

Oral Health Access and Inequities in Rural Regions

by

Maria Tovar

A thesis submitted to the Faculty of Graduate and Postdoctoral
Affairs in partial fulfillment of the requirements for the degree of

Master of Science

in

Health Sciences

Carleton University
Ottawa, Ontario

© 2022, Maria Tovar

Abstract

This thesis aims to systematically examine the patterns of, and factors associated with, dental utilization among rural Ontario residents by collating, integrating, and interpreting data from the Canadian Community Health Survey. A scoping review across three high-income countries was also undertaken to determine which interventions are most efficient in closing the gaps in dental utilization previously identified in the CCHS data analysis and to identify possible barriers and facilitators. This thesis provides evidence that oral health is influenced by geographical factors, socioeconomic status, and self-reported health behaviours. Equity in dental care was also influenced by structural factors like insurance and dental coverage. Overall, rural Ontario residents visit their dentists less frequently and have more problem-oriented dental visits. Additionally, the rural oral healthcare sector has experienced significant improvements in recent years through different oral health promotion and prevention programs, educational interventions, alternative delivery models and greater community and public health partnerships.

Acknowledgments

This project would not have been possible without the advice and support of many people. My first and foremost thank you goes out to all those who contributed to the success of this research.

My thesis supervisor, Dr. Paul Peters, deserves much credit for his supervision, guidance, and support on this project and for providing me with opportunities to grow as a researcher.

Special thanks to my MSc thesis advisory committee members for their support, Dr. Renate Ysseldyk and Dr. Sheryl-Ann Simpson, for sharing their knowledge and expertise on this research.

Also, thanks should go to Xuefeng Hu from the Statistics Canada Research Data Centre at Carleton University for his assistance.

Words cannot express my gratitude and love to my family, to husband and my life partner Hector who has never left my side and has supported me throughout the entire master's program, to my parents Malyory and Wilfredo, who have given me the strength to pursue all things in life and to my brother Wilfredo, whose words of encouragement and confidence rings in my ears in challenging times. Thanks to all for always being my support.

Finally, I would like to dedicate this thesis to my daughter Luna Sophia, who is still living in the womb; she has been my inspiration to complete this process. I am so thankful you were my study partner; we did this together. I adore you!

Table of Contents

<i>Abstract</i>	<i>ii</i>
<i>Acknowledgments</i>	<i>iii</i>
<i>Table of contents</i>	<i>iv</i>
<i>List of tables</i>	<i>vii</i>
<i>List of figures</i>	<i>viii</i>
<i>List of appendices</i>	<i>ix</i>
Chapter 1 - Introduction	11
1.1 Background	11
1.2 Statement of the problem	13
1.3 Central research questions and objectives	14
1.4 Thesis Outline	15
1.5 Key findings	16
Chapter 2 - Literature review	18
2.1 Concepts	18
2.1.1 Significance of disparities in Canada	18
2.1.2 Distinctions between health inequalities vs health inequity.....	19
2.1.3 The difference between utilization and access to dental care	19
2.1.4 Defining northern and rural Ontario	21
2.1.5 Oral health status and its significance.....	22
2.1.6 Determinants of oral health and access to dental care	23
2.2 The impacts of oral diseases	24
2.2.1 The link between chronic oral conditions with adverse systemic health	24
2.2.2 Oral Health and Quality of Life	26
2.2.3 Societal and health care systems outcomes.....	26
2.3 Canadian Oral Health Care System	27
2.3.1 Oral health disparities and access to care.....	27
2.3.2 Funding of dental health care in Canada.....	28
2.3.3 Dental care payments.....	28
2.3.4 Oral health status	29
2.3.5 International comparisons	29
Chapter 3 - Data Analysis 2018 annual component CCHS linked to 2016 index of remoteness	30
3.1 Abstract	30
3.2 Introduction	31
3.3 Methods and Materials	34
3.3.1 Data source: the Canadian Community Health Survey.....	34
3.3.2 Measures/variables.....	36
3.3 Descriptive statistics	41

3.4 Results	42
3.4.1 Survey sample characteristics	42
3.4.2 Ontario inequality in dental visits	45
3.4.3 Ontario inequality in dental visits by rurality degree.....	49
3.5 Discussion	52
3.5.1 Integrating rurality measures in oral health disparities research	52
3.5.2 Accounting for multiple gaps in access to dental services	52
3.5.3 Methodological caution in analyzing CCHS data	58
3.5.4 Incorporating spatial sampling methods in the implementation of evidence-based dental care interventions.	59
3.5.5 Conclusions.....	60
Chapter 4 - Disparities in Oral Health and Access to Dental Care in Rural Communities: Scoping review	62
4.1. Abstract	62
4.2 Introduction	64
4.3 Methods	68
4.3.1 Identifying the research question	68
4.3.2 Identifying relevant studies and eligibility criteria	69
4.3.3 Selecting studies and charting the data	70
4.3.4 Inclusion criteria	71
4.3.5 Critical appraisal of included studies	71
4.3.6 Charting the data.....	73
4.3.7 Collating, summarizing, and reporting the results	73
4.4 Results	74
4.4.1 Flow of studies.....	74
4.4.2 Characteristics of the included publications	75
4.4.3 Quality assessment results	78
4.4.4 Themes and categories identified in the reviewed literature	94
4.4.5 Levesque framework.....	107
4.4.6 Outcome variables	116
4.5 Discussion	117
4.5.1 Summary of evidence	118
4.5.2 Quality of Included studies	119
4.5.3 Strengths and limitations.....	119
Chapter 5 – Conclusion	121
5.1 Taking a closer look at the main findings: What are the contributions?	121
5.1.1 Inequities in oral health care and access to dental services.....	123
5.1.2 Rural dental policies and practices.....	124
5.2 Combined results of quantitative and qualitative data	128
5.2.1 Socioeconomic and cultural gaps.....	128
5.2.2. Disease outcomes.....	129
5.2.3 Health behaviours	130
5.3 Promising practices for Canada based on learned lessons from international dental interventions	131
5.3.1 Water fluoridation.....	131
5.3.2 Dental therapists	132
5.4 Policy implications	132
5.4.1 Shifts in dental care insurance policy in Canada.....	132

5.4.2 Surveillance of Oral Health Data	134
5.5 Future Direction of Research	135
5.6 Strengths and limitations	136
5.7 Conclusion	137
<i>Appendices.....</i>	<i>139</i>
6.1 Appendix A.....	139
6.2 Appendix B.....	140
6.3 Appendix C.....	141
7 References	143

List of Tables

Table 1: Comparison of oral health systems among Canada, Australia and New Zealand	29
Table 2 Variables included in the CCHS analysis	41
Table 3 Characteristics of the total sample and those with dental visits > 1 year, by quartile of remoteness, the Canadian Community Health Survey (CCHS), 2018. Weighted.....	42
Table 4 Results of the multivariate logistic regression analysis for dental visits > 1 year in Ontario, weighted, Canadian Community Health Survey (CCHS), 2018.	47
Table 5 Results of multivariate logistic regression analysis for dental visits > 1 year (irregular), stratified by quartile of remoteness, Ontario, weighted, Canadian Community Health Survey (CCHS), 2018.	50
Table 8 Summary of Research Classification.....	77
Table 9 Summary of Mixed methods appraisal tool – Qualitative studies	91
Table 10 Summary of Mixed methods appraisal tool – Randomized control trial.....	91
Table 12 Summary of Mixed methods appraisal tool – Non-randomized control trials ..	92
Table 13 Summary of Mixed methods appraisal tool – Quantitative studies.....	92
Table 14 Summary of Measurement tool to assess the methodological quality of systematic review.....	93
Table 15 Coding and themes.....	106
Table 16: Summary of use of Levesque framework and dimensions/abilities explored	114
Table 17 Summary of Levesque Classification	116

List of Figures

Figure 1 Conceptual diagram of the barriers and abilities required to achieve the benefits of primary dental care.	21
Figure 2 PRISMA Flow Diagram	75

List of Appendices

Appendix A: Government and compulsory insurance spending as proportion of total health spending by function of care. OECD Countries. 2019.....	139
Appendix B: Disability-adjusted Life-years Ranks for Oral Conditions in 1990 and 2010	140
Appendix C: Search strategies	141

Chapter 1 - Introduction

1.1 Background

As a concept, integral health refers to a state of physical, mental, and social well-being that is complete and balanced (1). Poor oral health can disturb this harmonic association by altering physical functioning due to its interconnection with heart and lung diseases, stroke, and diabetes (2–5). In addition, oral conditions can also adversely impact the quality of life and psychosocial functioning. For example, dental caries can cause pain and discomfort, infection, impaired chewing and nutrition, low self-esteem and speaking problems, leading to decreased productivity for missed school or working days (6,7). Beyond this, oral diseases incur substantial treatment costs for the individuals affected and the broader healthcare system.

These pathologies are highly preventable with regular visits to the dentist, among other preventive measures. In urban areas, these services are easily accessible to certain population segments; however, rural areas lack equitable access to comprehensive oral health programs because of various factors, including socioeconomic status, education access, and geographic location.

Canada is one of the most sparsely populated countries in the world, with the majority of the population (88.0%) living near cities in a narrow band in the southern part of the country; these municipalities occupy only 6.1% of its land area. Contrary to this, rural population only accounts for 12.0% of the total Canadian population, which is spread over approximately three-quarters (74.6%) of the land (8).

The geographical location of rural and remote areas of Canada has the potential to impact both oral health status and access to oral health care, with barriers reported such as shortages and maldistribution of oral health providers (9–13), poor access to public transportation (14–16), low oral health literacy (17–19), scarcity of fluoridated water systems (17–19), and high treatment costs and insufficient insurance coverage to cover these expenses (20–22). As a result, many dental diseases go untreated in these communities, which widens the gap between the oral health and that of the rest of the population.

Various health agencies have recognized oral health as a priority issue in recent decades due to the persistent global burden of oral conditions. According to the 2019 Global Burden of Disease Study, approximately 3.5 billion people suffer from oral diseases, being caries of permanent teeth the most prevalent, affecting 2 billion people, while 520 million children suffer from caries of their primary teeth. Periodontal disease also affects more than 1 billion adults in the world, ranking seventh globally for prevalence (23). This has spurred considerable scientific and research progress in understanding the nature of oral diseases (24). Unfortunately, rural oral health research agendas have not equally reached the same levels of interest and advocacy. See Appendix B.

The Canadian Health Act imposes the notion of a universal healthcare system (25); however, general oral health care is not included. Instead, the federal and provincial/territorial governments finance dental care for specific groups (26–28). As a result, Canada depicts a very low rank in the public financing of dental care. In 2017, only 6% of total dental care expenditure was publicly funded, with foreseeable results in differential outcomes depending on the social hierarchy position of individuals (27,29,30).

Financing and accessing periodic dental examinations may help prevent disease, identify other conditions, and contribute to stop the progression of risky and expensive future dental complications (31).

Even though statistics and epidemiological data on Canadians' oral health status and access are scarce compared with the available in the United States or Australia, several important studies demonstrate that oral health access problems need to be tackled. For example, the Canadian Health Measures Survey 2018 reported that around a quarter of Canadians (approximately 6.8 million people) avoided going to the dentist at least once because of the cost. Another significant income gradient trend has shown that dental care utilization diminished with decreased income. Although uninsured Canadians and those in the low-income quintile were the least likely to see a dental professional (49.6%), those in the middle-income quintile also experienced cost barriers to dental care (32). A study completed by researchers at the University of Toronto in 2013 reported that about 34% of Canadians had faced cost impediments to dental care in 2009 (33).

1.2 Statement of the problem

As it can be seen, measuring and monitoring oral health disparities in rural settings will ensure that all Canadians have the opportunity and ability to access quality oral health care. Yet, research on trends in oral health access in these communities remains limited, which disadvantages the planning and implementation of equitable solutions to oral health disparities. While it is long known that inequality exists in oral health outcomes, there is still little information on the magnitude of the gaps between urban and regional settlers. Most dental research has been concentrated on the effects of determinants of dental care access among specific subgroups of the general population in Canada, such as youth,

seniors, pregnant persons, and those receiving welfare, but only a few studies have examined dental care utilization estimations in rural Canada (34). Also, there is little information on the magnitude of oral health inequalities within and between countries of similar political and health system traditions, such as Australia and New Zealand.

