptive characteristics of our sample. Of the total respondents, 65.5% were male, 60.0% were 51 years or older and 14.4% were 40 years and younger. The majority, 74.5%, graduated from a Canadian dental school followed by 16.7% from an international dental school, and 7.9% from an American dental school. The majority, 90.0%, had been practicing for over ten years, and among those who were internationally or American-trained, 77.8% were practicing in Canada for ten or more years. The majority, 71.0%, were the primary income earners of their household, and 57.2% had two-to-four dependents.

The majority of respondents, 73.3%, reported either being the owners or partners in their primary practice. Around 56.0% of owners and partners in our sample had outstanding practice loans, of which, 35.0% perceived the loans to be medium or large. Similarly, one-in-two dentists reported having had a student loan. Of which, 62.4% perceived it to be medium or large. In terms of repayment time, almost 50.0% of those with loans were able to repay their school debt between a one to five-year timeline, while 10.7% had yet to fully repay their school loan at the time of the survey.

Regarding clinical characteristics, 85.7% of respondents reported working between 20-50 hours/week. Approximately 50.0% of owners and partners reported employing three or more hygienists with 43.2% having 50 or more hours of hygiene services delivered/week. Around 47.0% of respondents reported seeing more than nine patients/day. Dissatisfaction with practice busyness was not uncommon among the survey respondents, as approximately one-in-four dentists reported being either somewhat dissatisfied or very dissatisfied with their practice busyness. Table 2 presents the distribution of patients' insurance coverage as reported by dentists. Private insurance was the most common source of insurance for patients, at 65.7%, followed by out-of-pocket payments, 19.1%, and public insurance, 15.2%.

The average breakdown of clinical time spent on dental procedures per week is also presented in Table 2. On average, respondents spent around 57.5% of their clinical time performing treatment procedures (restorative, prosthodontics, extractions, orthodontics, etc.), 20.2% and 22.3% performing diagnostic/preventive procedures (x-rays, scaling, sealants, etc.) and elective procedures (cosmetic and full mouth construction), respectively. Approximately 11.3% of respondents reported utilizing four or more technologies in their daily practice (e.g. caries detection devices, cerec machine (CAD/CAM)).

The majority of respondents perceived other dentists as colleagues rather than competitors (81.9% vs. 19.1%) and themselves as health care professionals rather than business people (92.0% vs. 8.0%).

To assess the representativeness of the sample, the demographic characteristics of the respondents were compared to the members of the Ontario Dental Association (ODA). The sample was comparable in terms of gender, place of initial training, and practice ownership, but was overrepresented by older dentists (age and year of graduation).

Figure 2 presents the distribution of treatment intensity scores and ranged from a minimum score of '6' to a maximum score of '25'. The mean and mode of the distribution were 14.7 and 15.0, respectively. The reported 50th and 90th percentiles were 15.0 and 19.8, respectively. This indicates that, overall, dentists tended to report conservative treatment approaches.

Table 3 presents those variables that were significantly associated with reporting aggressive treatment decisions. In the binary logistic regression, an upward trend could be observed between age and treatment intensity. Dentists who belong to the youngest age group, 40 years and younger, had approximately twice the odds (95% CI: 1.39-3.06) of having a high treatment intensity score compared to the reference group, those 61 and older. A similar trend was observed with year of graduation. Dentists who graduated between 2010 and 2016 had 3.2 odds (95% CI: 1.71-6.00) of reporting aggressive treatment decisions compared to dentists who graduated before 1980. Regarding place of initial training, graduates from American dental schools had 2.5 odds (95% CI: 1.51-4.06) of reporting aggressive treatment decisions when compared to their Canadian counterparts. Years of experience also reveals a similar trend. Dentists who had less than ten years of experience had 1.5 odds (95% CI: 0.96-2.19) of reporting aggressive treatment decisions compared to those with more than ten years or more of experience. In addition, dentists who reported earning more than \$250,000/year had 1.8 odds (95% CI: 1.18-2.74) of reporting aggressive treatment decisions compared to those who earned less than \$100,000/year. Practice ownership also demonstrated a significant association; dentists who owned or were a partner in their practices had 1.3 odds (95% CI: 1.01-1.75) of reporting aggressive treatment decisions compared to dentists who were associates. Dentists who perceived themselves as business people had 1.6 higher odds (95% CI: 0.98-2.58) of reporting

aggressive treatment decisions compared to those who perceived themselves as healthcare professionals.

Dentists who perceived their student loans to be large had 1.5 odds (95% CI: 0.96-2.29) of reporting aggressive treatment decisions compared to those who perceived their loans as small. Dentists who perceived their practice loans to be large and medium had 1.6 (95% CI: 1.02-2.42) and 1.8 (95% CI: 1.18-2.61) higher odds of reporting aggressive treatment decisions, respectively, compared to those with no loans.

Other variables such as the number of dependents, number of hours worked/week, amount billed per hour to be profitable, percentage of patient's insurance, number of hygienists employed, and the personal gross billing/day demonstrated significant association, with variability in their association with treatment intensity within the categories.

In the multivariable regression, year of graduation, place of initial training, satisfaction with practice busyness, and perception of other dentists remained the strongest predictors for reporting aggressive treatment decisions after adjusting for all other variables simultaneously.

3.4 Discussion

The results of this study confirm the existence of an association between non-clinical factors and dentists' clinical decision-making in a representative sample of dentists in Ontario, Canada's most populated province and largest dental care market. Factors that demonstrated a significant association with treatment intensity include dentist's age, place of initial training, satisfaction with practice busyness, and perception of practice loans.

Older dentists with more experience tended to have lower treatment intensity scores. This corroborates with previous studies that reported the same outcome.(34,66,71,72) It might be that

the experience accumulated over years of practice allows dentists to be a better judge of their clinical cases.(72) Others believe that older dentists are more ethically inclined and less pressured by financial incentives when recommending procedures.(23)

Place of initial training also predicted differences in dentists' treatment intensity scores, which is supported by similar findings in previous studies.(37,42,73) One hypothesis that can explain these differences is the variation in dental curricula and clinical practices taught in different international settings. It has been suggested that such differences would fade away as time practiced in the host country increases, as practitioners adapt to the oral health needs and professional culture of the respective population.(42) However, in this study, the years practiced in Canada was not a significant predictor of treatment intensity scores.

Perception of practice loans and perception of practice busyness were also significant predictors in this study. It might be that dentists who are less busy and perceive their loans to be large tend to recommend more aggressive, higher cost treatments, which is reflected by higher treatment intensity scores. Previous studies have found a similar association between practice busyness and treatment decisions.(35,66)

Financial challenges facing dentists, such as outstanding educational loans and the perception of large practice loans, were all pointing in the same direction. Despite the absence of other empirical evidence to support these findings, anecdotally, it is suggested that when facing financial hardships, dentists may overtreat or recommend unnecessary procedures to alleviate some of their financial pressures.(74)

Practice ownership and perception of professional role were also significant predictors of treatment intensity. It can be argued that dentists who own their practices strive to maximize

profit in order to sustain their businesses. When faced with financial challenges, one can also hypothesize they feel more pressure to opt for more aggressive, often costlier treatment recommendations compared to dentists who are not business owners.(74)

A fundamental argument that has presented itself for a long time in dentistry is whether dentists are health care professionals and/or business persons.(17) Dentistry in general is described as a profession, which assumes that the professional professes to protect and foster "the benefit of the public."(75) This implies that the patient's welfare is always prioritized over those of the practitioners.(75) However, some argue that the values and norms of dentistry, as a health professional culture, often conflict with the demands of its other culture, namely that of business, which emphasizes profit and high income as a priority. (76) This can manifest when dentists prioritize the help of those who demand costly interventions (veneers) over those who are in more need of less costlier procedures (simple restorations) to maximize profit. (76) This could explain the differences in treatment intensity scores between those who consider themselves primarily as health care professionals compared to business persons.

There have been attempts to quantify clinical decision-making among dentists. The most popular method appears to be through assessing the depth of a carious lesion at which a dentist would restoratively intervene based on radiographic images.(34,41,77) Another method includes ethical calibration of recommended treatment options to a hypothetical vignette (78), and comparing the differences between treatments proposed and delivered by dentists under different reimbursement systems.(20,22) Importantly though, to our knowledge, our study is the first to use an aggregated treatment intensity score utilizing a variety of common clinical scenarios.

The most significant shortcoming of this study and other self-administered survey data is the potential presence of social desirability bias when answering the vignettes and other perception questions. Respondents may tend to provide answers based on textbook recommendations, which might not necessarily mirror their clinical practices. The potential presence of this bias may also persist despite the confidentiality promised to participants. Another limitation of this study is the underrepresentation of younger dentists (14% compared to 29% in the ODA's membership) within our sample. This has arguably led to the underestimation of the effects of age, which was a significant predictor based on our analysis and previous anecdotal reports. Also, it is important to consider the study design when interpreting the results. Due to its cross-sectional nature, causation cannot be inferred.

Strengths of this study include the achievement of the minimum sample size, which allows for, within its limits, the generalization of the findings to the entire population of practicing dentists in Ontario, as the data was collected province-wide by utilizing a comprehensive sampling frame (i.e. all registered dentists in Ontario). In addition, this study was robust compared to the previous studies exploring similar outcomes, as it investigated more than thirty variables potentially associated with clinical decision-making. Furthermore, from a methodological standpoint, the study presents a potentially innovative method to quantify clinical decision-making and presents an opportunity for formal exploration of its reliability and validity through future research.

The results of this study have numerous educational and professional implications. Some of the educational implications include training students to deal with the anticipated financial stresses of clinical life and emphasizing ethical principles in practice. From a professional standpoint, it is important that the public perceives dental professionals as their health advocates, first and foremost. Yet, unfortunately, due to the arguably prevalent shift in the mindset of dental practices towards a primarily business model, the erosion of public trust is a serious consequence

facing the profession.(15) Strengthening the ethical behavior of dentists will arguably minimize financially-driven treatment decisions, which in return can mitigate the general undermining of public trust.

3.5 Conclusion

The results from this study have shown a significant association between non-clinical factors and dentists' reported clinical decisions. This is the first study to explore the factors potentially contributing to the clinical decision-making of dentists in Canada. Moreover, it serves as a foundation for further studies exploring putative factors influencing dentists' treatment decisions using a novel measurement approach.

3.6 Acknowledgements

This study was financially supported by the Dr. George Vasiga Scholarship in Dental Public Health and could not have been completed without the data entry help of Ms. Elizabeth Chisholm and Ms. Leslie Park. Figure 3. The conceptual framework of factors affecting dentists' clinical decision-making.

Environmental characteristics	Provider	Practice	Patient	Clinical decision-
	characteristics	characteristics	characteristics	making
 Health care system - organization, financing, delivery Geographic location- urban, rural, downtown Community water fluoridation Policies and regulations Dentist Density, Competition 	 Age Gender Ethnicity Years of practice Place of graduation Number of dependents Debt - student, practice, personal loans Practice ownership - owner, associate, partner Number of hours worked Income Perception of competition Perception of busyness Ethics, Professionalism, Moral community Perceived professional role - business, health care profession 	 Practice setting - solo practice, small practice, large practice Number of dentists Number of hours worked Practice philosophy Type of practice - general practice, specialicty practice Age of practice Busyness of practice 	 Age Gender Ethnicity Socioeconomic status Socioeconomic status Insurance status General and oral health Oral health literacy Patient preferences Number of dependents Previous dental experience Accessibility - physical and financial 	• Aggressive Approach

Variable	n (% of total)					
Socio-demographics						
Gender	1070					
Male	701 (65.5)					
Female	369 (34.5)					
Age	1069					
40 and younger	154 (14.4)					
41 to 50 years	274 (25.6)					
51 to 60 years	325 (30.4)					
61 and older	316 (29.6)					
Place of initial training	1070					
Canadian dental school	807 (75.4)					
American dental school	84 (7.9)					
International dental school	179 (16.7)					
Year of graduation	1033					
Before 1980	220 (21.3)					
1980-1989	302 (29.2)					
1990-1999	296 (28.7)					
2000-2009	160 (15.5)					
2010-2016	55 (5.3)					
Total years of practice	1068					
0-10 years	106 (9.1)					
More than 10 years	962 (90.9)					
Years of practice in Canada among those	252					
that were internationally or American-						
trained						
0-10 years	56 (22.2)					
More than 10 years	196 (77.8)					
Primary income earner	1047					
No	122 (11.7)					
My partner and I contribute equally	177 (16.9)					
Yes	748 (71.4)					
Number of dependents	1066					
0	158 (14.8)					
1	233 (21.9)					
2-4	610 (57.2)					
5 or more	65 (6.1)					
Annual personal after-tax income	902					
Less than \$100,000	203 (22.5)					
\$100,000-150,000	267 (29.6)					
\$150,000-200,000	170 (18.8)					
\$200,000-250,000	98 (10.9)					
\$250,000 or more	164 (18.2)					
Clinical ch	aracteristics					

Table 1. Descriptive characteristics (categorical variables).

Number of hours worked/week	1059
Less than 20 hours	121 (11.4)
20-35 hours	474 (44.8)
35-50 hours	433 (40.9)
More than 50 hours	31 (2.9)
Number of dentists in practice	1059
1	372 (35.1)
2-4	606 (57.2)
5 or more	81 (7.6)
Practice ownership	1061
Associate	283 (26.7)
Owner/Partner	778 (73.3)
Number of practices owned/partnered in	771
1	677 (87 8)
2 or more	94 (12.2)
Practice age	771
0-10 years	109 (14 1)
More than 10 years	662 (85 9)
Number of hygienists employed	772
	82 (8.0)
1	128 (16 6)
$\frac{1}{2}$	126 (10.0)
	158 (20.5)
	121 (157)
5 or more	107 (13.9)
Number of hygiene hours/week	709
Less than 20 hours	61 (8 6)
20-35 hours	167 (23.6)
35-50 hours	175 (24.7)
More than 50 hours	306 (43.2)
Number of patients seen/day	1068
1-9 patients	569 (53.3)
More than 9 patients	499 (46 7)
Personal gross billing income/day	1038
Less than \$1500	169 (16 3)
\$1500 - 2000	155 (14 9)
\$2000 - 2500	210 (20.2)
\$2500 - 3000	183 (17.6)
\$3000 - 3500	115 (11.1)
\$3500 or more	206 (19.8)
Percentage of natients with private	975
insurance	715
0 - 69%	400 (41 0)
70 - 100%	575 (59 0)
Percentage of natients with public	977
insurance	

0-9%	409 (41.9)			
10 - 100%	568 (58.1)			
Percentage of patients paying out of pocket	977			
(OOP)				
0-19%	484 (49.5)			
20 - 100%	493 (50.5)			
Percentage of preventive procedures	1031			
0-15%	514 (49.9)			
16-100%	517 (50.1)			
Percentage of treatment procedures	1029			
0-59%	496 (48.2)			
60-100%	533 (51.8)			
Percentage of elective procedures	1031			
0-19%	480 (46.6)			
20-100%	551 (53.4)			
Number of technologies used	1061			
0	122 (11.5)			
1	414 (39.0)			
2	273 (25.7)			
3	143 (13.8)			
4 or more	106 (10.0)			
Perceptions				
Perceived professional role	926			
Health care professional	852 (92.0)			
Business person	74 (8.0)			
Perception of other dentists	917			
Colleague	751 (81.9)			
Competitor	166 (18.1)			
Had student loans	1072			
Yes	524 (48.9)			
No	548 (51.1)			
Time taken to pay student loans	512			
Less than 1 year	84 (16.4)			
1-5 years	255 (49.8)			
5-10 years	90 (17.6)			
More than 10 years	28 (5.5)			
My student loans are not yet paid off	55 (10.7)			
Perception of student loans	517			
Small	194 (37.5)			
Medium	175 (33.8)			
Large	148 (28.6)			
Satisfaction with practice busyness	999			
Very satisfied	289 (28.9)			
Somewhat satisfied	459 (45.9)			
Somewhat dissatisfied	206 (20.6)			
Very dissatisfied	45 (4.5)			

Perception of practice loans	767
No practice loans	335 (43.7)
Small	165 (21.5)
Medium	150 (19.6)
Large	117 (15.3)
Perception of pressure from other dental	1077
clinics	
No pressure	333 (31.5)
Small	365 (34.5)
Medium	237 (22.4)
Large	122 (11.5)



Figure 4. The distribution of treatment intensity score.

	Percentage of	Percentage of	Percentage of	Percentage of	Percentage of	Percentage of
	private	public insurance	out-of-pocket	diagnostic and	treatment	elective
	insurance			preventive	procedures per	procedures per
				procedures per	week	week
				week		
N valid	977	977	977	1034	1034	1034
Missing	98	98	98	43	43	43
Mean	65.7	15.2	19.1	20.2	57.5	22.3
Median	70.0	10.0	20.0	15.9	60.0	20.0
Mode	70.0	10.0	20.0	10.0	70.0	10.0
Standard	20.8	17.9	12.2	15.5	18.2	16.0
Deviation (SD)						
Minimum	0	0	0	0	0	0
Maximum	100	96	100	95	100	100
Percentiles						
25 th	60.0	5.0	10.0	10.0	45.0	10.0
75 th	80.00	20.00	25.00	29.4	70.0	30.0

Table 2. Descriptive characteristics (continuous variables).

	Bivariate Odds ratio* (95% CI)	Р	Multivariable Odds ratio† (95% CI)	Р
	Socio-demographic	I		1
Gender	8 F			
Male (reference)	1.00	-	-	-
Female	1.26 (0.98, 1.63)	0.075	-	-
Years of practice (continuous)	0.98 (0.96, 0.99)	< 0.001	-	-
Age				
40 and younger	2.06 (1.40, 3.06)	< 0.001	-	-
41-50	1.69 (1.21, 2.34)	0.002	-	-
51-60	1.40 (1.02, 1.92)	0.036	-	-
61 and older (reference)	1.00	-	-	-
Year of graduation				
Before 1980 (reference)	1.00	-	1.00	-
1980 - 1989	1.44 (1.01, 2.06)	0.046	1.83 (1.05, 3.21)	0.034
1990 - 1999	1.89 (1.32, 2.71)	< 0.001	1.77 (0.97, 3.22)	0.061
2000 - 2009	2.03 (1.34, 3.09)	0.001	1.76 (0.89, 3.50)	0.105
2010 - 2016	3.21 (1.71, 5.60)	< 0.001	3.08 (1.30, 7.29)	0.011
Years of practice categorized				
Less than 10 years	1.45 (0.96, 2.19)	0.075	-	-
More than 10 years (reference)	1.00	-	-	-
Place of initial dental training				
Canadian dental school (reference)	1.00	-	1.00	-
American dental school	2.48 (1.52, 4.06)	< 0.001	2.97 (1.36, 6.48)	0.006
International dental school	0.76 (0.55, 1.06)	0.108	0.69 (0.42, 1.14)	0.151
Number of dependents				
0 (reference)	1.00	-	1.00	-
1	0.63 (0.42, 0.95)	0.029	1.03 (0.55, 1.93)	0.925
2-4	1.16 (0.82, 1.66)	0.401	1.35 (0.77, 2.37)	0.295
5 or more	0.88 (0.49, 1.57)	0.654	0.76 (0.30, 1.90)	0.553
Annual personal after-tax income				
Less than 100,000 (reference)	1.00	-	1.00	-

Table 3. Binary and Multivariable logistic regression table presenting the Odds of adopting aggressive treatment approaches.

100,000-150,000	1.30 (0.90, 1.89)	0.167	1.160 (0.676, 1.992)	0.590	
150,000-200,000	1.72 (1.14, 2.61)	0.011	1.63 (0.87, 3.05)	0.130	
200,000-250,000	1.65 (1.01, 2.69)	0.044	1.35 (0.64, 2.87)	0.432	
More than 250,0000	1.80 (1.18, 2.74)	0.006	1.40 (0.69, 2.85)	0.355	
	Clinical characteristics				
Number of hours worked/week					
Less than 20 hours (reference)	1.00	-	1.00	-	
20-35 hours	1.80 (1.19, 2.71)	0.005	0.65 (0.33, 1.28)	0.213	
35-50 hours	1.53 (1.01, 2.32)	0.043	0.57 (0.28, 1.18)	0.131	
More than 50 hours	1.75 (0.78, 3.92)	0.173	0.41 (0.11, 1.49)	0.177	
Amount to bill per hour per chair to be profitable					
Less than \$200 (reference)	1.00	-	1.00	-	
200-300	1.96 (1.26, 3.05)	0.003	1.26 (0.69, 2.31)	0.460	
300-400	1.73 (1.11, 2.71)	0.017	1.20 (0.62, 2.31)	0.582	
400-500	2.66 (1.60, 4.42)	< 0.001	1.77 (0.82, 3.83)	0.147	
More than 500	1.89 (1.18, 3.02)	0.008	2.25 (0.97, 5.21)	0.059	
Percentage of private insurance					
0-69% (reference)	1.00	-	1.00	-	
70-100%	1.38 (1.07, 1.79)	0.014	1.20 (0.81, 1.75)	0.331	
Percentage of public insurance					
0-9% (reference)	1.00		-	-	
10-100%	0.80 (0.62, 1.04)	0.092	-	-	
Practice ownership					
Associate (reference)	1.00	-	1.00	-	
Partner/Owner	1.33 (1.01, 1.75)	0.044	1.25 (0.78, 2.00)	0.357	
Number of practices dentist is owner/partner					
1 (reference)	1.00		-	-	
2 or more	1.31 (0.843, 2.028)	0.232	-	-	
Number of hygienists					
0 (reference)	1.00	-	-	-	
1	3.15 (1.61, 6.15)	0.001	-	-	
2	2.90 (1.54, 5.48)	0.001	-	-	
3	4.13 (2.14, 7.95)	< 0.001	-	-	

4	3.32 (1.69, 6.52)	< 0.001	-	-		
5	3.69 (1.85, 7.35)	< 0.001	-	-		
Number of patients/day						
0-9	1.31 (1.03, 1.67)	0.030	1.61 (1.07, 2.43)	0.023		
9 or more (reference)	1.00	-	1.00	-		
Personal gross billing/day						
Less than \$1500 (reference)	1.00	-	1.00	-		
1500-2000	1.42 (0.91, 2.22)	0.120	1.25 (0.64, 2.45)	0.517		
2000-2500	1.60 (1.06, 2.42)	0.026	1.48 (0.75, 2.93)	0.260		
2500-3000	1.76 (1.15, 2.70)	0.010	1.90 (0.90, 3.98)	0.091		
3000-3500	1.59 (0.98, 2.59)	0.059	2.09 (0.87, 4.85)	0.099		
3500 or more	2.09 (1.40, 3.14)	< 0.001	2.10 (0.92, 4.81)	0.079		
Perception of practice loans						
No outstanding loans/Small (reference)	1.00	-	-	-		
Medium/Large	1.52 (1.12, 2.06)	0.007	-	-		
Status of student loans						
Loans paid off (reference)	1.00		-	-		
Loans not paid off yet	2.75 (1.47, 5.14)	0.002	-	-		
Perception of student loans						
Small (reference)	1.00		-	-		
Medium	1.26 (0.83, 1.90)	0.282	-	-		
Large	1.48 (0.96, 2.29)	0.078	-	-		
Satisfaction with practice busyness		·				
Very satisfied (reference)	1.00	-	1.00	-		
Satisfied	1.33 (0.98, 1.79)	0.065	1.45 (0.93, 2.28)	0.104		
Dissatisfied	1.58 (1.10, 2.27)	0.013	2.38 (1.32, 4.30)	0.004		
Very dissatisfied	1.33 (0.70, 2.51)	0.382	3.17 (1.14, 8.78)	0.027		
Percentage of diagnostic and preventive procedures/ week						
0-15% (reference)	1.00	-	1.00	-		
16 - 100%	0.71 (0.55, 0.91)	0.006	0.79 (0.54, 1.15)	0.209		
Perceived dentist role						
Healthcare professional (reference)	1.00	-	-	-		
Business person	1.59 (0.98, 2.58)	0.063	-	-		

Perception of other dentists				
Strongly a colleague (reference)	1.00	-	1.00	-
Colleague	1.40 (1.02, 1.94)	0.040	1.53 (0.98, 2.39)	0.061
Competitor	1.05 (0.69, 1.59)	0.812	1.21 (0.67, 2.19)	0.538
Strongly a competitor	1.77 (1.01, 3.10)	0.046	2.23 (0.94, 5.27)	0.068
Perceived pressure from other dental clinics				
No pressure/small amount (reference)	1.00	-	1.00	-
Medium/Large pressure	1.32 (1.02, 1.70)	0.037	0.90 (0.57, 1.52)	0.658

* Model 1 entered all the variables independently
† Model 2 entered significant variables (p<0.05) from Model 1, adjusting for all variables simultaneously

Chapter 4: Manuscript 2

How Does Competition Affect the Clinical Decision-Making of Dentists in Ontario? A Geospatial Analysis

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Abstract

Introduction: In Canada, almost all dental services are privately financed and delivered. Dentists run their private practices and encounter various financial challenges such as increased debt and reduced patient turnover. Competition between dentists prevails as more dentists are clustering in large urban areas. Concerns about the influence of the increased competition on patient outcomes were vocalized by leaders in the dental community. Previous studies in the medical literature have demonstrated that undesirable outcomes such as supplier-induceddemand and overtreatment are common among highly competitive markets. Nevertheless, positive outcomes such as improved quality of care have also been reported among competitive hospitals. **Objectives:** To investigate the association between dentists' geographic density and dentists' perception of competition with clinical decision-making among a representative sample of dentists in Canada's most populated province. **Methods:** Competition was quantified using dentist density, defined as the number of competing dental clinics lying within a one-kilometer radius around the respondents' clinic address. The outcome (clinical decision-making, or treatment-intensity), was measured using a set of clinical scenarios, which categorized dentists as either aggressive or conservative. Associations were assessed using bivariate analysis and logistic and linear regression. Self-perception about competition was also assessed. **Results:** Dentists who perceived large competitive pressure from other dentists (OR=1.63, 95% CI:1.07-2.49) have reported been aggressive in their treatment approaches. Interestingly, dentists located in very low dentist density areas (OR=1.31, 95% CI:1.03-1.68) were also more like to be aggressive in their treatment choices. **Conclusion:** This study is the first to explore the impact of competition on the clinical decision-making of dentists in a Canadian context. It presents a valuable addition to the competition literature to help understand the dynamics of the Canadian dental care market.

MeSH terms and Keywords:

MeSH terms: Dental clinics, Clinical Decision-Making, Dental Care

Keywords: Competition, Clinical decision-making, dentist density

4.0 Introduction

Dental services in Canada, unlike physician and hospital services, are for the most part privately financed and delivered. Canadians spend approximately 13.6 billion dollars annually on dental care, with approximately 94% financed through the private sector, either through private insurance (third-party insurance plans) and/or out-of-pocket (OOP) payments (56.2% and 37.5%, respectively).(79) Almost all dental services are delivered by independent practitioners operating

a private practice, charging on a fee-for-service (FFS) basis. Although provincial dental associations provide a recommended fee guide, dentists are free to set their own prices for services as they feel suitable. Similar to the conventional business model, dentists operate their practices with an objective to profit; they strive to increase income and productivity, minimize opportunity cost, and reduce overhead costs to increase their likelihood of success in the market.(80)

Owing to the private financing and delivery structure, dental care in Canada is considered a 'free market' where the exchange between the buyer (the patients) and the seller (the dentists) occurs with little to no interference from the government.(81) As a consequence, competition manifests between individual offices as a by-product of this privatized system .(82) Competition can be simply thought of as "the presence of a number of similar organizations in a specific area."(81) A highly competitive area would then be defined as a larger number of neighboring organizations competing for the same set of customers.

The debate about the usefulness of competition in health care is long-lasting and remains unsettled. Some believe that it improves performance by enhancing the quality of care delivered, while at the same time, reducing cost.(81,83,84) Others suggest that it incentives the delivery of unnecessary treatments.(27,85,86) The impact of increased competition on various patient outcomes has been explored in the literature. A systematic review conducted by Léonard et al.(87) found that physician density, measured by the physician-to-population ratio, was positively associated with health care consumption. This led them to suggest that increased competition between physicians could be a potential predictor for the potential increase in unnecessary services. In addition, Yuen and Quiñonez(24) found a positive association between financially related misconduct and competition measured through the number of dentists per

Forward Sortation Area (FSA), a geographical unit based on the first three characters in a Canadian postal code.

Several ways to measure competition have been developed in the medical and economic literature. Examples of the methods used are: 1) Herfindahl-Hirschman Index (HHI), which measures competition based on participants' market share; 2) Provider concentration per a preset geographic area (Census Subdivision, Census Tract, or Forward Sortation Areas) often reported as the number of providers/population; and 3) The number of competitors within a fixed or variable spatial buffer around each respective provider. Despite the method used to quantify competition, it is generally believed that areas with clustered providers tend to be more competitive in nature, as providers would compete for the same set of patients living or working within the given geographic area.

There has been some evidence to suggest that competition between dental clinics in on the rise, at least in large metropolitan areas. A spatial assessment of dental supply in Ontario by Meyer (13) highlighted the uneven distribution of dentists across the province. The study revealed that the majority of municipalities had a relative deficiency of general practitioners, specialists or both. This was explained by the clustering effect of dentists in large metropolitan areas where they benefit from higher population growth rates, higher median income and lower average ages. The clustering of dentists in hotspots has arguably played a significant role in the development of the competitive dental market in Ontario. Also, an annual report by R.K. House & Associates Ltd, produced for the Ontario Dental Association, has painted a similar picture. It estimated that the dentist/population ratio in Ontario has experienced a sharp decline from 1052 in 2001 to 657 in 2014 and is forecasted to further decrease to 551 in 2024. In the last decade, the number of dentists who perceive themselves to be "busy" has also declined from 30.0% to

15.0%, and the dentists who claimed to be "slow" rose from 30.0% to 45.0%. Another interesting finding of this report was the substantial increase in advertisement costs by dental clinics. It was noted that the expenses of advertisement and promotion have increased by 205.0% within the last fifteen years.(10) The increase that has significantly outpaced the total increase of total expenses (76.5%) in the same period. All of these are indicators that point towards a fiercer competition between dental clinics, which has raised concerns from leaders within the dental community, based on the perceived undesirable consequences of such competition.

Competition on the global scale has been studied in relation to different patient outcomes such as increase utilization rates, quality of care and cost. Sekimoto and Li, Van Dijk, et al., Delattre and Dormont (86,88,89) have reported evidence of increased services demand with increased competition in the areas with high physician densities in Japan, the Netherlands, and France, respectively.

Studies in the UK and Australia (83,84,90) have reported improvements in the quality of care as the result of increased competition between hospitals. Whereas, a study by Austin and Baker (30) reported a higher procedural price in areas with high physician competition compared to with lower competitive areas.

This study presents the findings of a geospatial analysis, which aims to understand the influence competition on dentists' clinical decision-making. It is part of a larger study aimed at understanding how different factors—environmental (competition), provider (age, gender, place of initial training, years of experience, perception of debt), practice (age of practice, number of hours worked/week, number of hygienists employed, number of patients seen/day), and patient factors (insurance status)—influence the clinical decision-making of dentists in Ontario, Canada's most populated province, and its largest dental care market. For its part, this paper

conceptualizes competition, the primary exposure, using two proxies: 1) The geographic density of dentists measured via spatial analysis; and 2) The self-perception of pressure from other dental clinics, collected via a self-administered survey. The outcome, clinical decision-making, was quantified using a dichotomized treatment intensity score measured via a series of hypothetical case scenarios.

4.1 Methods

This was a cross-sectional study conducted through a self-administered survey sent to a representative sample of Ontario dentists. The sampling frame was the Royal College of Dental Surgeons of Ontario (RCDSO) 2016 register and contained 8,467 registered dentists province-wide. After excluding specialists, public health dentists, military personnel, and dental faculty members of the University of Toronto and Western University (the province's two dental schools), 7,067 general dentists remained.

The sample size calculation as per Dillman was: $n = \frac{((P)(1-P))}{(C/Z)^2}$ where Z represents the zed statistic of the confidence interval, P represents the proportion of population that will choose one of two responses, and C represents the sample error. Based on a maximal variation (50/50), along with 95% confidence interval and 3% sample error, the required sample size was calculated to be 1,067 participants.(91) To ensure we reached our minimum sample size given the reported low response rates from dental professionals, we tripled this number and sent 3,201 surveys.(57) The sample was selected using a random start, systematic sampling technique. Each participant was assigned a unique number, by which their survey was matched to the register list. Three mailing waves were sent. Each mailing envelope contained the invitation/reminder letter, the survey, and a postage-paid envelope to return the survey.