Similarly, most reports describe provincial and territorial oral health initiatives and associated legislation and financing trend. Most initiatives also focus on children and older people, primarily those socially disadvantaged. However, other than that, little research has been conducted on other rural dental initiatives. Therefore, the study and incorporation of effective dental initiatives that reach a broader rural population would also significantly produce better oral health access and positive health outcomes that improve the national economic and health burden.

1.3 Central research questions and objectives

What are the disparities in oral health and dental care within and between rural and remote communities in Ontario, and how do underlying social-spatial determinants of health contribute to inequities in access to dental care?

What interventions and policies have the strongest evidence for reducing oral health disparities and improving rural access for rural and remote communities of Canada, Australia and New Zealand?

The purpose of this study is to:

- I. Examine inequities in oral health care and access to dental services and supplementary insurance.
 - a. Identify potential gaps in dental health care provision.

II. Examine inequities by sex, age, socioeconomic factors, and rural and remote communities. (*Conduct and submit a data analysis paper*)

III. Informed by the above findings, perform a structured scoping review on dental policies and practices to meet the above gaps. (*Conduct and submit a protocol and scoping review for publication*).

1.4 Thesis Outline

In addition to the introduction of the background and the statement of the problem, this thesis presents a series of coherent papers that emerged from the MSc research.

The following five chapters comprise this thesis:

The introduction (Chapter 1) provides readers with an overview of the global and Canadian perspectives on oral health, especially the problems confronting rural communities. Furthermore, this chapter outlines the thesis goals as well as its structure. A literature review (Chapter 2) provides the reader with key concepts for understanding oral health access, including its determinants, impacts, and relationship to quality of life. The chapter also provides a brief overview of the Canadian oral health care system and a comparison to Australia and New Zealand. Chapter 3 of this study consists of a paper named Disparities in Oral Health and Access to Dental Care in Rural Ontario, Canada: Data Analysis 2018 annual component of the Canadian Community Health Survey linked to the 2016 index of remoteness) to be submitted to a journal for publication. This study analyzes the nature and patterns of dental health utilization and determines gaps in dental health care for the rural population of Ontario. Chapter 4 consists of two studies to be submitted to journals for publication, a scoping review for Disparities in Oral Health and Access to Dental Care in Rural Communities and its respective protocol that outlines the steps necessary to

perform a systematic scoping review of literature in order to identify and report potential effective and innovative dental policies and practices that are frequently implemented in rural communities and have positive outcomes in addressing similar inequities in dental care provision found in the data analysis. In the final chapter, a discussion presents the main conclusions of this work, discusses potential implications, and describes future directions for this type of research.

Chapter 3 consists of two separate manuscripts (the protocol and the scoping review). As a result, each manuscript likely contains some repetition of information in terms of literature review, methods, results, and discussion. The author attempted to minimize this repetition while maintaining each stand-alone manuscript's coherence by providing sufficient information

1.5 Key findings

Apart from remoteness status, oral health is highly affected by lifestyle factors, including diet, alcohol and tobacco use, tooth brushing habits, and dental visits, which are determined by a complex interconnection of an individual's working, living, social and cultural characteristics. Because of this complexity, this paper used a national database to investigate health factors associated with dental care utilization in rural Ontarians. It examined a wide range of variables that interact with dental visit patterns in order to identify gaps and propose responses to improve oral health in rural areas and access to comprehensive dental care services. In addition to the quantitative method, a scoping review was conducted to retrieve relevant information about the Canadian dental system and its rural dental programs with respect to two international peers, with the objective of

assisting in the definition, implementation, and evaluation of specific interventions addressing rural dental care disparities. Four intervention types were identified:

1. Oral health promotion and preventive approaches that involve, for example, expanding sealant delivery in rural schools and increasing the proportion of the population with access to optimally fluoridated water.

2. Educational programs such as dental school rotations or internships where students and oral health professionals are educated about culture, specific rural health challenges and clinical practices, which make oral health promotion and dental care provision more effective.

3. Community engagement, shared responsibility, and partnership programs, for example, with interventions co-designed or operated by community leaders or organizations to break down cultural barriers.

4. Alternative service delivery methods such as e-Health and teledentistry.

Based on the findings of the scoping review, rural dental interventions are advanced in the international context, particularly in Australia. Despite this, knowledge and implementation gaps persist because of insufficient samples, weak scientific standards, and short follow-up times. Further, a lack of input from residents is another factor contributing to low success rates of dental interventions in rural communities. Thus, by combining data from the Canadian community health survey, we may be able to identify more specific and effective dental care solutions tailored to those communities. In summary, the findings suggest that triangulating statistical data to guide scoping review of effective rural interventions is a valid and effective method to address the gaps and limitations of dental care utilization in those areas.

Chapter 2 - Literature review

This chapter provides background information regarding disparities and inequities in oral health, access to dental services and associated determinants of oral health, provides a comparison of the current state of oral health in Canada with Australia and New Zealand, and concludes with an analysis of funding policies and supplementary insurance in Canada.

2.1 Concepts

2.1.1 Significance of disparities in Canada

Health disparities is a term central to the discussion in this paper. Health disparities refer to differences in health that occur across groups of people defined by specific characteristics (35–37). There is plenty of Canadian evidence that health disparities exist in Canada (35). Many health factors, including race, ethnicity, religion, socioeconomic status, age, mental health, disability, sexual orientation, and geographical location, have historically been associated with discrimination or exclusion. Reducing health disparities will lead to greater health equity.

Health inequities and health inequalities are other terms used internationally to describe differences in health status. Definitions and distinctions between these terms can be found in the "Distinctions between health Inequalities vs health Inequity" section.

The World Health Organization (WHO), the World Bank, UNICEF, and the United Nations Development Program have made health equity a priority issue, aiming to achieve the best possible health care for all, as well as to focus on the needs of those most at risk (38). Several highly developed countries have incorporated the reduction of health

inequalities into their health policies. However, it is challenging to define oral health inequalities as a global problem due to the lack of comparable data.

2.1.2 Distinctions between health inequalities vs health inequity

Inequality in health refers to general differences in the health of individuals or groups. The term "health inequality" refers to any measurable health aspect that differs between individuals or socially relevant groups(39). There is no moral judgment regarding the fairness or justice of observed differences in health.

In contrast, a health inequity or health disparity refers to a specific type of health inequality that occurs when there is an unjust difference in health. In accordance with one standard definition, it is unjust to allow health differences to persist when they could be prevented or avoided (40). Thus, health inequities are systematic differences in health that can be prevented by reasonable means. Health inequities, such as those based on race or religion, are generally regarded as social inequities because they reflect an unequal distribution of health risks and resources. Inequity differs from inequality in that the former is simply a dimensional description of unequal quantities, while the latter implies a moral judgment of injustice.

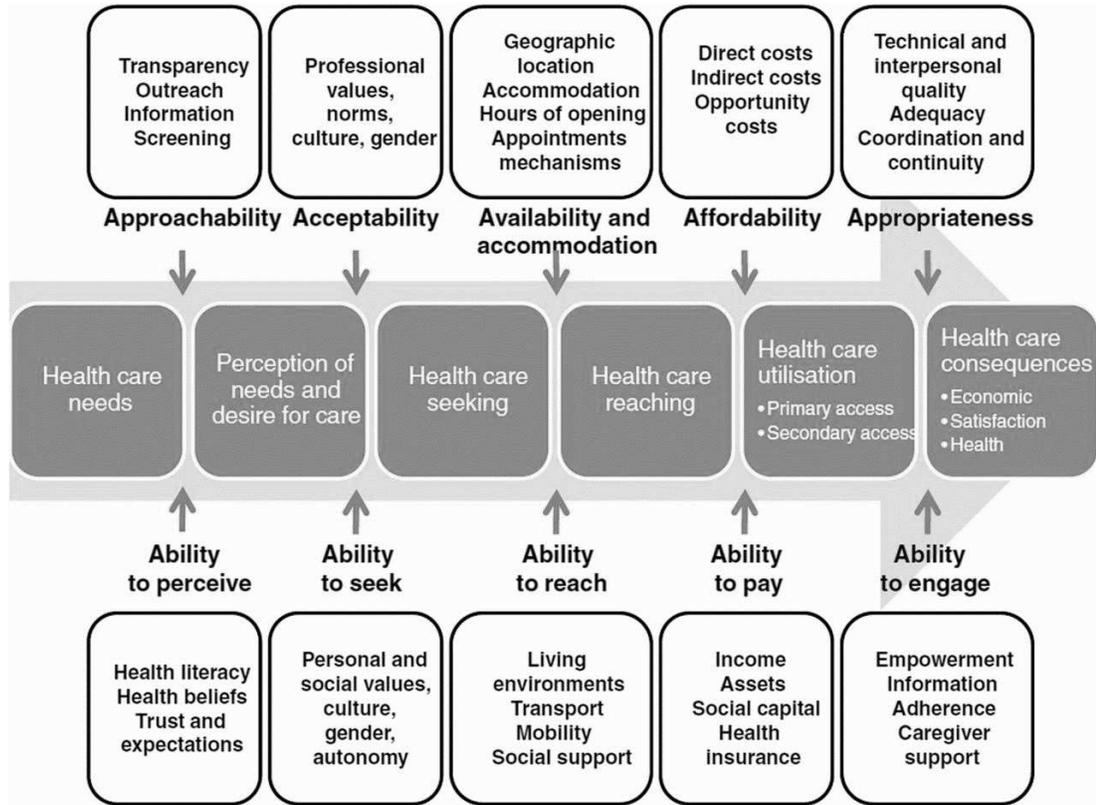
2.1.3 The difference between utilization and access to dental care

For the purpose of measuring "access to dental care", researchers and policy analysts often rely on individuals' self-reports of how long it has been since their last dental visit or how many dental visits they have had in a given period of time (usually one year). The following measures, however, are proxy access measures and represent more accurately dental care utilization. 'Access' refers to the ability to approach, reach, or enter dental services, while 'utilization' refers to the services used or consumed (41). They can be

influenced by supply-side characteristics of health systems and organizations and demand-side characteristics of populations.

Accordingly, the Conceptual Framework of Access to Health developed by Levesque in this thesis has been applied to provide a holistic perspective through five dimensions of access and five abilities of the population to access healthcare. In the first stage, Perception of Needs and Desire for Health Care, individuals are shaped both by their ability to recognize the presence of health care needs (Ability to Perceive) and their awareness of the existence of health care services (Approachability). Stage two, Health Care Seeking, examines an individual's ability to seek out health services when needed (Ability to Seek) and the appropriateness of health services with, for example, the social and cultural norms of the communities they serve (Acceptability). Stage three of the evaluation focuses on how easy it is to access health care services when needed (Ability to Reach) and whether those services are available in a timely manner (Availability and Accommodation). In step four, Health Care Utilization, costs for patients to access services are considered (Ability to pay) in conjunction with the costs incurred for running a health care system (Affordability). Finally, the fifth stage, Consequences of Having Access to Health Care, focuses on the individual's ability to participate in the services offered (Ability to engage) and the extent to which the services provided meet the needs of the communities they serve (Appropriateness)(42). All of these factors can contribute to the overall health outcomes of the country's population through access to health care. See Figure 1

Figure 1 Conceptual diagram of the barriers and abilities required to achieve the benefits of primary dental care.



Source: Levesque et al (42)

2.1.4 Defining northern and rural Ontario

A wide range of rural and rurality concepts are present in the literature, ranging from a sociological to a quantitative perspective (43). For analysis and research, rural quantitative definitions involve using statistical data from population demographics, community characteristics, and the geographic distance to the nearest service center. Indeed, Canada's most common urban and rural concepts are based on quantitative urban-rural classifications.