The 46-item self-administered survey was developed to collect information about provider, patient, and practice characteristics. The survey compromised questions about the respondents' personal and practice characteristics, including age, sex, place of initial training, years of experience, number of hours worked/week, practice ownership, as well as questions dealing with their perception about professional roles, school debt, and collegiality. In addition, the outcome, treatment decision-making was quantified via a series of hypothetical case scenarios. The case scenarios were about common clinical scenarios, such as the decision to restore proximal caries rather than providing a preventive treatment, recommending extractions of asymptomatic third molars, or the recommendation of elective procedures (e.g. veneers and whiting services). Each scenario was provided with four treatment options. The treatment options ranged from a very conservative approach to a very aggressive approach. The very conservative approach was assigned a '1', while the most aggressive approach was assigned a '4'. The scores from all the questions were then aggregated to represent the treatment intensity score of the respondent. The scores were then dichotomized using the median as a cut-off point, and respondents whose scored less than the median were categorized as conservative, while those who scored at or above the median were categorized as aggressive. The case scenario questions were developed from the literature and with the help of dental faculty members at the University of Toronto. The process also involved pilot testing the questions for face validity by among twenty dental practitioners.

Each entry in the register Excel spreadsheet contained the dentist's first and last name, their clinic(s) street address, postal code, the city of practice, as well as the unique identifying code assigned. The dataset used in this study contained 7,067 general dentists practicing in 3,878 different dental clinics across Ontario. The geographic analysis and map construction were all

performed using the geographic information system (GIS) software ArcGIS v.10.5.1. Statistical analysis was performed using SPSS v. 23.0. The cartographic boundary files (province, and dissemination areas (DA)), as well as the road network files, were all obtained from Statistics Canada's website.

The composite address locator function in ArcGIS was used to geocode dental clinics on the map created using the provided street addresses and postal codes as points. Geocoding is defined as "the process of assigning locations to addresses so that they can be placed as points on a map."(92)

The Excel spreadsheet containing the treatment intensity score of respondent dentists was then matched to the corresponding addresses and postal codes using the unique identifying code. The spreadsheet was then imported to ArcGIS. The 'Join' function was used to link the treatment scores of the respondents to their geocoded points in ArcGIS. Figure 1 presents the geocoded addresses of dental clinics and survey respondents in Ontario.

To calculate the dentist density in which the respondents operate, the trade area was delineated. Trade area defines "a geographic area within which a business enterprise or center of retail or wholesale distribution draws most of its business." The number of dentists within the trade areas were considered primary competitors. Many ways to delineate the trade area have been discussed in the literature. However, the method used in delineating the trade area of dentists in this study is the ring model. It defines the trade area as the area within the circle with the clinic representing the center. It identifies the other business within the circle as primary competitors for which they compete for the same customer base distributed within the circle.(93)

Using the spatial buffer tool, circular buffer with the radii of 0.5 km, 1 km and 3 km were created around each respondent to represent their respective trade areas. The number of dentists within the buffers were then counted. Figure 2 displays the circular buffers created around respondents.

To adjust for population density, The Census files of the 2016 population count was obtained from the Computing in the Humanities and Social Sciences (CHASS) website at the University of Toronto and joined to the feature class of Ontario dentists. Population interpolation was then performed to calculate the population density within the respective circular buffers. The interpolation assumes that the population within the DA is evenly distributed over the entire area. The interpolated population was calculated using the following equation:

$\frac{DA \text{ covered by the buffer}}{Total \text{ area of the DA}} \times population \text{ of the DA}$

For instance, if the buffer covers 20 km of the total 40 km DA (covers half of the DA), and 5000 people live in the DA, then this implies that around 2500 people live within this circular buffer. Figure 3 illustrates a snapshot of the population interpolation.

Following that, dentist density was calculated using the following equation:

 $\frac{The \ number \ of \ dentists \ within \ the \ buffer}{Interpolated \ population \ within \ the \ buffer} \times 1000, \ yielding \ the \ dentist \ density/1000 \ population.$

For example, if there are six dental clinics within this buffer over a total of 2500 people, then the dentist density/1000 population is 2.4/1000 population. The dentist density of the respondents was then categorized into quartiles (very low, low, high, very high). Table 1 presents the dentist density/1000 population of the three buffers. The resultant Excel spreadsheet was then imported into SPSS for statistical analysis.
The second proxy used to measure competition was via a self-perception question. Respondents were asked to rate the amount of pressure they perceive from other dental clinics. Their levels were noted on an ordinal categorical scale with the options of no pressure perceived, small, medium, and large amount of pressure.

The correlation between dentist density and the treatment intensity score was assessed using bivariate analysis (chi-square). If significant, binary logistic regression was then performed to calculate the unadjusted odds ratio. Also, to adjust for the potential confounding effect between dentist density and the other independent variables, they were correlated using the chisquare test. The presence of a significant association between dentist density and another independent variable will indicate a confounding effect. This will lead to the omission of one the variables. For instance, if age and dentist density were correlated, that would mean that age and dentist density explain the outcome in the same way; hence, only one of the two should be included in the data analysis.

4.2 Results

Table 2 presents the descriptive characteristics of the sample size. After excluding surveys for reasons such as the dentist has moved or retired, 1,075 surveys were usable yielding a 33.6% response rate. The respondents represented 929 (24.0%) different clinics from the total 3,878 geocoded clinics in Ontario. The majority of respondents were males (65.5%), 51 to 60 years old (30.4%), graduated from a Canadian dental school (75.4%), and practiced for more than ten years (90.9%). Also, 44.8% of respondents worked 20-35 hours/week, 73.3% owned their practices, and 57.2% worked alongside 2 to 4 dentists other dentists in a clinic. Furthermore, 92% of respondents perceived themselves as healthcare professionals and 81.9% considered

other dentists as colleagues rather than competitors. Interestingly, almost 1 in every 3 respondents (33.9%) perceived the pressure from other dental clinics to be medium or large.

Figure 4 presents the distribution of treatment intensity scores. The minimum score was '6' while the maximum score was '25'. The mean score was 14.7, and mode of the distribution was 15.0. Generally, dentists tended to report conservative treatment approaches as the reported 50th and 90th percentiles were 15.0 and 19.8, respectively.

There were 3,878 dental clinics geocoded. The number of respondents represented 929 dental clinics across Ontario. Bivariate analysis revealed a significant association between dentist density and the corresponding treatment score at the 1 km buffer. Dentists who practice in low dentist density areas tend to be significantly associated with aggressive treatment approaches (p=0.021). Similar trends were observed in the 0.5 km (p=0.406) and 3 km (p=0.813). However, the differences were not statistically significant at the 0.05 level.

Table 3 presents the associations between the independent variables and dentist density. None of the variables were significant at the 0.5 level, which rules out the potential confounding effect of the variables. Figure 5 presents the binary logistic regressions, which revealed that dentists who practice in very low dentist density areas have 1.4 odds (95% CI: 1.00-2.00) of high treatment intensity compared to their counterparts practicing in the very high dentist density areas. However, in contrast to our spatial assessment, a trend of increased odds of high treatment intensity is associated with increased self-perceived pressure. Dentists who perceive a large amount of pressure from other clinics are 1.6 (95% CI: 1.07-2.49) more likely to have high treatment intensity compared to those who perceive no pressure.

4.3 Discussion

The spatial analysis reveals that dentists who practice in very low dentist density areas are more likely to adopt aggressive treatment approaches compared to their counterparts in very high dentist density areas. Yet, according to their self-perception, dentists who perceived medium and large pressure from other clinics were more likely to adopt aggressive treatment approaches when compared to their counterparts who perceived no or small pressure from neighboring clinics. The findings indicate an association between competition and treatment intensity as an outcome. However, the direction of the association and the conflicting findings between the geographic assessment and self-perception is interesting and stimulates some hypotheses about the potential explanation.

One potential explanation is that dentists practicing in very low dentist density areas are mostly located in rural areas where general and specialist dental care might not be readily accessible for patients. As a consequence, whenever in doubt, dentists might tend to intervene more aggressively in the fear that patients lack access to sufficient follow up in the future. This can be relevant when they would decide to restore an incipient carious lesion rather than waiting to restore if it progresses to the dentin or opts for removing an asymptomatic third molar compared to adopting a "watch and see" approach.

Another potential explanation is that competition may manifest differently in areas with high dentist density. For instance, dentists in the high dentist density areas are likely to be aware of the competitive environment they practice within, and therefore they may choose to provide a higher frequency of conservative treatments rather than a lower frequency of aggressive treatments. A variation that was not captured by the outcome measure utilized in this study.

Geographic analysis tends to impose rigid artificial boundaries which do not account for other variables that could influence the catchment area of a clinic. (94) While it is more likely to be accurate within high-density areas, under or overestimation of the effects are more prominent in the low-density areas. One can also argue that the self-perception measure would offer a more reliable indicator of the quantity of competition, as it accounts for unmeasurable factors only perceived through the lenses of the respondent.

The study limitations are classified into measurement, conceptual, and outcomes. Measurement limitations are the shortcoming related to the methodological approach of the study. Whereas, conceptual limitations refer to the conceptual arguments behind the chosen approaches and outcome limitations pertain to the outcome chosen to reflect the clinical decision-making of dentists.

Previous studies that assessed competition between health care facilities (hospitals) have studied competition by utilizing similar approaches but have used circular buffers of 15 km and 30 km. While our findings might change based on the radius of our buffers, those distances do not seem justifiable in our context, as per the clustered distribution of dental clinics in Ontario and their relatively smaller competitive capacities compared to hospitals.

One could also argue that the use of the static ring model to delineate the trade area also provides too simplistic of an analysis of the competitive nature between dentists in Ontario. Indeed, the method fails to recognize natural features (water bodies), travel barriers (road networks suitable for patient accessibility), and the population distribution within the buffer (population centers).

Another shortcoming of this study is that it assumed that dentists compete with other dental clinics within the same region solely based on their location and without accounting for patient preferences in the choice of dental clinics. Patients will often choose their dentists based on a recommendation from family and friends (word-of-mouth) and not necessarily the dentist with the most convenient location. Furthermore, the study did not account for the size of the clinic, number of sales, and their advertising strategies. Those factors would potentially influence the clinics' capacity in attracting patients, as well as influence the treatment philosophy of dentists.(35,66) Moreover, the ring models' dimensions used were based on retail real estate estimates, which do not take into account the unique characteristics of healthcare markets compared to a typical retail market such as the heterogeneity of products and limited sensitivity to pricing.(95)

Finally, an important outcome limitation of this study is that it relies on only one outcome measure to assess dentists' decision-making. Consequently, not all the effects of increased competition on clinical decision-making are captured. For instance, one can argue that under financial pressures, some dentists would opt to overtreat patients by providing multiple, unnecessary treatments rather than a single aggressive treatment. An effect of overtreatment that is missed through the lens of the treatment intensity score as it tends to perceive adverse treatment outcome in a qualitative nature rather than a quantitative one. In addition, having multiple outcome measures would allow for cross validation between results.

This is the first study in Canada to assess the influence of competition on the clinical decisionmaking of dentists. The dentist density ratio calculated provides a better resolution picture of the competition between clinics in comparison to the traditionally used number of dentists per FSA.

4.4 Conclusion

Competition in health care often provokes controversies. In dental care, the debate is also challenged by a lack of empirical evidence. However, the evidence in the medical literature is mixed. Proponents of competition support the benefits of having a competitive market as it improves the quality of care and reduces prices, while opponents believe that it results in adverse patient outcomes. Competition is not a 'one-size fits all' concept that applies to all healthcare markets. It relies heavily on the context in which it manifests and is perceived as a concern only if it leads to adverse patient outcomes such as increased unnecessary services and overtreatment. This study informs the competition debate by providing insight on the competitive dental market in Ontario.

4.5 Acknowledgment

I would like to thank Dr. Don Boyes for his valuable input and his help with the spatial analysis.

Table 4. Dentist density/1000 population.

	Dentist density 0.5 km	Dentist density 1 km	Dentist density 3 km
N valid	1072	1072	1072
Missing	3	3	3
Mean	21.52	5.39	1.73
Percentiles			
25 th	0.37	0.34	0.56
50 th	0.64	0.59	0.74
75 th	1.15	0.97	0.93

Variable	n (% of total)			
Socio-demographics				
Gender	1070			
Male	701 (65.5)			
Female	369 (34.5)			
Age	1069			
40 and younger	154 (14.4)			
41 to 50 years	274 (25.6)			
51 to 60 years	325 (30.4)			
61 and older	316 (29.6)			
Place of initial training	1070			
Canadian dental school	807 (75.4)			
American dental school	84 (7.9)			
International dental school	179 (16.7)			
Year of graduation	1033			
Before 1980	220 (21.3)			
1980-1989	302 (29.2)			
1990-1999	296 (28.7)			
2000-2009	160 (15.5)			
2010-2016	55 (5.3)			
Total years of practice	1068			
0-10 years	106 (9.1)			
More than 10 years	962 (90.9)			
Years of practice in Canada among those	252			
that were internationally or American-				
trained				
0-10 years	56 (22.2)			
More than 10 years	196 (77.8)			
Primary income earner	1047			
No	122 (11.7)			
My partner and I contribute equally	177 (16.9)			
Yes	748 (71.4)			
Number of dependents	1066			
0	158 (14.8)			
1	233 (21.9)			
2-4	610 (57.2)			
5 or more	65 (6.1)			
Annual personal after-tax income	902			
Less than \$100,000	203 (22.5)			
\$100,000-150,000	267 (29.6)			
\$150,000-200,000	170 (18.8)			
\$200,000-250,000	98 (10.9)			
\$250,000 or more	164 (18.2)			
Clinical characteristics				

Table 5. Descriptive characteristics of the independent variables.

Number of hours worked/week	1059	
Less than 20 hours	121 (11.4)	
20-35 hours	474 (44.8)	
35-50 hours	433 (40.9)	
More than 50 hours	31 (2.9)	
Number of dentists in practice	1059	
1	372 (35.1)	
2-4	606 (57.2)	
5 or more	81 (7.6)	
Practice ownership	1061	
Associate	283 (26.7)	
Owner/Partner	778 (73.3)	
Number of practices owned/partnered in	771	
1	677 (87 8)	
2 or more	94 (12 2)	
Practice age	771	
0-10 years	109 (14 1)	
More than 10 years	662 (85.9)	
Number of hygienists employed	772	
0	82 (8 0)	
1	128 (16.6)	
	126(10.0) 196(25.4)	
	150(25.4) 158(20.5)	
- 5 - A	138 (20.3)	
5 or more	121(13.7) 107(13.0)	
Number of hygiana hours/week	700	
Less than 20 hours	61 (8 6)	
20-35 hours	167 (23.6)	
20-55 hours	107(23.0) 175(24.7)	
More than 50 hours	306(43.2)	
Number of notionts soon/day	1068	
1-9 patients	569 (53 3)	
More than 9 patients	499 (46 7)	
Porsonal gross billing incomo/day	1038	
Less than \$1500	160 (16 3)	
\$1500 2000	109(10.3) 155(140)	
\$1500 - 2000	133(14.3) 210(20.2)	
\$2500 - 2300	210(20.2) 182(17.6)	
\$2000 - 5000	103(17.0) 115(11.1)	
\$3000 - 3300 \$2500 on more	113(11.1) 206 (10.8)	
population of notion to with a winds	200 (19.8)	
refreentage of patients with private	975	
	400 (41.0) 575 (50.0)	
0 - 09%	575 (59.0)	
10 - 100%	077	
rercentage of patients with public	9// 400 (41 0)	
mout ance	407 (41.7 <i>)</i>	

0-9%	568 (58.1)	
10 - 100%		
Percentage of patients paying out of pocket	977	
(OOP)		
0 - 19%	484 (49.5)	
20 - 100%	493 (50.5)	
Percentage of preventive procedures	1031	
0-15%	514 (49.9)	
16-100%	517 (50.1)	
Percentage of treatment procedures	1029	
0-59%	496 (48.2)	
60-100%	533 (51.8)	
Percentage of elective procedures	1031	
0-19%	480 (46.6)	
20-100%	551 (53.4)	
Number of technologies used	1061	
0	122 (11.5)	
1	414 (39.0)	
2	273 (25.7)	
3	143 (13.8)	
4 or more	106 (10.0)	
Perce	ptions	
Perceived professional role	926	
Health care professional	852 (92.0)	
Business person	74 (8.0)	
Perception of other dentists	917	
Colleague	751 (81.9)	
Competitor	166 (18.1)	
Had student loans	1072	
Yes	524 (48.9)	
No	548 (51.1)	
Time taken to pay student loans	512	
Less than 1 year	84 (16.4)	
1-5 years	255 (49.8)	
5-10 years	90 (17.6)	
More than 10 years	28 (5.5)	
My student loans are not yet paid off	55 (10.7)	
Perception of student loans	517	
Small	194 (37.5)	
Medium	175 (33.8)	
Large	148 (28.6)	
Satisfaction with practice busyness	999	
Very satisfied	289 (28.9)	
Somewhat satisfied	459 (45.9)	
Somewhat dissatisfied	206 (20.6)	
Very dissatisfied	45 (4.5)	

Perception of practice loans	767
No practice loans	335 (43.7)
Small	165 (21.5)
Medium	150 (19.6)
Large	117 (15.3)
Perception of pressure from other dental	1077
clinics	
No pressure	333 (31.5)
Small	365 (34.5)
Medium	237 (22.4)
Large	122 (11.5)

Table 6. Associations between the independent variables and 1 km dentist density.

Variables	Outcome (Dentist Density)	
	p-value	
Demographics		
Age	0.481	
Year of graduation	0.295	
Gender	0.378	
Place of initial training	0.248	
Number of dependents	0.675	
Primary income earner	0.076*	
Personal income	0.275	
Practice characteristics		
Practice ownership	0.214	
Number of hours worked/week	0.186	
Age of practice	0.822	
Number of hygienists	0.597	
Number of hygiene hours/week	0.191	
Perce	ptions	
Current status of student loans	0.078	
Perception of student loans	0.934	
Satisfaction of practice busyness	0.446	
Perception of practice loans	0.513	
Perceived professional role	0.910	
Perception of other dentists	0.073*	
Perception of pressure from other dentists	0.695	
* Variable significant at the 0.1 level		

Figure 3. The distribution of dental clinics and respondents across Ontario.





Figure 4. A map representing the 0.5 km, 1 km, and 3 km circular buffers around a sample of respondents.

Figure 5. A snapshot of population interpolation.





Figure 5. The distribution of treatment intensity score.



Figure 6. The binary logistic regression of dentist density at 1 km and the self-perceived pressure.

Chapter 5: Discussion and Conclusions

5.0 Discussion

Variation in clinical decision-making is ubiquitous and for good or bad is generally accepted in dentistry. The factors contributing to this variation are often classified into 'clinical' and 'non-clinical' factors. Examples of clinical factors are a patient's history and their current or future risk of disease. Whereas 'non-clinical' factors do not directly pertain to the health status of the patient and include provider age, place of initial training, years of experience, the location, and size of their practice, as well as the patient's insurance status.

In the last decade, the profession of dentistry in Canada has witnessed some significant changes. Those changes can be categorized as competitive, financial, and professional. In Ontario, Canada's most populated province, the number of practicing dentists has outpaced the increase in population. The population-to-dentist ratio has dropped from 1052 in 2001 to 675 in 2014 and is expected to reach 551 by 2024. (10) Generally, where an increase in the number of professionals would arguably result in increased accessibility to care, this was not quite the case for Ontarians. A geographic assessment done by Meyer (13) revealed that dentists are more likely to cluster in urban and large metropolitan areas, which resulted in many underserved or unserved municipalities across Ontario. In turn, due to the increase in the number of dentists has arguably fostered the development of a hyper-competitive dental market where dentists fiercely compete for patients.

As noted, the second change is financial, with new graduates facing more challenges compared to their older peers in terms of financial pressures. Due to

reduced governmental loans, and the soaring cost of dental education, new dental graduates are facing significant amounts of school debt upon graduation.(8,9) Furthermore, the valuation and the cost of operating dental clinics is said to have risen significantly, which puts professionals in considerable debt when launching a new practice or purchasing an established one (11,96,97).

The third significant challenge is professional, and arguably the most critical one facing dentistry, as it is related to the erosion of public trust. According to a recent survey conducted by the Canadian Dental Association (CDA), around 63% of the public perceived dentists as business persons, not as health professionals. This has direct implications on the status of dentistry as a caring (self-regulated) profession, as patients believe that dentists are no longer acting altruistically, but exploiting the knowledge asymmetry between clinician and patient for financial gain.(98)

As a result of these challenges, leaders in the dental profession have expressed concerns about the detrimental consequences of the oversupply of dentists, increased competition between dental clinics, and erosion of professionalism and ethics among dentists, on patient outcomes. It is feared that dentists are overtreating and recommending unnecessary care for the sake of self-interest and financial gain.

Importantly, the influence of competition between healthcare providers has been studied with varying depth in the medical and dental professions. Previous studies in the medical literature have assessed the influence of these factors on patient outcomes such as the quality of care, costs, and the type and quantity of treatments provided (81). Similar studies exist in the dental literature (28,29,99,100); however, they are less extensive and generally more limited in scope, only exploring a limited number of variables, and often using a non-representative sample of participants.

Furthermore, prior to our research, there was no empirical work on the association between 'non-clinical' factors and clinical decision-making among Canadian dentists.

What is more, apart from some scattered anecdotal reports, there is no evidence to support the existence of adverse consequences in the context of increased competition in the Canadian dental care market. To inform this debate, this research was conducted to provide evidence about the influence of 'non-clinical' factors and competition on dentists' treatment decisions. In this regard, this research aimed to assess the association between factors such as provider age, place of initial training, years of experience, perceptions about their professional role, collegiality, financial loans, perceptions of competition and geographic dentist density on the clinical decision-making of dentists in Ontario. This was assessed using an aggregated score generated from responses on ten clinical scenarios. The aggregated score reflects the treatment intensity of dentists' recommended services and was used as a proxy to quantify clinical decision-making. The higher the score, the more aggressive and costlier the treatments are deemed.

The results from our study have shown that dentists in Ontario report being conservative with their clinical decisions in general terms. Yet dentists' age, place of initial training, years of experience, number of dependents, income, number of hours worked/week, practice ownership, number of hygienists employed, practice and student loans, satisfaction with practice busyness, perceived professional role, collegiality, and pressure from other dentists were all found to be significantly associated with treatment intensity. In addition, the results have shown that perceived professional role, perception of competition, and dentist density functioned in dentists' treatment decisions. This might suggest that dentists' financial context is intertwined with their clinical decisions. Interestingly, the results of this study also

suggest that dentists practicing in high dentist density areas tend to be more conservative in their treatment approaches. However, the self-perception of competition indicates the opposite. It revealed that dentists who perceive medium to large competitive pressure from other dental clinics tend to be more aggressive in the approaches adopted.

These findings are crucial in understanding what determines dentists' decisions. In markets where dentists are clustered, perceive competitive pressure, and are faced with financial hardships, having those influences predict their recommended treatment decisions seems problematic. Although the findings from this study are not conclusive and do not assert causation between the exposures and the outcome due to the cross-sectional design, they may help inform the debate about the potential predictors of clinical decision-making factors among dentists in Ontario.

Ultimately, dentists in Ontario are facing numerous financial and professional challenges. However, dentists who are overly concerned about their clinic's market survivability and are concerned over their financial status may tend to have those pressures amplified, which in turn may reflect on their treatment approaches. Competition arguably results from a group of factors that has to occur simultaneously, and not merely the presence of more dentists in a given area (high dentist density area). One can debate that relying solely on the geographic location to quantify competition might be misleading and would miss on some of the putative factors that contribute to the competitive pressures felt by dentists. As a result of this, one can argue that dentists' perception of competition is more meaningful to quantify the competitive status faced by dentists.

5.1 Strengths and limitations

Similar to the shortcomings of other self-administered surveys, this study suffers from social desirability bias. Respondents may tend to answer questions in a manner that makes them viewed as favourable by others. This can also persist despite the presence of confidentiality and even anonymity. This could have had a significant impact on our study, as we believe that it directly alters our estimates. We believe that when answering controversial questions about the perception of one's professional role, collegiality, and perceptions about busyness, dentists would tend to pick the answers that would view them in a more favourable manner. Similarly, when answering the case scenario questions, dentists would tend to pick the textbook answer rather than the response that reflects their actual clinical practice. Thus, it is very likely that the treatment scores were underestimated as a consequence of this shortcoming. Also, it is important to understand that due to the cross-sectional nature of this research, causation between the exposures and the outcome cannot be established.

To ensure the representativeness our sample, the characteristics of the sample were compared to the membership records of the Ontario Dental Association (ODA), which represents more than 90% of the dentists in Ontario. (98) Figure 1 presents the complete comparison with the ODA. According to this comparison, our sample was underrepresented by younger dentists (14% compared to 29% in the ODA's membership's record). We believe that this relative underrepresentation has likely underestimated the results of our research as well. The inclusion of more younger dentists in the sample would have likely strengthened the observed association between provider age, practice loans and student loans with treatment intensity.

In regard to the outcome of this research (treatment intensity), the reliance on one measure is considered a limitation. Ideally, more than one outcome should be

utilized to allow for more robust conclusions and cross-comparison of the results. Other outcomes such as the quantity of services delivered, patient satisfaction, and utilization rates to capture the whole picture of the influence of increased competition on patient outcomes from all perspectives will be important in future studies. In addition, while the treatment intensity score is a novelty to the literature in this area, it was only tested for face validity. One way to test the treatment intensity score for construct validity is through the cross-verification of services provided against the ones reported in the survey. This could be done by comparing the services provided in clinical practice against the options reported in similar case scenarios in the survey. From a spatial analysis standpoint, the use of the ring model also presents some limitations. First, it fails to recognize geographical barriers (rivers, lack of road networks, etc.) around the respondents, thus it might not accurately capture the physical accessibility of dental clinics. Also, it assumes that individuals within the buffer will seek the closest dentists out of convenience. It is generally believed that individuals rely on 'word-of-mouth' when choosing their dentists. Also, others usually prefer seeing dentists who are located closer to their work places.(10) Lastly, using the buffer sizes assumes that all clinics have an equal competitive power, and it fails to account for variation in the size of practices, the rate of referrals established with other clinics, as well as the advertising strategies adopted by clinics when delineating the trade areas. Nevertheless, this method provides a higher-resolution reflection of provider density numbers compared to traditional measures (providers per Forward Sortation Areas, district, etc.). It also narrows down the trade area and restricts the definition of competitors to the ones within the buffer areas yielding a more reliable measure of provider density.

In short, this research represents a unique contribution to the clinical decisionmaking literature in Canada and internationally by using a geographic/spatial approach. Compared to other studies in the literature, this research is robust as well, as it investigates over thirty variables believed to have an association with dentists' clinical decision-making.

5.2 Policy implications

This research highlights the importance of understanding the impact of different 'nonclinical' factors on dentists' clinical decision-making and has various policy implications. One of the important factors explored in this research is the financial pressures facing dentists. The substantial increase in school and clinic overhead costs has made school (8) and practice debt largely inevitable. As a result, the importance of preparing students with more education about debt management and ethical decision-making is essential. Dental schools should improve curricula to inform students of the financial and ethical challenges they might experience, and with the required skills to maximize sound clinical decisions when faced with such challenges, as well as how to handle their debt while maintaining their professional identity as healthcare professionals.

Along the same lines, leaders in the dental community have expressed their concerns about increased competition on dentists' clinical decisions. It is hypothesized that in competitive markets, dentists are becoming more commerciallyoriented. Hence, they prioritize their financial interests over their patients' welfare. This can manifest as overtreatment by delivering unnecessary services or recommending more aggressive, costlier treatments. This research informs this by providing evidence that supports the argument that in competitive markets, dentists' decisions might be adversely influenced by the financial pressures encountered.

Owing to the professional obligation to protect the public's right to quality oral health services, regulatory bodies and professional associations require evidence to support their actions to ensure the public's safety and well-being. It is important to inform them about the potential consequences of increased competition on important patient outcomes. As per the issues identified for dental schools, continuing dental education focussing on the same or similar areas is also paramount.

5.3 Future directions

This research lays the foundation for future studies of competition and clinical decision-making. Based on the findings of this research and the discussed limitations, the recommendations for future research can be classified into conceptual and measurement considerations.

Conceptually, other factors closely related to financial pressures in dentistry are essential to explore within the privatized dental market in Canada. For instance, variables supported by anecdotal reports such as the amount of pro bono work delivered, advertisement and promotion expenditure (advertisement power), as well as dentists' self-perception about the usefulness of competition are important to explore given their relationship to the conceptual framework developed as part of this research.

Regarding measurement, quantifying clinical decision-making through the development of the treatment intensity score represented an innovative addition to the literature. However, future studies should aim to validate such a score to ensure that it indeed measures what it purports to be measuring. In addition, similar to the medical literature, patient outcomes are important to explore to ensure a more robust description of the dynamic of competition and its effects on clinical decision-making.

Patients' satisfaction with services, utilization rates, and treatment costs are important outcomes that have been explored in the medical literature.

Regarding the measurement of competition, more detailed models that delineate trade areas will need to be utilized. Models such as data driven rings, drivetime polygon, and gravity modeling employ more data and yield more customized trade areas per provider. Finally, the utilization of mixed methods approaches provide a solid ground for the inclusion of putative variables influencing clinical decisionmaking. Interviewing leaders in the dental community and dentist about these issues would provide insights on their concerns and challenges, which could be further explored in future studies.

5.4 Conclusion

The influence of 'non-clinical' factors on the decision-making of healthcare providers is documented in the literature. Our research in particular has shown that factors such as age, place of initial training, amount of financial debt and satisfaction with practice busyness are significantly associated with clinical decision-making. Also, dentist density and self-perception of competition are significantly associated with this outcome. This research represents a valuable addition to the literature, as it is the first Canadian study to explore these associations, and can inform educational, professional, and regulatory efforts at maintaining the status of dentistry as a caring profession and the public's right to altruistic, appropriate and safe dental care.

References

 Tiffen J, Corbridge SJ, Slimmer L. Enhancing Clinical Decision Making: Development of a Contiguous Definition and Conceptual Framework. J Prof Nurs. 2014;30(5):399-405.

- Junges R, Zitzmann NU, Walter C, Rösing CK. Dental care providers' decision making regarding maintenance of compromised teeth and implant therapy indication: An analysis of gender and enrollment in teaching positions. Clin Oral Implants Res. 2014;25(9):1027–33.
- Hajjaj FM, Salek MS, Basra MKA, Finlay AY. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. J R Soc Med [Internet]. 2010;103(5):178–87. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2862069&tool=pm centrez&rendertype=abstract
- Lutfey KE. How are patient characteristics relevant for physicians' clinical decision making in diabetes?: An analysis of qualitative results from a crossnational factorial experiment. Soc Sci. 2009;67(9):1391–9.
- Restivo L, Apostolidis T, Bouhnik A-D, Garciaz S, Aurran T, Julian-Reynier C. Patients' Non-Medical Characteristics Contribute to Collective Medical Decision-Making at Multidisciplinary Oncological Team Meetings. PLoS One [Internet]. 2016;11(5):e0154969. Available from: http://dx.plos.org/10.1371/journal.pone.0154969
- Drane JF. "Ethical workup" guides clinical decision making. Health Prog [Internet]. 1988 Dec [cited 2016 Jul 8];69(11):64–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10290838
- Canadian Association of University Teachers. Access denied: the affordability of post-secondary education in Canada, 1857 to 2002. Education Review September 2002. 2002.