Statistic Canada's 2016 Index of Remoteness (IOR) is the newer measure of rurality. This index measures the relative remoteness of communities in Canada(44). Using this index, the relative remoteness of Canadian communities (CSDs) is measured based on the size and proximity of these communities to service centers and population centers (69). The value of remoteness ranges from zero to one, with zero representing the minimum and one representing the maximum value.

2.1.5 Oral health status and its significance

According to the Canadian Dental Association, oral health is defined as "the state of the oral and related tissues and structures that contributes positively to physical, mental and social well-being and the enjoyment of life's possibilities, by allowing the individual to speak, eat and socialize unhindered by pain, discomfort or embarrassment."

In 2016, the FDI World Dental Federation re-defined oral health as...

“... multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex. Further attributes include that it is a fundamental component of health and physical and mental wellbeing. It exists along a continuum influenced by the values and attitudes of individuals and communities; [it] reflects the physiologic, social, and psychological attributes that are essential to the quality of life; [it] is influenced by the individual’s changing experiences, perceptions, expectations and ability to adapt to circumstances”(45).

This new definition reflects a shift from the traditional bio-medical model of oral health to a more integrated bio-psychosocial model that considers both the impact of oral health on quality of life and broader social factors affecting the quality of life.

Various methods are used to measure oral health status and quality of life. The first measure is the self-report type, which provides subjective, qualitative data that can be used to assess the quality of life and is aimed at adults or children. Second are clinical surveys, which collect quantitative information and facilitate data extraction. These surveys are intended primarily for children and adolescents since obtaining a representative sample of children through school surveys is easier.

2.1.6 Determinants of oral health and access to dental care

The literature on the social determinants of oral, physical, and mental health overlap significantly. The Canadian public health care policies prioritize physical and mental health but not oral health, impacting the socioeconomic circumstances of individuals and families and influencing various health outcomes, including oral health(46).

The majority of the Canadian oral health inequalities literature has focused on the relationship between education, living conditions, and income with oral health outcomes and inequity(47). They create a complex causal web independent of genetics and behaviour factors, including stress, brushing, flossing, diet, and smoking, all of which can contribute to develop oral diseases, but social factors can also influence them. For example, a study conducted in Canada found that systemic inflammation and cumulative inflammatory load -both associated with periodontal disease - were related to socioeconomic status even after controlling for behavioural factors. It is suggested that socioeconomic position may exert a greater influence on periodontal disease than health behaviours by affecting immune system processes (48).

Income and education are generally correlated with the types of housing people can afford, the food choices they make, their access to health and social services, and the types of jobs they are able to obtain. Generally, the provision of employer-sponsored health or private insurance is differentially linked benefits of such jobs. In addition, insurance has a significant role in determining access to health care since it eliminates the cost of care at the time of purchase. This is considered a potent determinant of access to dental care at any income level since it determines a person's willingness to have dental treatment. In this context, it is not surprising that lower education and income levels are associated with poorer oral health and higher dental care barriers associated with greater disease and treatment needs.

People who suffer from poor oral health are more likely to develop chronic diseases, physical pain, psychological discomfort, and other disabilities and be unable to function in general and participate in the labour market, which we discuss later in this chapter.

2.2 The impacts of oral diseases

2.2.1 The link between chronic oral conditions with adverse systemic health

The mouth is an entry point for foods and infections, spreading to other body parts and affecting human physiological processes. Nowadays, it is well-known that the genome, oral microbiome, allostatic load, stress and socioeconomic status contribute to the oral-systemic health association (49–52).

Despite limited evidence proving causality in the oral-systemic association - oral diseases causing systemic health problems - extensive associational evidence confirms this relationship. For example, chronic inflammatory health conditions (such as cardiovascular disease and diabetes) and pulmonary conditions (such as aspiration pneumonia and chronic

obstructive pulmonary disease) have well-documented associations between dental conditions and systemic diseases.

2.2.1.1 Chronic inflammatory health conditions

Diabetes has shown a strong association with periodontal disease. Diabetes is a chronic metabolic disorder characterized by high blood glucose due to impaired insulin secretion and/or defective insulin action. It is considered one of the leading causes of death and a source of morbidity in Canada. The physiological effects of diabetes - immunity functioning, blood flow alterations, and hyperactive inflammatory state- worsen periodontal disease outcomes. Diabetics patients with poor periodontal health found difficulties controlling their blood sugar levels as periodontal inflammation promotes insulin resistance(53). For example, a long-term follow-up report of diabetic Ontarians demonstrated that for those reporting poor to fair oral health status, the adjusted risk of diabetes was 29% greater than those informing good to excellent oral health status(54). Another study found that patients receiving exhaustive periodontal treatment improved the functioning of their blood vessels and decreased their cardiovascular risk (55).

2.2.1.2 Pulmonary diseases

Aspiration pneumonia is a severe lung infection resulting from inhalation of bacterial colonization from the oropharynx. This is highly prevalent in older people or people in a supine position for long periods, intubated, enteral fed, or suffering from dysphagia. Clear evidence suggests that inadequate oral hygiene, dental caries, periodontal disease, and decreased salivary functions are risk factors for aspiration pneumonia (53,56,57). Effective oral hygiene and oral chlorhexidine application can prevent this disease(58,59). Another critical connection to report is periodontal and chronic obstructive pulmonary disease

(COPD). COPD conforms to a group of conditions that cause breathing tube inflammation, airflow blockage and breathing-related problems. Interventional studies have shown a lower frequency of exacerbations following periodontal treatment. Similarly, further observational studies about COPD flare-up frequency indicate incremental frequentness in patients with worse plaque scores and fewer teeth. (56,57).

2.2.2 Oral Health and Quality of Life

Untreated caries and periodontal disease can lead to chronic pain, discomfort, infections, abscesses, and loss of teeth (6,7,60). In addition, considering that our drinks and food choices go through the mouth first, oral diseases can interfere with the ability to chew and digest various foods, resulting in nutritional disbalances(61). Poor dental health can also lead to speech impairment, reducing verbal and non-verbal communication; appearance changes that translate into lower confidence; poor self-esteem reduces the ability to build social relationships(62,63). All this causes anxiety, depression, and social stigma, inhibiting opportunities for education, employment, and social relationships (64,65). The appearance of teeth can influence employer hiring practices and employee earnings(65). All beforehand mentioned studies conclude that tooth loss is associated with low quality of life scores.

2.2.3 Societal and health care systems outcomes

The absence of routine dental examinations can delay the diagnosis of conditions, leading to potentially preventable complications and economic impact on society. The increased cost of dental treatments covered by public or patient funds directly impacts the economic burden on families. In most cases, these out-of-pocket oral health expenditures represent enormous and unexpected health costs which push the family into poverty(66).

The indirect impact of the economic burden comes from productivity losses due to a substantial reduction in school attendance and working days(67,68). For instance, over 40 million hours are lost due to dental reasons each year in Canada, leading to an economic loss of over \$1 billion (67). In addition, poor dental care can consume primary and tertiary health care resources through unnecessary emergency department visits and physicians' use for non-traumatic and preventable dental conditions(69). These types of oral diseases are not effectively treated in such settings, which are unable to resolve dental problems beyond prescribing antibiotics and painkillers and referring individuals to a dentist. (69–71). According to another study, approximately 1% of all emergency department (ED) visits in Ontario are for dental care unrelated to trauma (72).

2.3 Canadian Oral Health Care System

2.3.1 Oral health disparities and access to care

The Canadian health system is recognized internationally as being public, universal, equitable, and accessible. Unfortunately, dental care is not as accessible as other forms of healthcare. Dentistry and other complementary health services are not covered under Canada's national health insurance program (Medicare), which provides publicly-funded coverage for health care costs at the point of purchase for hospital and physician services. Among the Organization for Economic Co-operation and Development (OECD) nations, Canada was ranked near the bottom regarding its public share entitled to dental care, or the proportion of dental care paid by the government out of all dental expenditures (73). The Canadian Institute for Health Information reports that approximately \$17.1 billion was spent on oral health care in 2018, with 94.2% of that amount being borne by the private sector (28). Of the 5.8% covered by the Canadian government, most went to

low-income children and adults (federal, provincial, and municipal) (21), meaning that the level of socioeconomic inequality affects health outcomes in significant ways. Ultimately, Canadian politics determines whether a population can maintain or improve its oral health status.

2.3.2 Funding of dental health care in Canada

Canada is a confederation nation in which the federal government shares and divides power with each of the ten provincial governments and three territorial governments. Due to recent restructuring, local governments now have the authority to make decisions about health care and social services (74).

Publicly funded dental care is provided to members of specific groups such as state-recognized Indigenous populations, refugees, federal prisoners, military personnel, veterans, and members of the Royal Canadian Mounted Police. In addition, provincial-territorial dental care funding is directed to various programs that provide dental care to low-income children, seniors, people on social assistance, people with disabilities and those suffering from craniofacial conditions (21).

In 2017, approximately 35 percent of the total public expenditure on dental services was directly funded by the federal government, while 65% was shared among provinces and municipalities (75).

2.3.3 Dental care payments

In 2018, approximately 64.6% of the Canadian population had dental insurance, and 32.4% had not, representing 12 million people. As part of the insurance pool, 76.3% of workers have dental insurance through their employers, 13.9% have publicly funded dental insurance, and 9.7% have private insurance (76).

2.3.4 Oral health status

Oral Health Statistics provided estimates of the number of Canadians with cavities of all ages with the 2007-2009 Canadian Health Measures Survey (CHMS). About 57% of 6–11-year-olds have experienced a cavity in the past. In addition, 59% of 12-19-year-olds have experienced this disease at some point in their lives. Around 96% of adults have had cavities. Similarly, the prevalence of the periodontal disease is high. Seven out of ten Canadians suffer from gum disease. The majority of adults with untreated dental decay and/or periodontitis were low-income, uninsured, and uneducated (77).

2.3.5 International comparisons

Table 1: Comparison of oral health systems among Canada, Australia and New Zealand

Indicator	Canada	Australia	New Zealand
Organization, management & delivery	<ul style="list-style-type: none"> - Mainly independent private practitioners. Privately delivered services on a fee-for-service basis in the majority. In the public sector, only a minority of dentists deliver care. -Emergency surgical, and dental care in public settings (78) 	<ul style="list-style-type: none"> -About 85% of dentists are private practitioners in 2019. Public dental care has a high rate of emergency care and tooth extractions.(79) -Australia's individual residents covered nearly half - 58 percent - of all dental care expenditures in 2016-17, far exceeding government and private health contributions. (80) 	<ul style="list-style-type: none"> -Private dentists typically provide dental care for adults. Most adults pay for dental care. (81) -Free oral health care to children up the age of 18
Funding	<ul style="list-style-type: none"> -Oral healthcare expenditures represented 6.2% of total healthcare spending in 2015. (16) 	<ul style="list-style-type: none"> - \$10.2 billion was spent on dental care, 5.6% of the overall expenditure in 2016-17. Government spending only accounted for \$0.8 billion.(80) 	
Population Covered	<ul style="list-style-type: none"> -According to the Canadian Community Health Survey 2018, 64.6% of all Canadians have dental insurance to cover their expenses -Private: 62.6%, public: 5.5% and no coverage / out of pocket: 32%(16) 	<ul style="list-style-type: none"> -54.3% of Australians have private health insurance for general treatments, including dental care. (80) -Dental expenses in Australia in 2013-14: private health insurers 17%, government 22%, individuals 60% and other 1%. (82) 	<ul style="list-style-type: none"> -25% of dental care expenditures come from public funds, mostly for children and adolescents. - 70% of the remaining expenses were paid by the patients and 5% by private insurance. (82)
Oral health outcomes	<ul style="list-style-type: none"> -Over 74% of Canadians have seen a dentist in the past year, but 22.4 avoided at least one visit due to cost (32). 	<ul style="list-style-type: none"> -Nearly half (48%) of adults visited a dentist in 2020-2021. However, among children aged 5-14, 81 percent had last been to the dentist in the last 12 months (83). -18% of people skipped or delayed dental care because of cost - much higher than for other types of care in 2016-17 (80). 	<ul style="list-style-type: none"> -Almost half of the adults (47.1%) saw a dentist, and about 4 out of 5 children saw a dentist in 2009 (84).

Chapter 3 - Data Analysis 2018 annual component CCHS linked to 2016

index of remoteness

The first and second objectives of the thesis are discussed in this chapter. It examines dental care inequities and identify potential gaps related to rurality, socioeconomics, and demographic factors. This study compared last year's self-reported last visit to the dentist with the factors associated with this outcome. Secondary data was derived from the 2017/18 Canadian Community Health Survey's dental care (DEN) and oral health (OHT) components. This chapter is organized in a manuscript format in the following sections: abstract, methods and materials, descriptive statistics, results, discussion, and conclusion. this section (chapter 3) is to be submitted for publication.

3.1 Abstract

Background: Oral health is a fundamental component of overall health and general well-being, and regular oral examination is essential for maintaining oral health care. Despite these established connections, there remain knowledge gaps about Ontarians' oral health, particularly for those residing in rural regions, the most populated province in Canada. This study aims to determine the patterns and factors associated with rural Ontario rural communities' utilization and dental care access.

Methods: Data from the dental care module of the 2018 Canadian Community Health Survey (CCHS) was used for the analysis and restricted to respondents aged 18 years and above living in rural settings. Individual-level CCHS data was merged with the Statistics Canada Index of Remoteness to identify rural communities. Dental care use was defined with the variable last time visiting a dental professional in the last year. Data on oral health

care, access to dental services, and supplementary insurance were compiled, and descriptive statistical analyses and logistic regression were performed to identify gaps and examine inequities among sociodemographic, socioeconomic and health-related factors. Logistic regression suggested that those living in rural communities with low educational attainment, low household income, no dental insurance, smokers, poor teeth brushing frequency or diabetes have increased odds of not visiting the dentist within the past year. Results: Approximately a quarter of participants had not visited the dentist in the past year, and 13.9% reported only visiting for emergencies. It has been found through logistic regression that rural settlers, low educated, low household income earners, uninsured, smokers, with poor dental brushing frequency or diabetes had higher odds of not visiting the dentist.

Conclusion: This study provides insights into potential factors contributing to disparities in access to and utilization of oral health care among rural Ontario residents. Rural Ontarians need to be targeted for improving dental care utilization, as indicated by these findings.

3.2 Introduction

Dental care has been excluded from Canada's universal health care system (27); as a result, most of the dental care in Ontario is privately funded, so Ontarians must use private insurance, employment-based plans, government programs, or pay out-of-pocket for dental care. This leads to significant gaps in access to dental care among certain subgroups, as dental care is largely determined by income and dental insurance coverage (85,86), with higher-income earners more likely to visit the dentist (22). Not only do low-income and uninsured Canadians have difficulty accessing dental care (85), but middle-class earners

do as well. Researchers at the University of Toronto found that about 34% of middle-income Canadians could not afford dental care in 2009 (33).

Studies have shown that Canada's oral health access problems need to be addressed despite the lack of statistics and epidemiological data. A recent Canadian Health Measures Survey report found that a quarter of Canadians avoided going to the dentist at least once due to the high cost (88). Evidence suggests that 12.6% sacrificed other spending to pay for dental treatment (89). A more direct approach demonstrated that people with reported barriers to accessing dental care also had worse oral health after controlling for private insurance coverage, household income, sex, age, and education. Specifically, the number of positive responses to cost barriers increased along with the extent and severity of OHIP-14 scores (90).

In addition to socioeconomic barriers, other less known issues include the exclusion of oral health from Canadian health care policy agendas, which results in a lack of public resources, transportation to dental offices, and a shortage of services in rural and remote areas (21,91).

Leaving dental infections untreated can lead to complications; therefore, regular dental examinations can help to prevent risky and expensive future dental problems such as tooth decay, tooth loss, oral cancer, and periodontal disease. (31). In addition, these diseases are often associated with chronic diseases like cardiovascular disease, respiratory disease, and diabetes (2–4). Similarly, untreated dental conditions can lead to pain, infection, missed school or workdays, and difficulty eating and speaking. Together, these outcomes negatively affect the quality of life, thriving, overall health, and survival (16).

Regular dental visits are the most important indicator of oral health care access (92). Many organizations, such as the American Academy of Pediatric Dentistry, recommend six-month dental visits. While the Canadian Dental Association suggests that dental visit frequency varies according to individual needs. Although some have questioned for decades whether this frequency is not somewhat arbitrary, given inconsistent and inconclusive research on how often people should see their dentists and the health benefits associated with visits (93). By examining two randomized controlled studies, the Cochrane Collaboration found disappointing findings. Researchers found little or no difference in adult oral health outcomes when 24-month recall intervals were compared to 6-month or risk-based recall intervals. However, the evidence for children and adolescents was insufficient. On the other hand, some observational studies reveal that people who see a dentist frequently have better clinical outcomes, as well as the better perception of their oral health (70–73). Thus, getting an oral examination regularly remains the standard of care.

In Canada, most dental research has addressed the determinants of dental care access for youth, seniors, pregnant women, and welfare recipients. However, there is little information available on dental care use in Ontario, Canada's most populous province, where around 14% of its population lives in rural areas (less than 1,000 residents). An additional 10% live in a small population centre (more than 1,000 but less than 30,000 residents), according to the 2016 statistics Canada census.

The first phase of this study examined dental health inequities using the 2018 CCHS oral module of the Public/Private Use Microdata File to determine dental health utilization patterns and identify gaps in dental health care provision for residents of Ontario. Later,

the data was combined with Statistics Canada's Index of Remoteness to assess access and inequality in rural communities through a rural-access classification system. The second phase involves a scoping review of dental interventions that integrate qualitative and quantitative results via a mixed-method matrix to fill the above gaps.

3.3 Methods and Materials

3.3.1 Data source: the Canadian Community Health Survey

Data from the dental care module of the 2018 Canadian Community Health Survey (CCHS) was used in the present study. The Canadian Community Health Survey is a cross-sectional study conducted by Statistics Canada and Health Canada to collect demographic, socioeconomic, and self-reported data about health care utilization, health status (including oral health), and health determinants data at the regional and provincial levels. In the CCHS, the topics that constitute common and optional content vary from survey year to survey year. The CCHS includes questions asked to all respondents (common content) as well as questions asked only to respondents within specific areas (optional content).

The targeted populations are individuals aged 12 years and older living in the ten provinces and three territories of Canada, representing 98% of the Canadian population. The CCHS does not include in its sampling frame persons living on Reserves or Crown Lands, institutionalized residents, members of the Canadian Forces, and residents of remote regions.

Apart from the CCHS data analysis, this study merged the 2018 annual component CCHS with the 2016 remoteness index (RI) index of remoteness to get the degree of rurality. This is a valuable tool for researchers to measure the geographic variability of dental disparities in Canada, including the effects on other CCHS variables, such as

income, education or dental insurance in oral health status and access and utilization. This remoteness index (RI) classification assigns a value to each populated community (census subdivision or CSD) and measures the relative remoteness of Canadian communities based on their population size and proximity to surrounding population centres distinguishing rural and remote areas from urban areas. The index value for each CSD ranges from 0 to 1, where "0" depicts the most accessible areas, and "1" represents the most remote areas. Then, a classification method approach was implemented to determine cut-off points of remoteness index between categories and to classify them into four quantiles [Q1: easily accessible area (<0.122), Q2: accessible area (0.122 to 0.2625), Q3: less accessible area (0.2625 to 0.41505), Q4 remote and very remote area (>0.41505)].

Public use microdata files were accessed through Carleton University Macodrum Library. According to Article 2.4 of the Tri-Council Policy Statement: Ethical Conduct for Research Involvement Humans, research ethics board approval is not required for this study.

To access the confidential microdata files of the CCHS, it was required to submit a proposal to the Statistics Canada Research Data Centre (RDC). The research team was conducted all statistical analyses at Statistics Canada's Ottawa Research Data Center (RDC) under the provisions of the Statistics Act in accordance with Statistics Canada's confidentiality rules. Confidential microdata at the RDC is accessible only to researchers with approved projects who have been sworn in under the Statistics Act as 'deemed employees.' Community and patient consultation or engagement.

3.3.2 *Measures/Variables*

Each variable was recoded for analysis (except sex). For the most part, re-coding involved collapsing response categories and removing don't know and refused. Both don't know and refused were considered missing categories and excluded from the analysis. Variables were recoded to clarify the factors, facilitate comparable analysis across variables and make interpretation easier. See Table 2.

3.3.2.1 Outcomes variable of dental care use

The outcome consists of reporting a dental visit within the past year for any reason. This variable is used by the Public Health Agency of Canada as a measure of oral health equity (94).

Visiting a dentist was determined by the following question: When was the last time you saw a dental professional? "Less than a year," "1–2 years", "2–3 years", "3–4 years", "4–5 years", "more than five years" or "never." The variable was fractionated at a one-year cut-off level and constructed as a two-level indicator: 1) 'potentially adequate - frequent' (the last appointment was in the last 12 months) and 2) 'potentially inadequate-infrequent' (the last appointment was prior to the last 12 months).

3.3.2.2 Covariates

Sociodemographic variables

The sociodemographic variables serve as controls and explanatory variables to examine the factors contributing to inequalities. The socio-demographic variables included sex (male and female), age, aboriginal and marital status. In the case of the age variable, we only analyzed respondents who are 18 years and older. Three age groups were created: 1) 18–34 years, 2) 35–54 years and 3) ≥ 55 years and older.

Education level and income

Studies have shown an association between educational attainment and health as well as health inequalities across countries (82). Education reflects the early life circumstances of an individual and determines their future income and occupation. Higher education may reduce resource barriers and increase health awareness and health literacy levels, influencing individuals' behaviour and lifestyle (83). The level of education of the head of the household was reported and classified into three categories: 1) “Less than high school diploma”, 2) “Secondary school graduation”, 3) “no post-secondary education”, and 4) those with a “Post-secondary education certificate diploma or University diploma. The question of being in the labour force over the last 12 months provides estimates of employment and unemployment rates (coded: no job, yes). There was also a question about "total annual household income". This is a proxy for socioeconomic status and is also indicative of an individual's ability to afford dental care. It was collapsed into five quintiles, where quintile one represented the poorest wealth quintile and quintile five, the richest.

The analysis also included dental insurance status (uninsured versus insured with government-sponsored, employer-sponsored, or private insurance). Although dental insurance is not a direct indicator of socioeconomic status, it indicates the resources available for dental care.

Financial difficulties were assessed using the variable, including cost barriers to dental care in the last 12 months (coded yes or no).

Health behavioural factors

Brushing, flossing, smoking, and alcohol consumption behaviours were assessed. As a measure of brushing and flossing habits, variables evaluating these practices was

categorized into: 1) >1 time daily, if participants brush/floss more than once a day, and 2) Once a day or less, if only brushing/flossing once each day.

The following health-related lifestyle characteristics were evaluated: Smoker status (yes or no). Alcohol consumption frequency: 1) Never 2) Less than once per month 3) At least once per month 4) At least once per week.

Types of dental attendance described another important health behaviour (coded: regularly visiting the dentist for a check-up, occasionally visiting the dentist for a check-up, only visiting the dentist for treatment or problems/never visiting the dentists), it was dichotomized into two options: 1) check-ups or treatments and 2) only for emergency care/never.

Health-related quality of life and well-being

The general well-being of society is measured using four self-reported systemic and mental health questions. Self-perceived general and mental health, life satisfaction, and sense of belonging have been shown to predict chronic disease incidence, use of medical services, recovery from illness, and functional decline (60). In addition, several studies have shown an association between oral health and mental health (62,95–98), indicating that poor oral health results in negative mental health and vice versa.