- Matthew IR, Walton JN, Dumaresq C, Sudmant W. The burden of debt for Canadian dental students: part 1. Review of the literature. J Can Dent Assoc [Internet]. 2006;72(7):635. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16978481
- 9. Dumaresq C, Sudmant W, Matthew I. The Burden of Debt for Canadian Dental Students : 2007;72(10).
- R.K. House & Associates Ltd. Economic report to the dental profession. Toronto: Ontario Dental Association. 2014.
- 11. The Globe and Mail. Oversupply of dentists sparks fierce competition in big Canadian cities - The Globe and Mail [Internet]. [cited 2018 Apr 9]. Available from: https://www.theglobeandmail.com/report-on-business/small-business/sbgrowth/glut-of-dentists-causes-aches-in-canadas-big-cities/article36322773/
- 12. Cantelon L, Sexty R. A Study of Ethics in the Profession of Dentistry. 2014;
- Meyer SP. A spatial assessment of dentist supply in Ontario, Canada. Can Geogr. 2014;58(4):481–98.
- 14. The Perceived Issue of Oversupply Dentists Oral Health Group [Internet].
 Oral Health. [cited 2018 Apr 9]. Available from: https://www.oralhealthgroup.com/features/the-perceived-issue-oversupply-dentists/
- Canadian Dental Association. Highlights of the 2014 CDA Annual General Meeting – Oasis Discussions [Internet]. [cited 2018 Apr 9]. Available from: http://oasisdiscussions.ca/2014/04/30/agm/
- 16. Masella RS, R.S. M, Masella RS. Renewing professionalism in dental

education: overcoming the market environment. J Dent Educ [Internet]. 2007;71(2):205–16. Available from:

http://www.embase.com/search/results?subaction=viewrecord&from=export&i d=L46504598%5Cnhttp://bj7rx7bn7b.search.serialssolutions.com?sid=EMBA SE&issn=00220337&id=doi:&atitle=Renewing+professionalism+in+dental+ed ucation:+overcoming+the+market+environment.&st

- 17. Welie JVM. Is Dentistry a Profession ? J Can Dent Assoc. 2004;70(10):675–8.
- Brennan DS, Spencer a J. Factors influencing choice of dental treatment by private general practitioners. Int J Behav Med [Internet]. 2002;9(2):94–110. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16848258
- Shen J, Andersen R, Brook R, Kominski G, Albert PS, Wenger N. The effects of payment method on clinical decision-making: physician responses to clinical scenarios. Med Care [Internet]. 2004;42(3):297–302. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15076830
- 20. Naegele ER, Cunha-Cruz J, Nadanovsky P. Disparity between dental needs and dental treatment provided. J Dent Res. 2010;89(9):975–9.
- Brocklehurst P, Price J, Glenny A-M, Tickle M, Birch S, Mertz E, et al. The effect of different methods of remuneration on the behaviour of primary care dentists. Cochrane database Syst Rev [Internet]. 2013;11(11):CD009853.
 Available from: http://www.ncbi.nlm.nih.gov/pubmed/24194456
- Tickle M, McDonald R, Franklin J, Aggarwal VR, Milsom K, Reeves D.
 Paying for the wrong kind of performance? Financial incentives and behaviour changes in National Health Service dentistry 1992-2009. Community Dent Oral Epidemiol. 2011;39(5):465–73.

- Walker I, Gilbert D, Asimakopoulou K. Are clinical decisions in endodontics influenced by the patient's fee-paying status? Bdj [Internet].
 2015;219(11):541–5. Available from: http://www.nature.com/doifinder/10.1038/sj.bdj.2015.921
- Yuen K, Quiñonez C. Competition and Financially Related Misconduct in Dental Practice : A Retrospective Descriptive Study. J Can Dent Assoc (Tor). 2015;81.
- 25. L??onard C, Stordeur S, Roberfroid D. Association between physician density and health care consumption: A systematic review of the evidence. Health Policy (New York). 2009;91(2):121–34.
- Bickerdyke I, Dolamore R, Monday I, Preston R. Supplier-induced demand for medical services. World Wide Web Internet And Web Information Systems. 2002.
- Xirasagar S, Lin HC. Physician supply, supplier-induced demand and competition: Empirical evidence from a single-payer system. Int J Health Plann Manage. 2006;21(2):117–31.
- Birch S. The identification of supplier-inducement in a fixed price system of health care provision. The case of dentistry in the United Kingdom. J Health Econ. 1988;7(2):129–50.
- Tsai WC, Kung PT, Chang WC. Influences of market competition on dental care utilization under the global budget payment system. Community Dent Oral Epidemiol. 2007;35(6):459–64.
- 30. Austin DR, Baker LC. Less physician practice competition is associated with

higher prices paid for common procedures. Health Aff. 2015;34(10):1753-60.

- Grytten J, S??rensen R. Type of contract and supplier-induced demand for primary physicians in Norway. J Health Econ. 2001;20(3):379–93.
- Madden D, Nolan A, Nolan B. GP reimbursement and visiting behaviour in Ireland. Health Econ. 2005;14(10):1047–60.
- Carlsen F, Grytten J. More physicians: Improved availability or induced demand? Health Econ. 1998;7(6):495–508.
- 34. Traebert J, Marcenes W, Kreutz JV, Oliveira R, Piazza CH, Peres MA. Brazilian dentists' restorative treatment decisions. Oral Health Prev Dent [Internet]. 2005;3(1):53–60. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fullte xt&D=med4&AN=15921338http://openurl.man.ac.uk/sfxlcl3?sid=OVID:medli ne&id=pmid:15921338&id=doi:&issn=1602-1622&isbn=&volume=3&issue=1&spage=53&pages=53-60&date=2005&title=Oral+Health+%26+Prev
- 35. Grembowski D, Fiset L, Milgrom P, Forrester K, Spadafora a. Factors influencing the appropriateness of restorative dental treatment: an epidemiologic perspective. J Public Health Dent [Internet]. 1997;57(1):19–30. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9150060
- Sundberg H, Mejàre I, Espelid I, Tveit a B. Swedish dentists' decisions on preparation techniques and restorative materials. Acta Odontol Scand. 2000;58:135–41.
- 37. Zadik Y, Levin L. Clinical decision making in restorative dentistry,

endodontics, and antibiotic prescription. J Dent Educ. 2008;72(1):81-6.

- Tveit AB, Espelid I, Skodje F. Restorative treatment decisions on approximal caries in Norway. Int Dent J [Internet]. 1999;49(3):165–72. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10858750
- Tubert-jeannin S, Doméjean-orliaguet S, Riordan PJ, Espelid I, Tveit AB.
 Restorative Treatment Strategies Reported by French University Teachers. Int Perspect Dent Educ. 2004;68(10):1096–103.
- 40. Kay E, Locker D. Variations in restorative treatment decisions: an international comparison. Community Dent Oral Epidemiol. 1996;24:376–9.
- 41. Gordan V V, Garvan CW, Heft MW, Fellows JL, Qvist V, Rindal DB, et al. Restorative treatment thresholds for interproximal primary caries based on radiographic images: findings from the Dental Practice-Based Research Network. Gen Dent [Internet]. 2009;57(6):595,654-656,680. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&d opt=Citation&list_uids=19906618
- Wang S, Chalkley M, Tilley C. Comparing the treatment provided by UK and non-UK trained health professionals: dentists in Scotland. J Health Serv Res Policy [Internet]. 2012;17(4):227–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22914546
- Kakudate N, Sumida F, Matsumoto Y, Manabe K, Yokoyama Y, Gilbert GH, et al. Restorative Treatment Thresholds for Proximal Caries in Dental PBRN. J Dent Res. 2012;1202–8.
- 44. McKay J, Quiñonez C. The Feminization of Dentistry: Implications for the

Profession. J Can Dent Assoc. 2012;78.

- 45. Suga USG, Terada RSS, Ubaldini ALM, Fujimaki M, Pascotto RC, Batilana AP, et al. Factors that drive dentists towards or away from dental caries preventive measures: Systematic review and metasummary. PLoS One. 2014;9(10).
- Lang-Hua BH, Mcgrath CPJ, Lo ECM, Lang NP. Factors influencing treatment decision-making for maintaining or extracting compromised teeth. Clin Oral Implants Res. 2014;25(1):59–66.
- 47. Walton JN, Matthew IR, Dumaresq C, Sudmant W. The burden of debt for Canadian dental students: Part 2. A report on survey participants and an analysis of dental education costs. J Can Dent Assoc (Tor). 2006;72(8).
- 48. Nicholson S, Vujicic M, Wanchek T, Ziebert A, Menezes A. The effect of education debt on dentists' career decisions. J Am Dent Assoc [Internet].
 2015;146(11):800–7. Available from: http://dx.doi.org/10.1016/j.adaj.2015.05.015

http://ax.doi.org/10.1010/j.dduj.2015.05.015

- 49. Iversen T, Ma C to A. Market conditions and general practitioners' referrals.Int J Health Care Finance Econ. 2011;11(4):245–65.
- Zitzmann NU, Zemp E, Weiger R, Lang NP, Walter C. Does a Clinician's Sex Influence Treatment Decisions? Int J Prosthodont. 2011;24(6):507–14.
- 51. Landon BE, Reschovsky J, Reed M, Blumenthal D. Personal, organizational, and market level influences on physicians' practice patterns: results of a national survey of primary care physicians. Med Care [Internet]. 2001;39(8):889–905. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/11468507

- Grembowski D, Milgrom '* '- P, Fiset ' L. DENTAL DECISIONMAKING AND VARIATION IN DENTIST SERVICE RATES. Sot SC; Med. 1991;32(3):287–94.
- 53. Natale JE, Joseph JG, Rogers AJ, Tunik M, Monroe D, Kerrey B, et al. Relationship of Physician-Identified Patient Race and Ethnicity to Use of Computed Tomography in Pediatric Blunt Torso Trauma. Acad Emerg Med [Internet]. 2016;n/a-n/a. Available from: http://doi.wiley.com/10.1111/acem.12943
- 54. Boissoneault J., Mundt JM., Bartley EJ., Wandner LD., Hirsh AT., Robinson ME. Assessment of the influence of demographic and professional characteristics on health care providers' pain management decisions using virtual humans. J Dent Educ [Internet]. 2016;80(5):578–87. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84969921217&partnerID=40&md5=addae0a2539455a958a6edae4cb9b4cb
- 55. Green CR, Wheeler JRC, LaPorte F. Clinical decision making in pain management: Contributions of physician and patient characteristics to variations in practice. J Pain [Internet]. 2003;4(1):29–39. Available from: http://www.sciencedirect.com/science/article/pii/S1526590002650059
- 56. Meyers DS, Mishori R, McCann J, Delgado J, O'Malley AS, Fryer E. Primary care physicians' perceptions of the effect of insurance status on clinical decision making. Ann Fam Med. 2006;4(5):399–402.
- 57. Hardigan PC, Succar CT, Fleisher JM. An analysis of response rate and economic costs between mail and web-based surveys among practicing

dentists: a randomized trial. J Community Health [Internet]. 2012;37(2):383– 94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21858591

- Dillman DA. The Design And Administration Of Mail Surveys. Annu Rev Sociol. 1991;17(1):225–49.
- Hoddinott SN, Bass MJ. The dillman total design survey method. Can Fam Physician. 1986;32(November):2366–8.
- Ahmad I. Risk management in clinical practice. Part 5. Ethical considerations for dental enhancement procedures. Br Dent J [Internet]. 2010;209(5):207–14.
 Available from: http://www.ncbi.nlm.nih.gov/pubmed/20829856
- Le Grand, J. Robinson R. The economics of social problems. 2nd ed. London: Macmillan; 1984.
- Reisine ST, Bailit HL. Clinical oral health status and adult perceptions of oral health. Soc Sci Med. 1980;14 A(6):597–605.
- 63. Thompson C, Stapley S. Do educational interventions improve nurses' clinical decision making and judgement? A systematic review. Int J Nurs Stud [Internet]. 2011;48(7):881–93. Available from: http://dx.doi.org/10.1016/j.ijnurstu.2010.12.005
- Bader JD, Shugars DA. Understanding Dentists' Restorative Treatment Decisions. J Public Health Dent. 1992;52(2):102–10.
- 65. Alexander G, Hopcraft, Tyas M, Wong R. Dentists' restorative decisionmaking and implications for an "amalgamless" profession. Part 2: a qualitative study. Aust Dent J [Internet]. 2014;(October 2011):420–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25090909

- Grembowski D. Factors Influencing Variation in Dentist Service Rates. J Public Health Dent. 1990;50(4):244–50.
- Plans DT, Reimbursement D, Author S, Source HMH, Macmillan P, Stable J. A Comparison of Dental Treatment Plans Under Different Reimbursement Systems. 2015;6(2):223–35.
- 68. Dillman DA, Smyth JD, Christian LM. Internet, phone, mail, and mixed mode surveys: The tailored design method (4th ed.). [Internet]. Internet, phone, mail, and mixed mode surveys: The tailored design method (4th ed.). 2014.
 Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc11&NE WS=N&AN=2014-34233-000
- 69. Brennan DS, Spencer a. J. The role of dentist, practice and patient factors in the provision of dental services. Community Dent Oral Epidemiol. 2005;33(3):181–95.
- 70. Bader JD, Shugars D a. What do we know about how dentists make caries-related treatment decisions? Community Dent Oral Epidemiol [Internet].
 1997;25(1):97–103. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9088698
- Grembowski D, Milgrom P, Fiset L. Factors influencing dental decision making. J Public Health Dent [Internet]. 1988;48(3):159–67. Available from: http://www.ncbi.nlm.nih.gov/pubmed/3045303
- 72. Grembowski D, Milgrom P, Fiset L. Variation in dentist service rates in a homogeneous patient population. J Public Heal Dent [Internet].
 1990;50(4):235–43. Available from:

http://pesquisa.bvsalud.org/portal/resource/pt/mdl-2118181

- 73. S. T-J, S. D-O, P.J. R, I. E, A.B. T. Restorative treatment strategies reported by French university teachers. J Dent Educ [Internet]. 2004;68(10):1096–103. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&i d=L39413984%5Cnhttp://pm6mt7vg3j.search.serialssolutions.com?sid=EMBA SE&issn=00220337&id=doi:&atitle=Restorative+treatment+strategies+reporte d+by+French+university+teachers.&stitle=J+D
- Hartshorne J, Sc B, Ch BD, Ch MD, Stell PD, Uk FRCP. ETHICS IN
 AESTHETIC DENTISTRY PART 2: ETHICAL CONSIDERATIONS OF
 OVERTREATMENT PATIENT INTERESTS VS BUSINESS INTERESTS.
- 75. Bertolami CN. Why our ethics curricula don't work. J Am Coll Dent [Internet].
 2006;73(2):35–46. Available from: http://www.jdentaled.org/content/68/4/414.full.pdf
- Franz C. Balancing Costs and Patients ' Health : Dental Students ' Perception of Economics in Dentistry. 2015;5(3).
- Schwendicke F, Stangvaltaite L, Holmgren C, Maltz M, Finet M, Elhennawy K, et al. Dentists' attitudes and behaviour regarding deep carious lesion management: a multi-national survey. Clin Oral Investig [Internet]. 2016;
 Available from: http://link.springer.com/10.1007/s00784-016-1776-5
- 78. Kazemian A, Berg I, Finkel C, Yazdani S, Zeilhofer H-F, Juergens P, et al. How much dentists are ethically concerned about overtreatment; a vignettebased survey in Switzerland. BMC Med Ethics [Internet]. 2015;16(1):43. Available from: http://www.biomedcentral.com/1472-6939/16/43