Each individual rated their general and mental health on five-point scales ranging from “excellent” to “poor.” A simplified scale has been developed into 1) poor/fair (Poor), 2) good and 3) very good/excellent. The life satisfaction question was scored from 1 to 5, where 1 meant “very dissatisfied” and 5 meant “very satisfied”. It was turned into three categories: 1) satisfied, 2) neither satisfied nor dissatisfied, and 3) dissatisfied.

Feeling accepted, connected, and equally valued by others in the community also plays a role in one's sense of belonging, especially in rural or small towns where isolation and health issues are common. Participants in the CCHS were asked to describe their sense of belonging to their local communities in three ways: very strong, neither strong nor weak, and very weak.

Chronic diseases

Diabetes is a chronic illness that has been strongly associated with poor oral health (99) and is one of the leading causes of death worldwide, according to the World Health Organization (100). The evidence suggests that oral health care providers can significantly and positively impact the oral and genital health of diabetes patients (54,101). The responses were dichotomized into yes (presence of disease) or no (no presence of disease).

Perceived oral health

Participants in this study were asked about perceived oral health and how satisfied they were with the appearance of their teeth or dentures. The information for the first variable was collected with the question: Would you say the health of your mouth is...? the results were initially reported as 5-point scales (excellent, very good, good, fair, and poor) but were grouped into three variables (1) excellent = excellent/very good, 2) good, and 3) poor/fair). The second question is, how satisfied are you with the appearance of your teeth or dentures? The results were reported as very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied, and very dissatisfied and were recoded into 1) satisfied, 2) neither satisfied nor dissatisfied, or 3) dissatisfied.

Oral/facial pain and symptoms

Our study examined five oral health symptoms/outcomes in the past year: uncomfortable eating, oral pain, gingival bleeding, and persistent bad breath. The frequency of these was reported by selecting one of the following answers: never, rarely, sometimes, and often. For data analysis, frequencies of variables were dichotomized as 1) yes (rarely/sometimes/often) and 2) no (never). Dentate status was also included. An edentate state usually results from tooth removal due to tooth decay or periodontal disease. It represents an accumulated load of oral disease.

Table 2 Variables included in the CCHS analysis

Dental care use factors	Oral health survey component	Sociodemographic factors	Health behavioural factors	Health-related quality of life and well-being	Chronic disease	Rurality
<i>Last visit to dental professional:</i> ≤ 1 year ago (regular)	<i>Dental insurance types:</i> None Employer Private Government	<i>Age:</i> 18–34 yrs 35–54 yrs 55 and older yrs	<i>Smoking Status:</i> No Yes	<i>Perceived systemic health:</i> Excellent Good Poor / Fair	<i>Diabetes:</i> No Yes	<i>Remoteness categories:</i> Q1 Easily accessible Q2 Accessible Q3 Less accessible Q4 Remote and very remote
> 1 year (irregular)	<i>Current dentate status:</i> Dentate Edentate	<i>Sex:</i> Male Female	<i>Alcohol Use:</i> Never Less than once a month	<i>Perceived mental health:</i> Excellent Good Poor / Fair		
<i>Type of dental visits:</i> Check-ups or treatments	<i>Perceived health of teeth and mouth:</i> Excellent Good Poor / Fair	<i>Aboriginal:</i> No Yes	At least once per month	<i>Satisfaction with life in general:</i> Satisfied		
Only for emergency care / Never	<i>Satisfaction with teeth appearance:</i> Satisfied Neither satisfied/dissatisfied Dissatisfied	<i>Marital status</i> Partner No partner	At least once per week	Neither satisfied/dissatisfied		
<i>Avoided going to a dental professional because of the cost:</i> No Yes	<i>Uncomfortable to eat food - freq - 12 mos:</i> No Yes	<i>Education Level:</i> Less than a high school diploma Secondary school graduation, no post-secondary education Post-secondary education certificate diploma or University diploma	<i>Brushing frequency:</i> > 1 times daily Once a day or less	<i>Sense of belonging:</i> Very strong Somewhat strong Somewhat weak Very weak		
	<i>Other persistent pain - freq - 12 mos:</i> No Yes	<i>Household income quintiles – health region level:</i> 1 (lowest) 2 3 4 5 (highest)	<i>Flossing frequency:</i> >1 times daily Once a day or less			
	<i>Problem with bleeding gums - 12 mos:</i> No Yes	<i>Labour force - 12 mos:</i> No job Yes				
	<i>Had persistent bad breath – freq- 12 mos</i> No Yes					

3.4 Descriptive Statistics

A series of descriptive analyses were conducted to compare dental care access and oral health status among various sociodemographic groups. Analyses were performed for each of the four independent rurality measures to assess their relationships with selected

variables. STATA version 16 (StataCorp LP, College Station, Texas) was used for descriptive analysis of the collected data since this is a strong tool for analyzing health survey data with complex sampling designs. The descriptive analysis includes frequency distributions of all categorical variables. Furthermore, bivariate analyses were conducted using cross-tabulations to examine the association between access and utilization of dental services among sociodemographic, behavioural, and geographic categories.

3.3.1 Regression Analysis

Two multivariate logistic regression analysis models were performed to explore the simultaneous effect of factors affecting access and use of dental services in the presence of other cofounders, with the self-reported last visit to the dentist in the last year as the dependent variable and some explanatory factors simultaneously. The first model was conducted to provide similar results to previous studies examining oral health in Canada. The second model performed a logistic regression *stratified* by degree of rurality, allowing us to explore the potential differences in these results by typology of rural areas.

To account for the complex sampling design, bootstrapping was performed to calculate the 95% CI estimates. Population weights, normalized weights and bootstrap weights were all created in the Research Data Centre of Statistics Canada. The crude and adjusted odds ratios recorded 95 percent CIs and P-values. The significance level was set at $P < 0.05$.

3.5 Results

3.5.1 Survey sample characteristics

The analytic study comprised a total of 17,095 Ontarians and incorporated a weighted sample of 10,625,802 respondents. The study revealed that 22.8% of respondents had not

visited a dentist within the past year and were considered bad visitors. In addition, 13.9% indicated they usually visited a dentist only during an emergency.

An overview of sample characteristics is presented in Table 3, which has a two-way or joint relative frequency design. The first section of the table shows the weighted values collected from the survey. Secondly, row relative frequencies in degrees of rurality are displayed. Finally, column relative frequencies among specific variables are shown.

Overall, survey population representation declines as the rurality of the population increases. The majority of participants (60-74%) lived in the least remote area, nearly a quarter (18-28%) of them inhabiting accessible areas, a small percentage (6 to 12%) residing in less accessible zones, and only a few (roughly 2%) living in the most remote areas. See Table 3.

3.5.1.1 Socioeconomic and cultural characteristics

The majority of the sampled population is composed of graduates from college or universities, no aboriginals, married or in common law unions and working in the labour force. There was a relatively even distribution of gender, household income, and age across all remoteness groups surveyed. Women dominate the least accessible (52%) and most remote (53%) areas, while both genders are equally represented in the two accessible rurality quartiles. The two lowest-income households account for less than a fifth of participants, and the middle- and high-income households constitute just under one-quarter of those surveyed. As expected, aboriginal representation is higher in less accessible and remote areas (8-9%) than in more accessible areas (2-3%). Approximately one-third of the residents in the most urban and remote quartiles did not have dental insurance, and almost half of settlers in the second and third quartiles were uninsured.

3.5.1.2 Use of dental services

Adults aged 18 and over in easily accessible areas (79%) were more likely to have seen a dentist in the past year than those who live in other more rural areas (74%, 72% and 70%). Additionally, participants who reside in areas with easy access (88%) tend to visit for a check-up more often than participants who reside in accessible areas (84%), less accessible areas (81%) or distant or very distant areas (80%). In contrast, the percentage of individuals reporting that they visited last for an emergency or never visited was higher among those living in remote environments (20%) than residents from other rural classifications.

Surprisingly, people in the most remote areas have reported fewer avoidance rates of going to a dental professional because of the cost (19%) than those from the other three remoteness categories, with urban settlers reporting the highest percentage (23%) of avoidances.

3.5.1.3 Health-related quality of life and well-being

According to the survey results, the majority of the respondents had excellent or very good self-rated perceived general and oral health, were satisfied with life and teeth, and had a relatively strong sense of belonging.

3.5.1.4 Disease outcomes

Most of the respondents to the survey did not have diabetes, did not experience eating difficulties, did not have painful gums, nor did they have persistent bad breath.

Table 3 Characteristics of the total sample and those with dental visits > 1 year, by quartile of remoteness, the Canadian Community Health Survey (CCHS), 2018. Weighted

Variable	Q1	Q2	Q3	Q4	Total	Column				
						Q1	Q2	Q3	Q4	Total
SOCIODEMOGRAPHIC VARIABLES										
Sex										
Female	3777420	1170506	411566	75103	5434595	52%	50%	50%	53%	51%
Male	3536928	1182200	404676	67403	5191207	48%	50%	50%	47%	49%
Age										
18–34 yrs	2332764	631623	208321	30170	3202878	32%	27%	26%	21%	30%
35–54 yrs	2538934	764737	263918	51580	3619169	35%	33%	32%	36%	34%
≥ 55 yrs	2442650	956346	344004	60756	3803756	33%	41%	42%	43%	36%
Aboriginal										
No	7133935	2271095	750524	130140	10285693	98%	97%	92%	91%	97%
Yes	180413	81611	65719	12366	340109	2%	3%	8%	9%	3%
Marital status										
Partner	4422073	1562095	538084	103501	6625752	60%	66%	66%	73%	62%
No Partner	2892275	790612	278159	39005	4000050	40%	34%	34%	27%	38%
Total	7314348	2352706	816243	142506	10628802	100%	100%	100%	100%	100%
Education level										
Less than secondary school graduation	287206	142151	55401	13728	498487	4%	6%	7%	10%	5%
Secondary school	973883	323313	109577	18811	1425584	13%	14%	13%	13%	13%
Post secondary certificate or university degree	6053258	1887242	651265	109966	8701731	83%	80%	80%	77%	82%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Household income level										
1 (lowest)	1093195	403888	139838	22344	1659264	15%	17%	17%	16%	16%
2	1136551	434205	148392	24546	1743694	16%	18%	18%	17%	16%
3	1487611	482559	166649	31481	2168300	20%	21%	20%	22%	20%
4	1722318	509641	172567	33896	2438421	24%	22%	21%	24%	23%
5 (highest)	1874673	522414	188797	30240	2616123	26%	22%	23%	21%	25%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Labour force										
No job	2482207	914620	343941	56761	3797528	34%	39%	42%	40%	36%
Yes	4832141	1438086	472302	85745	6828274	66%	61%	58%	60%	64%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
HEALTH-RELATED QUALITY OF LIFE AND WELL-BEING										
Perceived health										
Excellent/Very good	4737291	1485474	492192	77782	6792740	65%	63%	60%	55%	64%
Good	1916840	639378	231944	46877	2835039	26%	27%	28%	33%	27%
Poor	660216	227854	92106	17846	998023	9%	10%	11%	13%	9%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%

Variable	Q1	Q2	Q3	Q4	Total	Column Q1	Q2	Q3	Q4	Total
Satisfaction with life in general										
Satisfied (ref)	6873803	2213534	771803	134349	9993488	94%	94%	95%	94%	94%
Neither satisfied/dissatisfied	271496	83204	29083.1	6510.14	390293	4%	4%	4%	5%	4%
Dissatisfied	169049	55968	15356.9	1646.92	242021	2%	2%	2%	1%	2%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Sense of belonging										
Very strong	932228	318823	138841	35191.2	1425084	13%	14%	17%	25%	13%
Somewhat strong	3591204	1191406	447483	75908.9	5306001	49%	51%	55%	53%	50%
Somewhat weak	2129630	652464	178126	27102.5	2987323	29%	28%	22%	19%	28%
Very weak	661286	190013	51793	4303	907395	9%	8%	6%	3%	9%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
HEALTH BEHAVIOURS										
Smoker										
No	5892684	1868289	649041	112663	8522678	81%	79%	80%	79%	80%
Yes	1421663	484417	167202	29842.8	2103124	19%	21%	20%	21%	20%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Alcohol intake										
Never	864350	268912	122498	17239.5	1273000	12%	11%	15%	12%	12%
Less than once a month	1035028	336383	127262	27070.6	1525743	14%	14%	16%	19%	14%
At least once per month	1522158	414325	161418	27357.8	2125259	21%	18%	20%	19%	20%
At least once per week	3892813	1333086	405064	70837.7	5701800	53%	57%	50%	50%	54%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
CHRONIC DISEASE										
Diabetes										
No	6914211	2178522	747035	126383	9966151	95%	93%	92%	89%	94%
Yes	400137	174184	69207.8	16122.5	659651	5%	7%	8%	11%	6%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
ORAL HEALTH SURVEY COMPONENT										
Dental insurance										
None	2423400	1101522	360341	71416.8	3956680	33%	47%	44%	50%	37%
Employer	4361010	1074481	377204	62197	5874892	60%	46%	46%	44%	55%
Private	278700	88032.1	30043.4	3118.57	399894	4%	4%	4%	2%	4%
Govt	251238	88671.4	48653.8	5773.25	394337	3%	4%	6%	4%	4%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Brushing frequency										
>1 times daily	6054870	1897780	659616	117912	8730177	83%	81%	81%	83%	82%
Once a day or less	1259478	454926	156627	24594	1895625	17%	19%	19%	17%	18%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%
Flossing frequency										
>1 times daily	2093548	737368	284814	50142	3165873	29%	31%	35%	35%	30%
Once a day or less	5220800	1615338	531428	92363.6	7459929	71%	69%	65%	65%	70%
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%

Variable	Column					Total	Q1	Q2	Q3	Q4	Total
	Q1	Q2	Q3	Q4	Total						
Dentate status											
Dentate	7007492	2216718	757402	130907	10112518	96%	94%	93%	92%	95%	
Edentate	306856	135988	58840.3	11599	513284	4%	6%	7%	8%	5%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Perceived health of teeth and mouth											
Excellent	4817047	1494642	502837	88915.8	6903442	66%	64%	62%	62%	65%	
Good	1850758	624046	228168	38807.5	2741779	25%	27%	28%	27%	26%	
Poor /Fair	646543	234018	85237.4	14782.3	980581	9%	10%	10%	10%	9%	
total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Satisfaction with teeth appearance											
Satisfied	6022632	1967488	671444	122514	8784078	82%	84%	82%	86%	83%	
Neither satisfied/dissatisf	819029	227872	82635	12704.3	1142240	11%	10%	10%	9%	11%	
Dissatisfied	472686	157346	62163.8	7287.01	699483	6%	7%	8%	5%	7%	
total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Uncomfortable to eat food											
No	6174420	1967563	665484	119549	8927015	84%	84%	82%	84%	84%	
Yes	1139928	385144	150759	22956.8	1698787	16%	16%	18%	16%	16%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Other Persistent Pain - Freq - 12 Mo											
No	6482916	2095411	707095	125822	9411244	89%	89%	87%	88%	89%	
Yes	831432	257295	109148	16683.4	1214558	11%	11%	13%	12%	11%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Bleeding Gums											
No	5518211	1793894	615450	115017	8042573	75%	76%	75%	81%	76%	
Yes	1796136	558812	200792	27488.7	2583229	25%	24%	25%	19%	24%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Had Persistent Bad Breath											
No	6386396	2045825	696148	126109	9254478	87%	87%	85%	88%	87%	
Yes	927952	306881	120094	16396.5	1371324	13%	13%	15%	12%	13%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Avoided going to the dentist for cost											
No	5,705,749	1,843,873	626,225	115,110	8,290,957	78%	78%	77%	81%	78%	
Yes	1,608,599	508,833	190,017	27,395.80	2,334,845	22%	22%	23%	19%	22%	
Total	7,314,348	2,352,706	816,243	142,506	10,625,802	100%	100%	100%	100%	100%	
Type Of Dental Visits											
Check-Ups or Treatments	6403251	1970079	664681	113438	9151450	88%	84%	81%	80%	86%	
Emergency Care /Never	911097	382627	151561	29067.6	1474352	12%	16%	19%	20%	14%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	
Last visit to dental professional											
≤ 1yr (regular)	5761117	1747939	589246	100269	8198571	79%	74%	72%	70%	77%	
> 1yr (irregular)	1553230	604767	226997	42236.5	2427231	21%	26%	28%	30%	23%	
Total	7314348	2352706	816243	142506	10625802	100%	100%	100%	100%	100%	

3.5.2 *Ontario inequality in dental visits*

Table 4 presents the results of a multivariate logistic regression that evaluated the impact of multiple explanatory variables on the dental use outcome, the last dental visit in the past 12 months.

3.5.2.1 Socio-economic and cultural characteristics

Patients over 55 years old were more likely to report frequent dental visits than those under 35 years old, with significant odds ratios and confidence intervals (OR 0.67; 95% CI: 0.53-0.85). Additionally, households' highest education level was positively associated with visiting the dentist once or more times a year. Graduates from post-secondary or university institutions experienced a reduction of 34% in the odds (95% CI: 0.46-0.93) of irregular dental visits during the last year compared to the less educated participants. Similarly, household income quantiles were associated with regular oral health visits in a graded manner, except for people in the household income quintile 2 (OR 1.02; 95% CI: 0.78-1.34), where there was no significant effect on the odds of irregular dental visits in the past year. In addition, subjects with dental insurance had an increased odds of visiting the dentist at least once annually than those without dental coverage. Among all the types of dental coverage, participants with private dental insurance had 62% lower odds (95% CI: 0.24-0.60) of not having a dental visit within the last 12 months than those with employer-based [OR 0.40 (60%) ; 95% CI: 0.34-0.48] and government-based [OR 0.45 (55%); 95% CI: 0.29-0.72] dental insurances.

3.5.2.2 Health behaviours

Smokers have a 36% greater chance of avoiding dental visits within the past year than non-smokers (95% confidence interval: 1.10-1.69). Similarly, patients brushing their teeth less frequently per day had 64% higher odds (95% CI: 1.34-2) of not visiting the dentist within the past year than those brushing their teeth at least twice daily. Conversely, patients reporting less frequent flossing were 30% reduced odds (95% CI: 0.58 to 0.85) of failing to see a dentist at least once a year than those reporting daily flossing. Another unpredictable trend was seen in alcohol intake. The odds ratios for irregular visit to the dentist were 20% lower (95% CI: 0.62 to 1.01) for people drinking at least once per week than those that never had consumed alcohol.

3.5.2.3.Disease outcomes

Diabetic patients had a 55% higher likelihood (95% CI: 1.09-2.19) of visiting their dentist irregularly than patients without this chronic condition. Moreover, edentate respondents had 7.61 times (95 % CI: 4.95-11.71) more odds to report irregular dental visits than those with teeth. Also, the odds of reporting infrequent dental visits were 152% and 115% higher in those with good (95% confidence interval: 1.70-2.72) or poor/fair (95% confidence interval: 1.82-3.48) health of teeth and mouth, respectively compared to the ones with excellent perceived teeth and mouth health group.

Table 4 Results of the multivariate logistic regression analysis for dental visits > 1 year in Ontario, weighted, Canadian Community Health Survey (CCHS), 2018.

Variable	Adjusted OR	[95% conf. interval]	
SOCIODEMOGRAPHIC VARIABLES			
Sex			
Female (Ref)	1.00		
Male	1.17	0.99	1.39
Age			
18–34 yrs (ref)	1.00		
35–54 yrs	0.79	0.61	1.02
≥ 55 yrs	0.67	0.53	0.85
Aboriginal identity			
No (Ref)	1.00		
Yes	1.31	0.70	2.42
Marital status			
Partner (ref)	1.00		
No Partner	1.03	0.87	1.23
Highest level of education - household			
Less than secondary school graduation (ref)	1.00		
Secondary School	0.77	0.52	1.14
Post secondary certificate diploma or university degree	0.66	0.46	0.93
Household income quintiles - health region level			
1 (lowest) (ref)	1.00		
2	1.02	0.78	1.34
3	0.71	0.52	0.98
4	0.57	0.43	0.77
5 (highest)	0.47	0.34	0.64
Labour force last 12 month			
No job (ref)	1.00		
Yes	1.25	0.98	1.58
HEALTH-RELATED QUALITY OF LIFE AND WELL-BEING			
Perceived mental health			
Excellent/Very good (ref)	1.00		
Good	1.03	0.67	1.59
Poor	1.06	0.73	1.54
Perceived health			
Excellent/Very good (ref)	1.00		
Good	0.99	0.82	1.20
Poor	1.13	0.82	1.55
Satisfaction with life in general			
Satisfied (ref)	1.00		
Neither satisfied/dissatisf	1.43	0.96	2.13
Dissatisfied	1.09	0.62	1.92
Sense of belonging			
Very strong (ref)	1.00		
Somewhat strong	1.12	0.90	1.41
Somewhat weak	1.33	0.98	1.79
Very weak	1.33	0.96	1.83
HEALTH BEHAVIOURS			
Smoker			
No (ref)	1.00		
Yes	1.36	1.10	1.69
Alcohol intake			
Never (ref)	1.00		
Less than once a month	0.80	0.61	1.04
At least once per month	0.78	0.58	1.06
At least once per week	0.80	0.62	1.01
CHRONIC DISEASE			
Diabetes			
No (Ref)	1.00		
Yes	1.55	1.09	2.19

Variable	Adjusted OR	[95% conf. interval]	
Dental insurance			
None (Ref)	1.00		
Employer	0.40	0.34	0.48
Private	0.38	0.24	0.60
Govt	0.45	0.29	0.72
Brushing frequency			
>1 times daily (ref)	1.00		
Once a day or less	1.64	1.34	2.00
Flossing frequency			
>1 times daily (ref)	1.00		
Once a day or less	0.70	0.58	0.85
Dentate status			
Dentate (ref)	1.00		
Edentate	7.61	4.95	11.71
Perceived health of teeth and mouth			
Excellent (ref)	1.00		
Good	2.15	1.70	2.72
Poor /Fair	2.52	1.82	3.48

Unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) reported.

The bolded reflect statistically significant findings

3.5.3 *Ontario inequality in dental visits by rurality degree*

The results of a multivariable logistic regression, stratified by degree of rurality, are presented in Table 5, which examines the effect of several explanatory variables on the dental use outcome of the last dental visit in the previous 12 months among different levels of rurality. See Table 5.

3.5.3.1 Socio-economic and cultural characteristics

Not surprisingly, regular dental visits increased with age. For example, in comparison to the young-old (18–34 years) groups, the oldest-old (aged 55+ years) were less likely to report visiting the dentist after one year with significant odds ratios and confidence intervals of (OR 0.67; 95% CI: 0.46-0.96) among the residents in accessible areas.

3.5.3.2 Health behaviours

Less frequent flossing is associated with 42% (95% CI 0.35-0.96) reduced odds of not visiting the dentist in the last year in remote and very remote areas, compared with residents from the same area that floss their teeth more than once a day.

3.5.3.3 Health-related quality of life and well-being

As decreases self-perceived general and mental health, it significantly increases the odds of not having visited the dentist in the last year than individuals. Additionally, people reporting a somewhat weak sense of belonging in accessible areas had 12% (95% CI 0.64-1.99) increased odds of having irregular dental visits than those with other sense of belonging rates and rurality categories. Similarly, people dissatisfied with life living in accessible and remote and very remote areas had 14% (95% CI 0.43-3.02) and 62% (95% CI 0.18-14.23) increased odds of having irregular dental visits than those satisfied with life.

Table 5 Results of multivariate logistic regression analysis for dental visits > 1 year (irregular), stratified by quartile of remoteness, Ontario, weighted, Canadian Community Health Survey (CCHS), 2018.