- 79. Canadian Dental Association. The State of Oral Health [Internet]. [cited 2018 May 30]. Available from: https://www.cdaadc.ca/stateoforalhealth/servicescanada/
- Grembowski D, Conrad D, Weaver M, Milgrom P. The structure and function of dental-care markets. A review and agenda for research. Med Care. 1988;26(2):132–47.
- 81. Chen S, Ye J. Evidence scan: Competition in healthcare. 2011;(April).
- Nash KD, Brown LJ. The market for dental services. J Dent Educ [Internet].
 2012;76(8):973–86. Available from: http://pesquisa.bvsalud.org/portal/resource/pt/mdl22855583%5Cnhttp://www.jdentaled.org/content/76/8/973.long
- 83. Cooper Z, Gibbons S, Jones S, McGuire A. Does Competition Save Lives?
 Evidence from the English NHS Patient Choice Reform. LSE Heal Work Pap. 2010;121:228–60.
- 84. Gaynor BM, Moreno-serra R, Propper C. American Economic Association Death by Market Power : Reform , Competition , and Patient Outcomes in the National Health Service Author (s): Martin Gaynor , Rodrigo Moreno-Serra and Carol Propper Source : American Economic Journal : Economic Policy , Vo. 2013;5(4).
- 85. Forbes I, Lecturer S, Hindle D, Management HS, Degeling P, Zhang K, et al. The effects of increased market competition on hospital services in Shandong and Henan Provinces I AN F ORBES, D ON H INDLE, P IETER D EGELING, K AI Z HANG, Aust Heal Rev. 2002;25(2):52–65.
- Sekimoto M, Ii M. Supplier-Induced Demand for Chronic Disease Care in Japan: Multilevel Analysis of the Association between Physician Density and Physician-Patient Encounter Frequency. Value Heal Reg Issues [Internet].
 2015;6:103–10. Available from: http://dx.doi.org/10.1016/j.vhri.2015.03.010
- Léonard C, Stordeur S, Roberfroid D. Association between physician density and health care consumption: A systematic review of the evidence. Health Policy (New York). 2009;91(2):121–34.
- 88. van Dijk CE, van den Berg B, Verheij RA, Spreeuwenberg P, Groenewegen PP, de Bakker DH. MORAL HAZARD AND SUPPLIER-INDUCED DEMAND: EMPIRICAL EVIDENCE IN GENERAL PRACTICE. Health Econ. 2013;22(3):340–52.
- Delattre E, Dormont B. Fixed fees and physician-induced demand: A panel data study on French physicians. Health Econ. 2003;12(9):741–54.
- Palangkaraya A, Yong J. Effects of competition on hospital quality: An examination using hospital administrative data. Eur J Heal Econ. 2013;14(3):415–29.
- Sudman S. How to conduct your own survey: Salent,P and Dillman,DA. Vol.
 33, Journal of Marketing Research. 1996. p. 118–9.
- 92. What is geocoding?—ArcGIS Pro | ArcGIS Desktop [Internet]. [cited 2018 May 24]. Available from: https://pro.arcgis.com/en/proapp/help/data/geocoding/what-is-geocoding-.htm
- Gray AC. Spatial Delineation of Market Areas: A Proposal Approach [Internet]. 2014. Available from: http://spatial.usc.edu/wp-

content/uploads/2014/04/GrayAmanda.pdf

- 94. Nobles M, Serban N, Swann J. Spatial accessibility of pediatric primary healthcare: Measurement and inference. Ann Appl Stat. 2014;8(4):1922–46.
- 95. Makhkamova L, Consultant S, Johnson M, Noble R. TECHNIQUES FOR GEOGRAPHIC MARKET DEFINITION IN HOSPITALS.
- 96. Industry Trends: What's in Store for Dental Practices [Internet]. [cited 2018 Jul
 3]. Available from: http://www.mnp.ca/en/posts/industry-trends-whats-in-store-for-dental-practices
- 97. Too many dentists means tough times for them, good deals for customers: report - National | Globalnews.ca [Internet]. [cited 2018 Jul 3]. Available from: https://globalnews.ca/news/429450/too-many-dentists-means-tough-times-forthem-good-deals-for-customers-report/
- Ontario Dental Association. About Us [Internet]. [cited 2018 Jun 14].
 Available from: https://www.youroralhealth.ca/about-the-oda
- Palmujoki RTJ. Perceived competition in private dental practice in Finland.
 Acta Odontol Scand. 2000;58(5):213–6.
- 100. Grytten J, Srensen R. Competition and dental services. Health Econ.2000;9(5):447–61.

Appendices

Appendix 1: Components of the survey with the matched literature review

Question	Conceptual model	Exposure/Outcome	Source	Methodological notes/Comments
Gender	category Provider characteristic	Exposure	Brennan and Spencer (2005) - The role of dentist, practice and patient factors in the provision of dental services. The study found a significant negative association for male dentists with preventive services. This suggests that gender might play a role in the provision of dental treatments. McKay and Quiñonez's (2012) - The Feminization of Dentistry: Implications for the Profession. The literature review found that gender may reflect a different perspective when deciding on treatment. The findings from the studies can be summarized as follows; female dentists favour preventive strategies in the early disease stages, as compared to men who have been reported to be more interventionist. Kakudate et al. (2012) - Restorative Treatment	Results from studies in different settings were consistent and showed that gender is associated with differences in treatment decisions.
			Restorative Treatment	

			Thresholds for Proximal Caries in Dental PBRN. The authors found that male dentists would intervene in enamel surfaces significantly more often compared to their female counterparts in a high-risk caries model.	
			Traebert et al. (2007) - Thresholds of Restorative Decision in Dental Caries, treatment among Dentists from Small Brazilian Cities. The study did not find that gender was a significant factor in the interventionist attitude of dentists (restoring caries in enamel, at the DEJ, or at outer dentine).	
Age	Provider characteristic	Exposure	Grembowski et al. (1997) - Factors influencing the appropriateness of restorative dental treatment: an epidemiologic perspective. The study found that overtreatment was prevalent across different age groups of dentists. Traebert et al. (2007) - Thresholds of Restorative Decision in Dental Caries, treatment among Dentists from Small Brazilian Cities. stated that	Age played a significant role in explaining the variations in the clinical decision making of dentists.

			age was not a factor in interventionist attitude (restoring caries in enamel, at the DEJ, or at outer dentine)	
			Sundberg et al. (2000) - Swedish dentists' decisions on preparation techniques and restorative materials. The study found that variation in ages between Swedish dentists accounted for differences in treatment decisions regarding materials used and restorative decisions.	
Initial training	Provider characteristic	Exposure	Kay and Locker (1996) - Variations in a restorative treatment decision: an international comparison. Dentists who received their initial training in Canada had a greater propensity to restore caries at each lesion depth than dentists who got their initial treatment in Scotland. Zadik and Levin (2007) - Clinical Decision Making in Restorative Dentistry, Endodontics, and Antibiotic Prescription. The study found a significant variation in clinical decisions among a sample of	Despite the small sample sizes in some of the studies, the variation in clinical decisions across different countries is ubiquitous. The compiling evidence supports the association of initial training location with treatment decision. Since practitioners in Ontario are a rich blend of Canadian and international trained dentists, it is important to understand how this variable will impact the clinical decisions within a Canadian context.

dentists with initial dental training
in Israel, Eastern Europe, and
Latin America.
Kakudate et al. (2012) -
Restorative Treatment
Thresholds for Proximal Caries
in Dental PBRN. found that
Japanese dentists were at high risk
of restoring caries lesions in
enamel.
Tubert-Jeannin et al. (2004) -
Restorative Treatment
Strategies Reported by French
University Teachers. found that
French dental school teachers'
attitudes differed from those of
private practitioners: they tended
to intervene surgically at a later
stage, but they would intervene
earlier in the treatment of the
carious process than would
Scandinavian dentists.
Gordan et al. (2009) -
Restorative Treatment
Thresholds for Interproximal
Primary Caries Based on
Radiographic Images: Findings
from The Dental PBRN. The
authors compared treatment
decisions of dentists from

			 Scandinavian countries and the US. Scandinavian dentists were found to be more conservative and delay the interventions until later stages of disease compared to their US peers. Wang et al. (2012) - Comparing the treatment provided by UK and non-UK trained health professionals: dentists in Scotland. The study found that the, initially, the UK trained dentists had different decisions than the non-UK trained dentists. However, the differences tend to converge as dentists practice longer. 	
The year of graduation	Provider characteristic	Exposure	Gordan et al. (2012) - Repair or replacement of defective restorations by dentists in The Dental PBRN. The treatment	The year of graduation and the number of years in practice changes dentists' perspectives and will have a significant impact on
Years of practice	Provider characteristic	Exposure	pattern differed significantly according to the time since graduation. Dentists with less time since graduation from dental school tended to replace restorations rather than repairing them.	their treatment decisions.
			Traebert et al. (2005) - Brazilian Dentists' Restorative Treatment	

	 Decisions. The study found that those who had graduated less than 10 years ago (less experienced) were less interventionist when compared to their, more experienced peers (graduated more than 10 years). Zadik and Levin (2007) - Clinical Decision Making in Restorative Dentistry, Endodontics, and Antibiotic Prescription. The study suggested that general practitioners with less than 10 years of experience after graduation were more likely to overmedicate (antibiotics) and over treat (caries). Walker et al. (2015) - Are clinical decisions in endodontics influenced by the patient's feepaying status? The study suggested that experienced dentists in the UK (20 years postgraduation) were not influenced by patient's insurance plan. The authors suggested that experienced 	
	dentists in the UK (20 years post- graduation) were not influenced by patient's insurance plan. The authors suggested that experienced dentists may be practicing in entirely an ethical way and not driven by a financial gain.	

Years of practice in Canada	Provider characteristic	Exposure	Wang et al. (2012) - Comparing the treatment provided by UK and non-UK trained health professionals: dentists in Scotland. The results revealed that, initially, internationally trained dentists had different treatment decisions. However, this difference tended to diminish over approximately two years of practice in the UK.	It takes some time for the foreign trained health professionals to become familiar with the health needs of indigenous patients and their preferred practice methods.
Number of hours of work	Provider characteristic	Exposure/Outcome	Nicholson et al. (2015) - The effect of education debt on dentists' career decisions. This study concluded that recent dental graduates (dentists who graduated 7 years ago or less) were more likely to work more hours.	We hypothesize that dentists who feel the financial pressure may tend to work longer hours compared to their peers.
Amount needed to bill to become profitable	Provider characteristic	Outcome		We hypothesize that the higher amount needed to become profitable, the more aggressive and financially oriented the dentists will be.
Insurance coverage	Patient characteristic	Exposure	Meyers et al. (2006) - Primary care physicians' perceptions of the effect of insurance status on clinical decision making. The insurance status of patients accounted for alterations in clinicians' decisions in the vast majority of the sample population.	Despite the small sample size of the study, it is crucial to explore this variable on a wider scale. It is anticipated to have a role in the treatment decisions of dentists

			The quality of care, however, was not assessed as part of the study. Grembowski et al. (1997) - Factors Influencing the Appropriateness of Restorative Dental Treatment: An Epidemiologic Perspective. The study did not find an association between type of insurance coverage of patients and the treatment rendered.	
Number of dentists	Practice characteristic	Exposure	Grembowski et al. (1997) - Does fluoridation reduce the use of dental services among adults? The study found that solo dentists were more likely to overtreat than those in group practices. Grembowksi et al. (1991) - Factors Influencing the Appropriateness of Restorative Dental Treatment: An Epidemiologic Perspective. The study found that practice size explained variation in treatment decisions.	We hypothesize that group practice dentists may feel less financial pressure compared to their solo counterparts. As a consequence, this might affect their clinical decisions.
Employment status (Type of practice)	Practice characteristic	Exposure	Landon et al. (2001) - Personal, Organizational, and Market Level Influences on Physicians'	Anecdotally, dentists who are owners (compared to associates) will more likely take the financial

			Practice Patterns. Results from this study suggest that physicians in solo practices were more likely to refer and request a test in order to pursue treatment in comparison to other practice settings.	aspects of the clinic into consideration when making treatment decisions.
			Gordan et al. (2012) - Repair or replacement of defective restorations by dentists in The Dental PBRN. The study suggested that dentists from large group practices were more likely to repair than to replace defective restorations than dentists in solo practices.	
			Grembowski et al. (1997) – Factors Influencing the Appropriateness of Restorative Dental Treatment: An Epidemiologic Perspective. The authors suggested that potentials of overtreatment (restoring a non- decayed tooth with no previous filling) may be common in solo practices.	
Age of the practice	Practice characteristic	Exposure	Grembowski (1990) - Factors Influencing Variation in Dentist Service Rates. The study found that fewer services per patient were provided as the age of the	Well-established practices may tend to be less financially driven and therefore will adopt preventive approaches.

			 practice increased, controlling for other factors. Grembowski et al. (1991) - Factors Influencing the Appropriateness of Restorative Dental Treatment: An Epidemiologic Perspective. The study results found that practice age explained variations in treatment decisions. 	
Perception of practice loans	Provider characteristic	Exposure	"See the study loan section below."	The financial situation of the dentist and clinical decision making had shown to be associated in the literature. This association may be stronger in a fee-for- service model.
Number of hygienists	Practice characteristic	Exposure	Grembowski (1990) - Factors Influencing Variation in Dentist	The presence of more hygienists in a practice may indicate it's
Total hours the hygienists work	Practice characteristic	Exposure	Service Rates. The study states that larger practices characterized by having a higher number of dental hygienists rendered more preventive and periodontic treatments than the smaller practices employing fewer hygienists.	orientation towards preventive measures.
Study loans	Provider characteristic	Exposure	Nicholson et al. (2015) - The effect of education debt on	We hypothesize that students graduating with substantial school

Perception of	Provider	Exposure	dentists' career decisions. It was	loans might tend to be more
study loans	characteristic		found that higher initial	financially driven when practicing.
			educational debt was not	As a consequence, we hypothesize
			associated with the choice of	that they might develop an
			employment setting (entering	aggressive approach when treating
			private practice, accepting high-	patients.
			paying jobs on graduation, and	
			working longer hours), practice	
			ownership, and whether to provide	
			Medicaid and charity care.	
			Chambers et al. (2002) - Debt	
			and Practice Profiles of	
			Beginning Dental Practitioners.	
			The study found that for beginning	
			practitioners, there was no	
			association between educational	
			debt and propensity to engage in	
			unconventional procedures	
			(procedures that other respondents	
			did not routinely perform). In fact,	
			larger debt discouraged or delayed	
			practice ownership.	
			Walton et al. (2014) - The	
			Burden of Debt for Canadian	
			Dental Students: Part 4. The	
			Influence of Debt on Program	
			and Career Decisions. This study	
			concluded that debt influenced the	
			choices of recent dental graduates	
			as well as students contemplating	
			to start their dental career.	

Number of patients seen/ day	Provider characteristic	Exposure/Outcome		Anecdotally, practicing dentists who are owners have increased motivation to see more patients. Dentists who have full schedules may make different clinical decisions than those who do not have full schedules
Gross billing/day	Provider characteristic	Outcome		Comparing the "gross billing/day" with the "Amount needed to bill to become profitable" can give us a rough estimate on the financial status of the practice.
Perception of the level of busyness	Provider characteristic	Outcome	Kakudate et al. (2012) - Restorative Treatment Thresholds for Proximal Caries in Dental PBRN. The decision to restore caries lesions had many variables that demonstrated significance. However, according to this study, the busyness of the dental office did not show a significant difference in the variation of clinical decision making of dentists. Grembowski et al. (1997) - Factors Influencing the Appropriateness of Restorative Dental Treatment: An Epidemiologic Perspective. The results suggested that practice busyness may be inversely related to overtreatment because dentists	As a result of the competitive nature of the dental practices in the Canadian market nowadays, the perception of busyness will have an effect on dentists' clinical decisions.

		1		1
			with too few patients may provide	
			services more intensively,	
			controlling for other factors.	
			C C	
			Grembowski et al. (1997) - Does	
			Fluoridation Reduce the Use of	
			Dental Services Among Adults?	
			This study found that dentists were	
			more likely to undertreat if they	
			had a busy practice. The	
			relationship between perception of	
			busyness and decision making by	
			dentists is prominent.	
			Gordan et al. (2009) -	
			Restorative Treatment	
			Thresholds for Interprovimal	
			Primary Caries Based on	
			Radiographic Images: Findings	
			from The Dental PRRN The	
			authors found that dentists who	
			belong to busier practices and	
			practices with higher percentages	
			of time arout doing asthetic	
			of time spent doing esthetic	
			procedures recommended	
			restorative treatment more often	
			on enamel surfaces. Dentists in	
			practices that are "not busy	
			enough" also intervened	
			significantly more often in the	
			treatment of enamel surfaces.	
Procedure time	Provider	Outcome		Although not being studied in the
breakdown/week	characteristic			literature, we hypothesize that

				financially driven dentists may tend to devote the majority of their time towards elective and cosmetic treatments.
Clinical technologies used	Provider characteristic	Outcome	Grembowski (1990) - Factors Influencing Variation in Dentist Service Rates. This article hypothesized that lower number of services were provided to patients in older practices or treated by older dentists who were not well oriented with the new technologies in the market. The awareness of dental technologies by dental professionals may be correlated to the number of services offered to the patients and therefore can be an indirect factor affecting the clinical decision making.	Dentists who choose to invest in the most recent, expensive technologies may feel pressured to utilize them regardless the actual need.
Referrals	Provider characteristic	Outcome	Iverson and Ma (2011) - Market conditions and general practitioners' referrals. The study found that the rates of referrals were positively associated with competition. It was suggested that in a competitive field, general practitioners tend to satisfies patients' requests for referrals.Zitzmann et al. (2011) - Does a Clinician's Sex Influence	We hypothesize that financially oriented dentists will tend to refer out less patients.