Variable	Q1 Less remote (ref)	Q2	[95% conf. interval]	Q3	[95% conf. interval]	Q4 Most remote	[95% conf. interval]			
SOCIODEMOGRAPHIC VARIABLES										
sex										
Female (ref)	1.00	1.00		1.00		1.00				
Male		1.23	0.94	1.62	1.28	0.90	1.83	0.93	0.50	1.73
age										
18–34 yrs (ref)	1.00	1.00		1.00		1.00				
35–54 yrs		0.97	0.68	1.40	0.81	0.51	1.30	0.78	0.38	1.60
≥ 55 yrs		0.67	0.46	0.96	1.09	0.66	1.79	0.60	0.28	1.30
Aboriginal identity										
No (ref)	1.00	1.00		1.00		1.00				
Yes		0.88	0.32	2.39	1.19	0.50	2.81	1.07	0.36	3.20
Marital status										
Partner (ref)	1.00	1.00		1.00		1.00				
No Partner		0.94	0.71	1.24	0.69	0.49	0.97	0.98	0.57	1.67
Highest level of education – household										
Less than secondary school graduation (ref)	1.00	1.00		1.00		1.00				
Secondary school		0.90	0.50	1.64	1.33	0.72	2.45	0.79	0.30	2.09
Post secondary certificate diploma or university degree		0.76	0.45	1.30	1.29	0.63	2.62	0.86	0.35	2.13
Household income quintiles – health region level										
1 (lowest) (ref)	1.00	1.00		1.00		1.00				
2		0.80	0.53	1.20	1.04	0.63	1.72	1.42	0.50	4.04
3		0.92	0.60	1.43	1.24	0.71	2.15	1.52	0.58	3.96
4		1.00	0.60	1.66	1.37	0.76	2.46	2.03	0.79	5.20
5 (highest)		1.06	0.56	2.00	1.04	0.58	1.89	2.11	0.80	5.59
Labour force last 12 month										
No job (ref)	1.00	1.00		1.00		1.00				
Yes		0.80	0.59	1.10	0.97	0.63	1.48	0.72	0.42	1.26
HEALTH-RELATED QUALITY OF LIFE AND WELL-BEING										
Perceived mental health										
Excellent/Very good (ref)	1.00	1.00		1.00		1.00				
Good		1.05	0.54	2.05	1.12	0.46	2.71	1.81	0.41	8.00
Poor		1.43	0.74	2.74	1.11	0.53	2.35	1.22	0.31	4.88
Perceived health										
Excellent/Very good (ref)	1.00	1.00		1.00		1.00				
Good		1.16	0.86	1.55	1.16	0.76	1.78	0.96	0.54	1.70
Poor		1.16	0.68	1.99	0.80	0.43	1.51	0.78	0.30	2.03
Satisfaction with life in general										
Satisfied (ref)	1.00	1.00		1.00		1.00				
Neither satisfied/dissatisf		0.70	0.34	1.43	0.80	0.36	1.76	1.16	0.21	6.35
Dissatisfied		1.14	0.43	3.02	0.82	0.31	2.19	1.62	0.18	14.23
Sense of belonging										
Very strong (ref)	1.00	1.00		1.00		1.00				
Somewhat strong		0.85	0.51	1.41	0.72	0.45	1.18	0.67	0.40	1.14
Somewhat weak		1.12	0.64	1.98	0.66	0.34	1.28	0.61	0.30	1.22
Very weak		0.87	0.50	1.52	0.60	0.25	1.43	0.47	0.09	2.43

Variable	Q1 Less remote (ref)	Q2	[95% conf. interval]		Q3	[95% conf. interval]		Q4 Most remote	[95% conf. interval]	
HEALTH BEHAVIOURS										
Smoker										
No (ref)	1.00	1.00			1.00			1.00		
Yes		0.78	0.48	1.25	1.38	0.93	2.04	1.02	0.59	1.78
Alcohol intake										
Never (ref)		1.00			1.00			1.00		
Less than once a month	1.00	1.28	0.84	1.98	1.07	0.64	1.80	0.89	0.31	2.58
At least once per month		1.14	0.71	1.83	1.18	0.66	2.10	1.07	0.40	2.85
At least once per week		1.09	0.70	1.69	0.96	0.59	1.55	0.92	0.44	1.95
CHRONIC DISEASE										
Diabetes										
No (ref)	1.00	1.00			1.00			1.00		
Yes		0.97	0.65	1.45	0.69	0.39	1.23	1.21	0.51	2.87
ORAL HEALTH SURVEY COMPONENT										
Dental insurance										
None (ref)		1.00			1.00			1.00		
Employer	1.00	0.99	0.74	1.34	1.00	0.69	1.45	0.67	0.35	1.29
Private		1.21	0.52	2.79	0.37	0.13	1.05	0.30	0.07	1.38
Govt		0.85	0.46	1.58	1.14	0.58	2.23	1.46	0.36	5.96
Brushing frequency										
>1 times daily (ref)	1.00	1.00			1.00			1.00		
Once a day or less		0.90	0.64	1.27	1.19	0.81	1.74	1.30	0.68	2.47
Flossing frequency										
>1 times daily (ref)	1.00	1.00			1.00			1.00		
Once a day or less		0.86	0.64	1.16	1.10	0.69	1.75	0.58	0.35	0.96
Dentate status										
Dentate (ref)	1.00	1.00			1.00			1.00		
Edentate		0.89	0.54	1.46	0.78	0.32	1.91	1.16	0.26	5.17
Perceived health of teeth and mouth										
Excellent (ref)	1.00	1.00			1.00			1.00		
Good		0.89	0.61	1.30	0.54	0.33	0.88	0.83	0.45	1.54
Poor /Fair		1.39	0.86	2.26	0.85	0.48	1.49	1.05	0.52	2.14

Unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) reported.

The bolded reflect statistically significant findings

3.6 Discussion

3.6.1 Integrating rurality measures in oral health disparities research

Several strengths of the study were noted. To the best of our knowledge, this is the first study to examine the relationship between several demographic, socioeconomic, and health-related factors, and dental care use in Ontario among both urban *and* rural populations based on large, nationally representative datasets. Consequently, well-rounded perspectives were gained on communities' experiences of oral health services utilization. The study also utilized appropriate survey procedures and statistical methods in order to provide valuable population-level adjusted prevalence estimates and confidence intervals.

Informed by our findings, rural communities could improve the quality and access of dental care and increase uptake by individuals in rural areas. Several Canadian provinces have similar financing schemes and dental care systems, so program coordinators and managers from other jurisdictions may find the resulting gaps useful for guiding change within their context. It is also possible that the results of this study may not apply to every remote community in Canada. Future studies may add robustness to the recommended strategies by increasing the sample size and incorporating perspectives from other provinces.

3.6.2 Accounting for multiple gaps in access to dental services

Evidence supports that rural Canadian communities have lower dental care access and utilization levels than their urban counterparts (102,103). Understanding the risk factors associated with these oral health disparities provides insight into the dental health service needs within rural and remote populations. It also facilitates the identification of potential

areas of focus in designing and implementing interventions and policies to improve dental care utilization.

This study explored the associations between diverse socio-demographic, socioeconomic, behavioural and health-related factors and not visiting a dental professional in the past 12 months in different rurality groups to understand these risk factors better. It makes an important contribution to the literature by combining CCHS data with Statistic Canada's Rurality Index, allowing the creation of a rurality variable with four levels of remoteness: easy access, accessible, less accessible, and rural and remote areas.

A key finding of this analysis is that 22.8% of Ontarians adults had not seen a dentist within the past 12 months, which despite the increasing recognition of oral health, is a level similar to previously reported levels (27.8%) in 2014 (92).

Additionally, the prevalence of infrequent dental visits was significantly higher among partnered adults. A few studies have examined the association between marital status and access to dental care in Ontario (92,104), but no association was established.

The rural residency was found to be an independent factor associated with lower dental care utilization. The results of our study are similar to those of an Australian study, which found that people living in regional and remote areas of Australia have poorer oral health than those living in metropolitan areas (105). Dental care use in rural areas may be reduced due to the lower density of dentists there. Several nationally and abroad studies have shown that dentists are more likely to practice in metropolitan areas than in rural areas (106–108). A variety of socioeconomic characteristics have been associated with the distribution of dentists in additional analyses (109). For example, in a study examining patient satisfaction with oral health care, rural and urban Quebec residents differed significantly on four items,

including dental office location, dental equipment, cost of dental treatment, and cleanliness of dental office.

According to the findings, people younger than 35 years of age were positively associated with insufficient dental health care utilization. This finding agrees with evidence from Canada, and internationally suggesting that dental visits increase as people age (92,104,110).

Additionally, this study found that subjects with diabetes were more likely to have infrequent dental appointments. According to a recent study, the same is true for Australians with diabetes (111). This could be explained by fewer dental visits among diabetic patients due to lack of perceived needs, cost barriers, or fear (112). Population-based studies suggest that poor self-reported oral health is associated with an increased risk of acute and chronic diabetes complications (113), which can lead to severe oral health, periodontal, or dental conditions requiring emergency dental treatment. Study results also showed that people without teeth or fewer teeth were less likely to seek dental care. Those living in poverty are more likely to suffer from edentulism. Dental insurance coverage, access to dental care, dentist-population ratio, and age also contribute to the prevalence of complete tooth loss. The consequences of edentulism range from ridge resorption to impaired masticatory function, poor diet, social disability, and poor oral health quality of life. Additionally, edentulous individuals are at greater risk for systemic diseases such as cancer and mortality (114). Regular dental care might improve outcomes by detecting cancer earlier (115). Additionally, routine dental care contributes to better health outcomes by preserving physiologic dentition.

Engaging in risky health behaviours like smoking is also associated with poorer dental health utilization, making this the most significant risk factor for the prevalence and severity of periodontal disease (116). Previous studies have shown smokers to be less likely to visit the dentist than non-smokers (117). Low dental care utilization includes dental anxiety, lack of perception of need, and financial barriers (118).

Interestingly, our results revealed that those who consumed alcohol at least once per week were less likely to report having poor dental care use. Two previous data analyses of the dental care module of the 2014 CCHS cycle confirmed these findings about the protective effects of alcohol in dental care utilization in Ontarians and Ontarians aboriginals (92,104). In addition, previous studies have found a weak correlation between alcohol consumption and caries and periodontitis. A possible biological model was suggested to explain the potential association between heavy alcohol abusers and dental care use. Microorganisms may produce acetaldehyde from ethanol in saliva, which potentially increase fluoride release from certain filling materials, reducing caries susceptibility by decreasing cariogenic bacteria and resulting in fewer dental visits (119).

Furthermore, this study confirms that social-economic disparities in oral health and self-reported abstention from dental care due to cost persist (86,90,120–122). Cost is still a major obstacle to obtaining dental care. Around one in five Ontarians report financial barriers to dental care. Low household education, income, and no dental insurance are significantly associated with poor dental care usage. However, income has a larger impact on dental care use not via dental health but because income levels affect an individual's decision to get dental coverage (123).

In this study, education level and frequent dental visits were also significantly associated, with high educated individuals reporting less poor dental care use. There is a positive correlation between dental education and use in international studies as well. In Australia, researchers found a strong association between education and recent dental visits (124). Education and health are interrelated in several ways. One way is that Education relates to health literacy. Research has shown that health literacy predicts an individual's health, behaviour, and health outcomes to make informed decisions about their health. Two studies found that oral health literacy levels were significantly higher among those who attended more often for dental care (125,126). Secondly, in many models of health service use, tertiary education is an enabling factor of socioeconomic status and social class (127). Finally, education plays a significant role in health by shaping employment opportunities, which are a major determinant of economic resources. People with more education tend to have lower unemployment rates, which are strongly associated with poorer health (43).