			Treatment Decisions? The study	
			found that female practitioners	
			tended to refer more patients out	
			while male care providers would	
			perform the care themselves.	
Continuing	Provider	Outcome	Suga et al. (2014) - Factors That	Newer procedures and techniques
education courses	characteristic		Drive Dentists towards or Away	taught through continuing
attended			from Dental Caries Preventive	education courses tend to be less
			Measures: Systematic Review	invasive and more preventive in
			and Metasummary, Authors	nature. Exploring this factor may
			suggested that education and	identify the dentist's treatment
			training have a direct effect on the	orientation.
			dentist's provision and motivation	
			towards preventive services. It was	
			also stated that low or no	
			remuneration for preventive	
			services may reduce dentist's	
			willingness to provide them.	
			Grembowski et al. (1997) - Does	
			Fluoridation Reduce the Use of	
			Dental Services Among Adults?	
			The study results found that	
			dentists who had less continuing	
			education were more likely to over	
			treat their patients.	
			Traebert et al. (2005) - Brazilian	
			Dentists' Restorative Treatment	
			Decisions, Traebert et al. (2007)	
			- Thresholds of Restorative	
			Decision in Dental Caries,	
			treatment among Dentists from	

			 Small Brazilian Cities. The studies found that dentists who attended postgraduate courses were less interventionist (less likely to restore caries in enamel, at the DEJ, or at outer dentine). Lang- Hau et al. (2014) - Factors influencing treatment decision making for maintaining or extracting compromised teeth. Variations in treatment decision-making with respect to retaining periodontally compromised teeth exist between dental practitioners with and those without postgraduate training in implant dentistry. 	
Perception of competition	Provider characteristic	Exposure	Yuen and Quiñonez (2015) - Competition and Financially Related Misconduct in Dental Practice: A Retrospective Descriptive Study. The study found a positive correlation between competition and financially related misconduct. The finding may suggest that dentists who perceive high competition from neighbor peers may become financially driven in making their clinical decisions.	It is important to gauge dentist's perception of competition to testify the competition status assigned to dentists as per our spatial analysis.

			Tuominen and Palmujoki (2000) - Perceived competition in private dental practice in Finland. Despite being a descriptive study, the authors identified the perception of competition as an important manifestation of private dental market in Finland	
Primary income earner	Provider characteristic	Exposure		Though studies have not explicitly used income as an independent
How many dependents	Provider characteristic	Exposure		variable, it can be inferred that when someone is the primary
Income	Provider characteristic			income earner in the household and is constantly struggling to make ends meet, these circumstances may influence their daily clinical treatment decisions.

Appendix 2: The survey instrument

This survey will consist of a mixture of questions about yourself, your dental office(s), and your practice of clinical dentistry via case scenarios.

First, some questions about yourself.

1. You are?



2. What is your age?



3. Where did you receive your initial dental training?



- 4. What year did you graduate from your initial dental training?
- 5. Considering all jurisdictions, how many years have you been in practice?



6. If you are American or internationally trained, how many years have you been practicing in Canada?



Now some case scenarios.

Please read the following case scenarios and select the answer that is <u>closest</u> to what you would do for each patient.

7. A 20-year-old male patient presents to your clinic for a regular check-up. Today's radiographs and clinical examination show he has impacted 18 and 28 and fully erupted 38 and 48. He mentions he has had slight discomfort on 38 in the past. How would you proceed?

Advise on the importance of extracting third molars because they will be harder to extract as he gets older.
Take a "wait-and-see" approach.
Extract 38, and refer him to an oral surgeon to extract 18, 28.
Extract 38, 48 and monitor 18, 28.

8. The images below refer to a 25-year-old female patient with a history of depression and poor oral hygiene. She presents to your clinic complaining of dry mouth. At what caries lesion depth do you think it would be best to do a permanent restoration instead of trying a preventive therapy? Please circle one answer.



9. A 27-year-old male patient presents to your clinic. He has not gone to a dentist in five years and requests an exam and completion of any necessary treatment. You find he has good oral hygiene, a slight catch on the occlusal amalgam of 37, a sticky pit on the occlusal of 36 and dark stains along the margins of an amalgam on 35. How would you proceed?



Restore 36, 37, monitor 35.

Restore 37, 36, 35.

Restore 36, monitor 35, 37.

10. A 35-year-old female patient presents to your clinic. She is new to your practice, having recently moved to the city. She has a non-contributory medical history and fair oral hygiene. She tells you that at her last dentist visit two years ago, the dentist performed a complete examination and radiographs. She asks you how often she should have a complete examination and radiographs? What is your response?

I perform complete examinations every year and radiographs whenever indicated.

I perform complete examinations every year and radiographs every two years.

I will do a complete examination for your initial visit and will only take radiographs if needed.

I will need to do a complete examination and radiographs every year.

Now some questions about your clinical practice:

11. On average, how many hours a week do you currently work in clinical practice?



12. On a per chair basis, how much do you feel you have to bill **per hour** to be profitable?

Less than \$100	\$600 - 700
\$100 - 200	\$700 - 800
\$200 - 300	\$800 - 900
\$300 - 400	\$900 - 1000
\$400 - 500	Greater than \$1000
\$500 - 600	

13. What percentage of your patients are covered by: (Percentages should add up to 100%.)

Private insurance	%
Public insurance	%
Out-of-pocket	%
Total	100%

14. Considering your primary practice, how many dentists are in the practice, including yourself?



15. Which describes your current employment status? (Please check <u>all</u> that apply.)



If you picked <u>Sole owner</u> or <u>Partner</u> in question 15, please answer the following questions.

If not, please go to question 22.

- 16. How many practices do you own/partner in?
- 17. What percentage of time do you spend in each of your practices? (Percentages should add up to 100%.)

Primary practice you are an owner/partner	%
Secondary practice you are an owner/partner	%
Tertiary practice you are an owner/partner	%
Remaining practices you are an owner/partner	%
Practices you are an associate	%
Total	100%

18. Considering your current situation, do you feel your practice loans are:

Small
Medium
Large
I do not

I do not have outstanding loans

Please answer the following questions for your **primary practice**.

19. How old is your practice?



20. How many hygienists do you employ?



21. How many **total hours a week** does the hygienist work? (**If you have more than one hygienist, please total their hours.**)

Less than 20 hours
20-35 hours
35-50 hours
More than 50 hours

Now more case scenarios. Please select one answer for each scenario.

22. A 25-year-old female reporter on a local TV channel presents to your clinic for her regular check-up. She has a non-contributory medical history and good oral hygiene. She has discoloured 11 and 21 facial composite restorations and extrinsic stains on her maxillary anterior teeth. She states, "I hate those stains, they make me look ugly." How would you proceed?

Recommend in-office whitening and then replace the old composites with new fillings.

Recommend full-coverage porcelain crowns on the anterior teeth.

Recommend porcelain veneers on the maxillary anteriors.



23. A 10-year-old patient presents to your clinic for a check-up. He has no medical conditions and good oral hygiene. The exam reveals sticky pits on 54 O, 64 O, 36 O and 46 O. What treatment would you recommend?

Place sealants on 54, 64, 36, 46.
Monitor 54, 64, and place sealants on 36, 46.
Place restorations on 54, 64, 36, 46.
Place sealants on 54, 64, and restorations on 36, 46.

24. A 48-year-old male present to your clinic. He hasn't been to a dentist in six years, and his chief complaint is having sensitivity when biting on 36. He has a non-contributory medical history and good oral hygiene. You find that teeth 15, 26 and 36 are chipped. In 15 and 26, this involves only the enamel, and on 36, this involves the dentine. The patient mentions he may have a clenching habit. What do you do next?

Restore 15, 26, 36, and fabricate a night guard.

Restore 15, 26, place a crown on 36, and fabricate a night guard.

Monitor 15, 26, restore 36, and fabricate a night guard.

Place crowns on 15, 26, 36 and fabricate a night guard.

Now some questions about your student loans:

25. Did you have any student loans?



If you answered No, please go to question 28.

26. How long did it take to pay off your student loans?



27. Do you feel your student loans are/were:

Small
Medium
Large

Please read the following case scenarios and select one answer for each.

28. A 50-year-old male patient comes to your clinic for a check-up. The patient has a noncontributory medical history. His radiographs reveal a periapical radiolucency on the 46, which is an abutment for a 3-unit bridge from 44 to 46. The patient reports no pain and never having a problem concerning this site. How would you proceed?

Remove the bridge, perform endodontic treatment on 46, and place a new bridge.

Monitor the periapical lesion and advise the patient to come back for recalls.

Remove the bridge, perform endodontic treatment on 46, place crowns on 46, 44, and a 45 implant.

Perform endodontic treatment on 46 through the crown.

29. A 65-year-old female patient has 2mm of gingival recession on teeth 34 and 35, with moderate abrasion on teeth 24 and 25. She also has stained and sticky surfaces on the exposed buccal roots of 34 and 35. She takes medications that contribute to mild xerostomia. She demonstrates good manual dexterity and good oral hygiene. What would you recommend for this patient?

Place her on a 3-month recall and apply fluoride varnish at every visit.

	Restore 34, 35, place her on a 3-month recall and apply fluoride varnish at every visit.
	Restore 24, 25, 34, 35, place her on a 3-month recall and apply fluoride varnish at every visit.
	Restore 34, 35, place her on a 6-month recall and refer her to a periodontist for gingival grafts on the exposed root surfaces.

30. An 8-year-old female patient presents to your clinic. Upon clinical examination, you find she has a normal tooth eruption pattern, excellent oral hygiene and no caries. What is your recommended treatment plan and recall frequency for this patient?

	Do a complete exam, prophy, give fluoride, and advise a 9-month recall.
	Do a complete exam, take radiographs, perform scaling, give fluoride, and advise a 9-month recall.
	Do a complete exam, take radiographs, perform scaling, prophy, give fluoride, and advise a 6-month recall.
	Do a complete exam, perform scaling, give fluoride, and advise a 6-month recall.

Now some questions about your clinical work.

31. Not including hygiene checks, how many patients do you see on an average day?



32. On an average day, what would you estimate your personal gross billings to be?

Less than \$1000	\$5500 - 6000
\$1000 - 1500	\$6000 - 6500
\$1500 - 2000	\$6500 - 7000
\$2000 - 2500	\$7000 - 7500
\$2500 - 3000	\$7500 - 8000
\$3000 - 3500	\$8000 - 8500

\$3500 - 4000
\$4000 - 4500
\$4500 - 5000
\$5000 - 5500

	\$8500 - 9000
	\$9000 - 9500
	\$9500 - 10,000
	More than \$10,000

33. Are you satisfied with the level of busyness in your practice?

Very satisfied
Somewhat satisfied
Not sure
Somewhat dissatisfied
Very dissatisfied

34. During a typical work week, what percentage of **your** time is devoted to each of the following procedures? (**Percentages should add up to 100%.**)

Diagnostic and preventive (exam, x-rays, scaling, prophylaxis, sealants,	%
fluoride, etc.)	
Restorative (fillings)	%
Crowns (tooth-supported and implant-supported)	%
Extractions	%
Implant surgery	%
Orthodontics (including Invisalign)	%
Cosmetic Dentistry	%
Full-mouth reconstruction	%
Other:	%
Total	100%

35. What type of clinical technologies do you use in your practice? (Please check all that apply.)

Cone Beam Computed Tomography (CBCT)
Panoramic radiographs
Cephalometric radiographs
Fluorescence visualization devices (e.g. Velscope)
Cerec machine (CAD/CAM)
Laser periodontal debridement devices (e.g. Periowave)
Caries detection devices (e.g. VistaProof, Canary)

Other:

36. How often do you refer patients to other practitioners for the categories listed below? (Check one response for each item.)

	Never	Occasionally	Often	Always
Periodontics				
Complex periodontics				
Prosthodontics - fixed				
Prosthodontics - removable				
Endodontics				
Complex endodontics				
Extractions				
Complex extractions				
Orthodontics				
Medically compromised				
Behaviour management				

37. For the past two years, **please check the** <u>three subject areas</u> where you took the most continuing education:



Treatment planning	Anaesthesia
Paediatric dentistry	Fixed prosthodontics
Malpractice	Oral surgery
TMD	Other:
Implants	

38. Dentists have various roles, such as being a health care professional and a business person. In terms of the relative balance between the two roles, please place an 'X' on the line below to describe where you perceive yourself to be.



39. Do you perceive other dentists as colleagues or competitors? Please place an 'X' on the line below to describe your relationship.



- 40. How would you rate the amount of pressure you feel from competition from other dental practices?
 - Small amount
 Medium amount
 Large amount
 I do not feel pressure from other dental practices.

Now we would like to hear your perspective on some issues regarding the profession and the dentist-patient relationship:

41. To which patient populations do you think you have a duty to care? Please state your level of agreement for each of the following groups.

Group	Strongly	Disagree	Not Sure	Agree	Strongly
	Disagree				Agree

Population at large			
All patients in my practice			
Low-income children			
Low-income adults			
Low-income seniors			
Adults on social assistance			

42. Please make one selection for each statement.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
It is important to understand a	Disagice		Bure		Agree
patient's culture and background in					
order to treat a patient's illness.					
Patients should be treated as if they					
were partners with the dentist, equal					
in power and status.					
That I provide an equally good					
standard of care whether working on					
publicly or privately insured patients					
is important to me.					
Reducing inequalities in oral health					
across the population is important to					
me.					
Dentists should lobby for dental					
benefits for the disadvantaged.					

Now some statements about your dental practice.

43. Please make one selection for each statement.

	Strongly	Disagree	Not	Agree	Strongly
	Disagree		Sure		Agree
Identifying new business opportunities					
for the practice is important to me.					
Positioning the practice in the					
marketplace is important to me.					
Having remuneration in line with my					
years of training/skills is important to					
me.					
Thinking about the financial					
implications for the practice when I					

advise patients of treatment options is			
important to me.			

Finally, some questions about you and your family:

44. Are you the primary income earner in your household?



Me and my partner contribute equally

Prefer not to say

45. How many dependents do you have (people you support financially)?



46. Approximately, what is your **personal** after tax income?

Less than \$100,000/year
\$100,000 - 150,000/year
\$150,000 - 200,000/year
\$200,000 - 250,000/year
\$250,000 - 300,000/year
\$300,000 - 350,000/year
\$350,000 - 400,000/year
\$400,000 - 450,000/year



If you have any other comments you would like to add, please use the space below.



Appendix 3: The Data Dictionary

Legend	VARIABLE = Used for statistical analysis			
	VARIABLE = Scale variable			
Excel variable name	Excel Coding	SPSS Recategorization: Variable	Rationale for	
(description)		name and labels	categorization	
URBAN_RURAL	1= Urban	-	-	
(Location of practice)	2= Rural			
Q1_GENDER	1= Male	-	-	
(Gender)	2= Female			
Q2_AGE	1 = Less than 31	AGE	Not enough	
(Age)	2=31 to 40	1 '40 and younger'	respondents for the	
	3 = 41 to 50	2 '41 to 50 years'	categories	
	4= 51 to 60	3 '51 to 60 years'		
	5=61 and older	4 '61 and older'.		
Q3_WHERE_TRAINING	1= Canadian Dental School	-	-	
(Place of initial dental training)	2= American Dental School			
	3= International Dental			
	School			
YEARS_PRACTICE	-	YEAR_GRAD_CAT		
(Years of practice)		1 'Before 1970'		
		2 '1970 - 1979'		
		3 '1980 - 1989'		
		4 '1990 - 1999'		
		5 '2000 - 2009'		
		6 '2010 - 2016'.		
		YEAR_GRAD_CAT2	Not enough	
		1 'Before 1980'	respondents for the	
		2 '1980 - 1989'	categories	
		3 '1990 - 1999'	_	

		4 '2000 - 2009'	
		5 '2010 - 2016'.	
		YEAR_GRAD_CAT3	
		1 'Before 1986'	
		2 '1986 - 1995'	
		3 '1996 - 2005'	
		4 '2006 - 2016'.	
Q5_PRAC_ALL	1 = 0.5 years	PRAC_ALL	Not enough
(Years of practice categorized)	2 = 6 - 10 years	1 '0-10 years'	respondents for the
	3= More than 10 years	2 'More than 10 years'.	categories
Q6_PRAC_CANADA	1=0-5 years	PRAC_CANADA	Not enough
(Years of practice in Canada)	2 = 6 - 10 years	1 '0-10 years'	respondents for the
	3= More than 10 years	2 'More than 10 years'.	categories
Q7	1= Most conservative	1= Conservative	Categorized to
Q8	2= Conservative	2= Aggressive	facilitate data
Q9	3= Aggressive		analysis
Q10	4= Most aggressive		
Q11_NUM_HOUR	1= Less than 20 hours	Q11_NUM_HOUR2	-
(Number of hours worked per	2= 20-35 hours	1 'Less than 35 hours'	
week)	3= 35-50 hours	2 '35 or more hours'.	
	4= More than 50 hours		
Q12_BILL_HOUR	1 = Less than \$100	BILL_HOUR	
(Amount to bill per hour to be	2=\$100-200	1 'Less than \$100'	
profitable)	3=\$200-300	2 '\$100 - 200'	-
	4=\$300-400	3 '\$200 - 300'	
	5=\$400-500	4 '\$300 - 400'	
	6=\$500-600	5 '\$400 - 500'	
	7=\$600-700	6 '\$500 - 600'	
	8=\$700-800	7 '\$600 or more'.	
	9=\$800-900		
	10=\$900-1000	BILL_HOUR2	
	11= More than \$1000	1 'Less than \$200'	
	2 '\$200 - 300'	Not enough	
----------------------------------	-------------------------	-----------------------	
	3 '\$300 - 400'	respondents for the	
	4 '\$400 - 5 00'	categories	
	5 '\$500 or moro'	categories	
	5 \$500 01 more .		
	BILL_HOURS		
	1 Less than \$300		
	2 '\$300 or more'.		
Q13_PRIV -	PRIV_CAT		
(Percentage of private insurance	1 '0-10%'		
patients)	2 '11-20%'	-	
	3 '21-30%'		
	4 '31-40%'		
	5 '41-50%'		
	6 '51-60% '		
	7 '61-70%'		
	8 '71-80%'		
	9 '81-90%'		
	10 '91-100%'.		
	PRIV CAT2		
	1 '0-19%'		
	2 '20-39%'		
	3 '40-59%'		
	4 '60-79%'		
	5 '80 100%'		
	5 80-100%.		
	PRIV CAT3	Skewed distribution:	
	1 0 - 69%'	cut-off at the median	
	2'70 - 100%'	point	
O13 PUB	PUB CAT	Skewed distribution:	
(Percentage of public insurance	1 0 - 9%'	cut-off at the median	
natients)	2'10 - 100%'	point	
	2 IU IUU/U.	Point	

Q13_OOP		OOP_CAT	Skewed distribution;
(Percentage of out-of-pocket		1 '0 – 19%'	cut-off at the median
patients)		2 '20 – 100%'.	point
Q14_DENT_NUMB	1=1 dentist	-	-
(Number of dentists in primary	2=2-4 dentists		
practice)	3=5 or more dentists		
Q15_SOLE	0 = Not sole owner	-	-
(Sole owner or not)	1 = Sole owner		
Q15_PART	0= Not partner	-	-
(Partner or not)	1= Partner		
Q15_ASSOC	0= Not Associate	-	-
(Associate or not)	1= Associate		
Q15_OWNERSHIP	0= Associate	-	-
(Owner/Partner or not)	1= Owner or Partner		
Q16_NUM_PRACS	Scale	NUM_PRACS	Not enough
(Number of practices dentist is		1 '1 practice'	respondents for the
owner or partner)		2 '2 or more'.	categories
Q18_PRAC_LOAN	1= Small	Q18_PRAC_LOAN_RECAT	-
(Perception of practice loan)	2= Medium	1 'No outstanding loans'	
	3= Large	2 'Small'	
	4= I don't have outstanding	3 'Medium'	
	loans	4 'Large'.	
		Q18_PRAC_LOAN_RECAT2	
		1 'No outstanding loans/Small'	
		2 'Medium/Large'.	
Q19_PRAC_AGE	1=0-5 years	PRAC_AGE	Not enough
(Practice age)	2 = 6 - 10 years	1 '0-10 years'	respondents for the
	3= More than 10 years	2 'More than 10 years'.	categories
Q20_NUM_HYG	1=0 hygienists	Q20_NUM_HYG2	-
(Number of hygienists)	2=1 hygienist	1 '0 - 1'	
	3=2 hygienists	2 '2 or more'.	
	4=3 hygienists		

	5=4 hygienists		
	6=5 or more hygienists		
O21 HYG HOUR	1 = Less than 20 hours	O21 HYG HOUR2	
(Number of hygienist hours per	2 = 20-35 hours	1 'Less than 35 hours'	
week)	3 = 35-50 hours	2 '35 or more hours'	
	4 = More than 50 hours		
022	1= Most conservative	1= Conservative	Categorized to
023	2= Conservative	2= Aggressive	facilitate data
024	3= Aggressive		analysis
	4= Most aggressive		
Q25_STUD_LOAN	1=Yes		-
(Had a student loan)	2= No		
Q26_PAY_LOAN	1= Less than 1 year	PAY_LOAN_ADJ	-
(Time to pay off student loans)	2=1 to 5 years	1 'Less than 1 year'	
	3=5 to 10 years	2 '1-5 years'	
	4= More than 10 years	3 '5-10 years'	
	5 = My student loans are not	4 'More than 10 years'.	
	yet paid off		
		PAY_LOAN_ADJ2	
		1 'Less than 5 years'	
		2 '5 or more years'.	
		PAY LOAN DICHOT (Current	
		status of student loans)	
		1 'Student loan paid off'	
		2 'Student loan not off naid vet'	
O27 FEEL LOAN	1= Small	-	-
(Perception of student loan)	2 = Medium		
	3= Large		
Q28	1= Most conservative	1= Conservative	
Q29	2= Conservative	2= Aggressive	

Q30	3= Aggressive		Categorized to
	4= Most aggressive		facilitate data
			analysis
Q31_NUMB_PAT	1 = Less than 5	Q31_NUMB_PAT2	Anecdotal
(Number of patients per day)	2=5-7	1 '1 - 9 patients'	
	3=7-9	2 '9 or more patients'.	
	4=9-11		
	5=11-13		
	6= More than 13		
Q32_GROSS_BILL	1= Less than \$1000	GROSS_BILL	
(Personal gross billings per day)	2=\$1000-1500	1 'Less than \$1000'	
	3=\$1500-2000	2 '\$1000-1500'	
	4=\$2000-2500	3 '\$1500-2000'	
	5=\$2500-3000	4 '\$2000-2500'	
	6=\$3000-3500	5 '\$2500-3000'	
	7=\$3500-4000	6 '\$3000-3500'	
	8=\$4000-4500	7 '\$3500-4000'	
	9=\$4500-5000	8 '\$4000 or more'.	
	10=\$5000-5500		
	11=\$5500-6000	GROSS_BILL2	Not enough
	12=\$6000-6500	1 'Less than \$1500'	respondents for the
	13=\$6500-7000	2 '\$1500 - 2000'	categories
	14=\$7000-7500	3 '\$2000 - 2500'	
	15=\$7500-8000	4 '\$2500 - 3000'	
	16=\$8000-8500	5 '\$3000 - 3500'	
	17=\$8500-9000	6 '\$3500 or more'.	
	18=\$9000-9500		
	19=\$9500-10,000	GROSS_BILL3	
	20= More than \$10,000	1 'Less than \$2000'	
		2 '\$2000 or more'.	
Q33_BUSY	1= Very satisfied	Q33_BUSY_RECAT	-
(Satisfaction with practice	2= Somewhat satisfied	1 'Very Satisfied/Somewhat satisfied'	
busyness)		-	

	3= Not sure (considered a	2 'Very dissatisfied/Somewhat	
	missing value)	dissatisfied'.	
	4= Somewhat dissatisfied		
	5= Very dissatisfied		
Q34_PREV_PERCENT	-	PREV_PERCENT_DICHOT	Skewed distribution;
(Percentage of diagnostic and		1 '0 - 15%'	cut-off at the median
preventive procedures per week)		2 '16-100%'.	point
Q34_TREAT_PERCENT		TREAT_PERCENT_DICHOT	Skewed distribution;
(Percentage of treatment		1 '0 - 59%'	cut-off at the median
procedures per week)		2 '60 - 100%'.	point
Q34_ELECT_PERCENT		ELECT_PERCENT_DICHOT	Skewed distribution;
(Percentage of elective procedures		1 '0 - 19%'	cut-off at the median
per week)		2 '20 - 100%'.	point
Q35_SUM_TECHNOLOGY		SUM_TECHNOLOGY	Not enough
(Number of technologies used)		0 'No technologies in the list'	respondents for the
		1 '1 '	categories
		2 '2'	
		3 '3'	
		4 '4 or more'.	
		SUM TECHNOLOGY2	
		1 '0 - 1'	
		2 '2 or more'.	
		Q35 SCALE – Scale variable	
		calculated from aggressiveness of	
		technologies	
		Q35_SCALE_DICHOT	Skewed distribution;
		1 '0 - 1'	cut-off at the median
		2 '2 or more'.	point
Q36_procedure	1=Never	Q36_SCALE – Scale variable	
(Referral of <i>procedure</i>)	2= Occasionally	calculated from all the procedures	

	3= Often 4= Always	Q36_SCALE_DICHOT 1 'Conservative (11-16)' 2 'Aggressive (17-22)'.	Not enough respondents for the categories
Q36_ <i>procedure</i> _DICHOT (Referral of <i>procedure</i> recategorized)	1= Never/Occasionally 2= Often/Always	_	-
Q38_ROLE (Dentist role scale)	-	DENTIST_ROLE 1 'Health care professional' 2 'Business person'.	Skewed distribution; categorized to facilitate data analysis
		DENTIST_ROLE_QUARTILES 1 'Strongly Health care professional' 2 'Health care professional' 3 'Business person' 4 'Strongly business person'	
Q39_PERCEIVE (Perception of other dentists scale)		DENTIST_PERCEIVE 1 'Colleague' 2 'Competitor'.	Skewed distribution; categorized to facilitate data analysis
		DENTIST_PERCEIVE_QUARTILES 1 'Strongly Colleague ' 2 'Colleague ' 3 'Competitor' 4 'Strongly Competitor'.	
Q40_PRESSURE (Perceived pressure from other dental practices)	1= Small amount 2= Medium amount 3= Large amount 4= I do not feel pressure from other dental practices	Q40_PRESSURE_RECAT 1 'Do not feel pressure' 2 'Small' 3 'Medium' 4 'Large'.	
		Q40_PRESSURE_RECAT2	

		1 'Do not feel pressure/small amount	Categorized to
		of pressure'	facilitate data
		2 'Medium/Large amount of pressure'.	analysis
Q41	1= Strongly disagree	1 'Strongly disagree/Disagree/Missing'	Categorized to
	2= Disagree	2 'Agree'	facilitate data
	3= Not sure (considered a	3 'Strongly agree'.	analysis
Q42	missing value)	1 'Strongly disagree/Disagree'	
Q43	4= Agree	2 'Strongly agree/Agree'.	
	5= Strongly agree		
Q44_PRIM_INC	1=Yes	Q44_PRIM_INC_RECAT	-
(Primary income-earner in	2= No	1 'No'	
household)	3= Me and my partner	2 'My partner and I contribute equally'	
	contribute equally	3 'Yes'.	
	88= Prefer not to say		
Q45_NUM_DEP	1=0	Q45_NUM_DEP2	-
(Number of dependents)	2=1	1 '0'	
_	3=2-4	2 '1'	
	4=5 or more	3 '2 or more'.	
Q46_PERS_INC	1= Less than \$100,000/year	PERS_INC	Not enough
(Annual personal after-tax income)	2= \$100,000-150,000/year	1 'Less than \$100,000'	respondents for the
	3= \$150,000-200,000/year	2 '\$100,000-150,000'	categories
	4= \$200,000-250,000/year	3 '\$150,000-200,000'	
	5= \$250,000-300,000/year	4 '\$200,000-250,000'	
	6= \$300,000-350,000/year	5 '\$250,000 or more'.	
	7= \$350,000-400,000/year		
	8=\$400,000-450,000/year		
	9= \$450,000-500,000/year		
	10= \$500,000-550,000/year		
	11= \$550,000-600,000/year		
	12= \$600,000-650,000/year		
	13=\$650,000-700,000/year		
	14=\$700,000-750,000/year		
	15= More than \$750,000/year		

	88= Prefer not to say		
ADJUSTED_SUM_7_OF_10	-	1 'Conservative (0-14)'	Categorized to
(Treatment scale for those who		2 'Aggressive (15-28)'.	facilitate data
completed at least 7 of 10 case			analysis; cut-off at
scenarios)			median (50 th
ADJUSTED_SUM_5_OF_7			percentile)
(Treatment scale for those who			
completed at least 5 of 7 case			
scenarios)			
MC_SCALE		0 'Small Moral Community (0-28)'	Categorized to
(Moral community scale)		1 'Large Moral Community (29-42)'.	facilitate data
MC_SCALE_ADJ		0 'Small Moral Community (0-28)'	analysis; cut-off at
(Moral community scale excluding		1 'Large Moral Community (29-41)'.	median (50 th
respondents who scored '42')			percentile)
Missing data (in Excel)	999 = Missing		
	66 = Not applicable		
	88 = Prefer not to say		

Appendix 4: Initial invitation, reminder, and final letters



Dear Doctor,

We are inviting you to participate in a study investigating the dynamics of the dental care market in Ontario. From practice ownership, busyness and clinical decision-making, to the number of hours worked, competition, and practice philosophy. The study is being conducted at the Faculty of Dentistry, University of Toronto. We expect that the information gathered will be helpful to policy makers and educators. There are no significant risks in participating, and your participation is completely voluntary.

This invitation is being sent to a random sample of general dentists in Ontario, and the questionnaire will take approximately 20 minutes to complete. Your answers will be confidential. Only members of the research team (see below) will have access to the data. The questionnaire has an identification number so that we may check your name off our mailing list when we receive your survey and to ensure confidentiality during data analysis. Completed surveys will be retained in a locked filing cabinet in a secure room at the Faculty of Dentistry for seven years as per record keeping protocol.

By completing the survey, you are automatically entered into a lottery to win <u>one free Category 1 Core</u> <u>continuing education course</u> from utooth.ca, the University of Toronto's online oral health teaching hub.

Again, your participation is strictly voluntary. There is no penalty if you choose not to participate or answer specific questions. You are welcome to contact us at the addresses below if you have questions about the study or the Research Oversight and Compliance Office - Human Research Ethics Program at 416-946-3273 or ethics.review@utoronto.ca.

Access to the results of this study will be available to the dental community via scholarly journals once it has undergone the peer-review process. Please be advised that the Human Research Ethics Program may access study-related data and/or consent materials for quality assurance, and to help ensure participant protection procedures are followed at all times. Also, please note that you can withdraw from the study, but given that your responses will ultimately be anonymized during data extraction and analysis, there will come a point when withdrawal will no longer be possible. If you do wish to withdraw from the study, please notify us as soon as possible by calling or emailing at the information below.

If you wish to participate in the study, please complete and return the questionnaire in the enclosed, postagepaid envelope. Your cooperation is greatly appreciated, and we thank you in advance for your time and help on this important project.

The Research Team:





Dr. Bonnie Yu bonnie.yu@mail.utoronto.c a



Dr. Carlos Quiñonez carlos.quinonez@utoronto.c a



Dear Doctor,

About a month ago, we wrote to you seeking your participation in a study of the dental care market. As of today, we have not received your questionnaire. If you have already mailed the questionnaire, please disregard this letter.

If you have not completed the questionnaire, please consider participating in our study. The information from this study may be helpful to policy makers and may lead to improvements in the education of dentists. By completing the survey, you are automatically entered into a lottery to win <u>one free Category</u> <u>1 Core continuing education course</u> from utooth.ca, the University of Toronto's online oral health teaching hub.

If you wish to participate in the study, please complete and return the questionnaire in the enclosed, postage-paid envelope. Thank you for your help!

If you have questions about the survey, please contact us:

The Research Team:





Dr. Abdulrahman Ghoneim abdulrahman.ghoneim@mail.utoronto.ca

Dr. Bonnie Yu bonnie.yu@mail.utoronto.ca

Dr. Carlos Quiñonez carlos.quinonez@utoronto.ca



Dear Doctor,

About two months ago, we wrote to you seeking your participation in a study of the dental care market. As of today, we have not received your questionnaire. If you have already mailed the questionnaire, please disregard this letter.

By completing the survey, you are automatically entered into a lottery to win one free Category 1 Core continuing education course from utooth.ca, the University of Toronto's online oral health teaching hub.

If you wish to participate in the study, please complete and return the questionnaire in the enclosed, postage-paid envelope. Thank you for your help!

If you have questions about the survey, please contact us:

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Dr. Bonnie Yu



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