Regarding dental care behaviours, infrequent dental care visits were significantly correlated with less frequent brushing and poor self-rated teeth and mouth. Higher incomes and employment are associated with better self-rated oral health; being employed with a stable and good income may enable healthier lifestyle choices and ultimately result in better self-rated oral health (121,128). It may also result in more frequent preventative dental visits than emergency ones. This is consistent with a previous Canadian study about dental care utilization predictors, in which poor oral health was associated with lower dental care utilization, possibly due to fear of dental costs or anxiety about treatment (89). One unexpected and opposite finding from the brushing and self-rated oral health was flossing once or less a day, which was associated with an adequate dental visit pattern. Although

the literature has suggested that professional flossing in children with low fluoride exposures is highly effective in reducing interproximal caries, self-performed flossing has not shown evidence of diminishing caries risk (129). This finding might be explained by long-standing aggressive and incorrect dental floss techniques that cause interproximal cervical lesions, tooth abrasion, and gingival recession. In one large observational study, flossing was associated with a lower prevalence of periodontitis, but the magnitude of the association was modest. Furthermore, the authors support the idea that flossing twice or four times a week might be as beneficial as flossing more frequently (130).

Despite the fact that not all results were significant in the multivariate logistic regression analysis for irregular dental visits by quartile of remoteness, it was considered necessary to discuss the general directions of some of those findings briefly since they can be useful as a rough guide in future replications with large extent on the sample size. The intervals of confidence were very wide in most cases, indicating that the sample size was small and that the sample does not accurately reflect the population mean. Further information and studies are needed to confirm or deny the association. A possible explanation for these results may be the lack of adequate sample size, and redefining the rural definition into three levels could address this situation.

According to the findings, socio-demographic factors such as being male, aboriginal, and not participating in the labour force were positively associated with insufficient dental health care utilization. Regular dental visits vary by sex, with women more likely to visit regularly than men. According to a recent US survey, women visited the dentist more proactively than men, and the rate of periodontal disease, oral cancer, and dental trauma are also lower among them (131). Previous studies from York University indicated that

more than a quarter of Indigenous communities in Ontario saw a dentist irregularly and only for emergencies (117). According to Australian researchers, Aboriginal Australians also have lower access rates to oral health services and are more likely to visit for emergencies (132,133).

Dental visits are also likely associated with health-related quality of life and well-being variables: perceived mental and systemic health and satisfaction with life. The observed patterns revealed that the rate of dental visits would probably decrease as participants reported poorer mental and systemic health and more dissatisfaction with life. A comparison of the findings with those of other studies confirms that patients with lower mental health levels usually underutilize dental services. The reasons for underutilization include stigma, shame, helplessness, low self-esteem, lack of financial or health insurance, dental fear, anxiety, phobia, and restlessness (134). Individuals with poor mental health are also more likely to be from low-socioeconomic groups, unemployed, and have substantial medical conditions (135), and these factors could aggravate the underutilization of dental services. Another study reported that British regular dental attendees felt that oral health positively enhanced their quality of life (136).

3.6.3 Methodological caution in analyzing CCHS data

Several limitations exist in the study that restricts the results' applicability and generalizability. Due to the cross-sectional nature of the CCHS survey, this study design cannot test temporality or identify specific causes for inequalities in oral health and dental non-attendance; it can only identify associations. It will be necessary to conduct longitudinal studies to establish causality. Secondly, the CCHS survey excludes some population groups such as Canadians that reside in institutions, on Crown Land or Indian

Reserves, any Canadians that are full-time members of the Canadian Forces, and, more importantly, those that live in very remote regions. The survey results were therefore influenced by a small number of rural-dwelling adults, reducing the power of statistical tests to detect associations. Further research could investigate different definitions of “rural” compared to “urban.”

Moreover, self-reported survey data may be biased in many ways. As no clinical data is available, it has been challenging to evaluate the reliability and validity of data about clinical aspects such as tooth decay, tooth loss, tooth fillings, and the depth of periodontal pockets, which may provide insight into the effects of dental visits on oral health. Data could be inaccurate due to misinterpretation of questions or survey fatigue. During surveys, individuals may answer questions incorrectly due to recall errors or give socially acceptable responses due to social desirability bias. Further research is needed to clarify whether there are any associations between reported and objective data. Finally, the sample size was chosen in order to estimate the prevalence of oral health utilization in Ontarians. Analyses that use variables with multiple categories have a reduced level of power.

3.6.4 Incorporating spatial sampling methods in the implementation of evidence-based dental care interventions.

A wide range of dental health policies, practices, and interventions are now being implemented in many developed countries, providing dental care and training dental professionals to rural populations. Finding conclusive evidence to support the effectiveness of these interventions remains a challenge in oral health services research. Most literature contains several programs and interventions with serious flaws, as fundamental knowledge gaps are not adequately acknowledged. Therefore, it is crucial to conduct more well-

planned oral epidemiological studies that incorporate sampling methods in urban and rural groups at a nationally representative level and use those as a foundation to develop interventions funded by statistical research collaborations with a substantial body of evidence-based research and guidance. Hence, the changes are more effective and sustainable than targeted interventions at the individual level.

This study will serve as an excellent example of such a strategy as the findings will serve as a foundation for developing a scoping review in rural dental care interventions conducted by the same author. Once the contemporary factors influencing the Ontarian rural settlers' lack of regular dental visits were identified, specific interventions and policies can be searched in the literature to close those gaps in dental care provision. They would have important implications for governments, oral health professionals, policy makers, and public health initiatives.

3.6.5 Conclusions

A study shows dental care use patterns in Ontario's rural areas for the first time. The study found differences in dental visiting frequency by geographic location, gender, age, income, education and health behaviours.

Over 23% of people reported not going to the dentist in the past year, while 14% reported only visiting for emergency reasons or not visiting at all. Rural and remote populations have lower dental visit rates than those who live in urban areas. Additionally, the odds of poor dental visits were higher for males, individuals with aboriginal status, low household income, low education levels, lack of dental insurance, poor dental health, smokers, edentates, and diabetics. In addition, poor dental visitors were significantly less likely to practice oral hygiene habits than exemplary dental visitors. Finally, regular dental visits

also improved various components of quality of life, such as self-perceived systemic, mental and dental health, sense of belonging and life satisfaction.

The findings of this study support the recommendation that oral health providers and policymakers should be aware of the unacceptable disparities in access to dental care experienced by rural Ontarians, to understand the factors contributing to these disparities, and to resolve these issues by integrating oral health programs into rural health care and policies. Further research can suggest effective programs associated with dental care utilization among rural individuals. These interventions must change attitudes and behaviours towards oral health and health policy reforms to obtain more affordable dental care or include publicly funded financial support programs for rural settlers without dental insurance. This will improve dental care-seeking behaviours and create a healthier nation by preventing chronic conditions that often follow dental diseases.

Chapter 4 - Disparities in Oral Health and Access to Dental Care in Rural Communities: Scoping review

In this chapter, it was assessed the third objective of this study. Building from the above results in Chapter 3, dental policies and practices in Canada, Australia and New Zealand were reviewed to examine those that address key factors related to observed inequities. This chapter consisted in structured scoping review with the following sections: 1) Introduction, 2) Methods, 3) Results and 4) Discussion, both of them will be submitted for publication.

4.1. Abstract

Introduction: Although equity in access to health services is a priority concern for the World Health Organization, numerous studies have shown that not all people have rates of key oral health indicators, even in highly developed nations. In particular, rural communities generally exhibit poorer access to oral health services.

Objective: This study aimed to map rural dental care interventions in three comparable highly developed nations (Australia, Canada, and New Zealand), to inform rural oral health policies in Ontario, Canada. Most study designs were considered for inclusion, excluding opinion-based articles.

Methods: The JBI methodology for scoping reviews was followed. Databases searched include CINAHL (EBSCO), PubMed Central (PubMed), and Scopus (Elsevier). Articles published in English after 2000 were included. Selected data was extracted in a customized table by two independent reviewers. Results were summarized in a tabular form and narratively on intervention characteristics. Interventions were also evaluated against the framework developed by Levesque et al.'s access model (42).

Results: Out of 295 potentially eligible articles, 60 studies describing program initiatives to improve access to oral health care in rural and remote communities were selected for this scoping review. There were four categories of initiatives: oral health promotion and prevention, education, community engagement, shared responsibility and partnerships, and service delivery models. The programs were successful in reducing caries and periodontal disease, increasing dental access rates and rural practice, and enhancing the competence and self-efficacy of dental and allied health professionals. This review may serve as models for other rural and remote regions world however the complex interplay between psychosocial and cultural determinants of oral health should be considered as poses a challenge when it comes to implementing successful oral health interventions in rural communities.

4.2 Introduction

Despite overall improvements in oral health, there are still unfair and unjust differences in the access and quality of oral health, known as disparities, among populations, such as lowest-income earners, uninsured, members of racial or ethnic minority, immigrant, or rural populations. This problem is particularly severe in those living in rural regions, experiencing a disproportionate burden of oral health inequalities (16,21,137,138). Evidence suggests that disparities in oral health faced by rural communities are influenced by various factors but relate predominantly to the marked differences in the determinants of health, such as poverty, remoteness, access to services, government policies, and cultural and environmental factors (42,82,86). There are several problems associated with remoteness, including shortages and uneven geographic distribution of the dental workforce, with the majority working in private practices and clustered in urban areas (16), which is detrimental taking into account that Canada is the second largest country in the world in terms of area after Russia. Rural areas comprise the vast majority of Canada's landmass. Other causal factors associated with poor rural oral health access may include scarcity of resources and socioeconomic gradients in many communities (140). As a result, many dental diseases amongst low socioeconomic status (SES) groups go untreated, widening the gap between their dental health and the rest of the population (21,141). The lack of access to fluoridated water and the cost of healthy food choices and oral care products may also contribute to this population's poor oral health (21).

There is plenty of evidence from comparable countries, such as Australia and New Zealand, that dental health is still problematic in their remote populations. For example, the Council of Australian Governments, the peak intergovernmental body in Australia,

reported that people in regional and remote areas of Australia have poorer oral health than those living in the greater metropolitan areas and the status of oral health deteriorates with increased remoteness (105,137). In addition, Australian children and adolescents living in rural areas experience higher rates of dental caries than in those living in metropolitan regions (142). A number of factors contribute to oral health care being unavailable in these rural areas, including fewer dental practitioners compared to those in cities, longer travel times, and limited transportation options (105,137,143).

New Zealand's child oral health statistics are unfavourable compared to those in Australia, a 2003 study on the oral health of New Zealand children reported that children living in rural areas have a greater risk of poor oral health than those living in urban areas (144). Lack of access to water fluoridation and/or oral health services and attitudes to oral health can contribute to these oral health inequities (84). For example, community water fluoridation is prevalent in larger communities. However, water fluoridation has been a well-documented ongoing issue in rural New Zealand for some time, notably in children in rural areas, such as Northland, Eastern Bay of Plenty, and Tairāwhiti, who do not have access to the benefits (145). In addition, Māori people may be unable to access oral health services due to distance or poor transportation, especially in rural or isolated areas where the school's dental clinic may be some distance away and where dental therapists may only be available for a brief period of time (146).

Furthermore, inequalities in untreated tooth decay are also evident in the literature. Australian children and adolescents living in rural areas experience higher rates of dental caries than those living in metropolitan regions (147). Similarly, evidence from the Dunedin Multidisciplinary Health and Development Study (DMHDS) found that children

born to younger or less educated mothers or who lived in rural areas had a higher risk of dental caries (148). Nevertheless, disparities in untreated caries are wider in New Zealand than in Australia (141).

Dental caries and other oral diseases can result in physical consequences such as pain and acute and chronic infection if left untreated (21). Dental caries can adversely affect both the individual and interpersonal relationships (e.g. family, friends, etc.) due to the unsightly appearance and loss of teeth, resulting in embarrassment, shame, low self-esteem, and potentially limiting employment opportunities (6).

Apart from the health consequences, the economic burden of dental diseases remains high globally. For example, in Australia, the cost of dental care increased from \$6 to \$9 billion between 2005 and 2013(149). In Canada, public sector spending on dental care has increased over the years, going from \$311 million in 1988 to \$933 million in 2017; it still represents a small portion of national spending on dental care. Indeed, of the \$15 billion spent on dental services in 2017, only 6% was attributed to the public sector (federal, provincial and municipal governments) (28).

The majority of dental diseases can be prevented or managed, and preventive measures can minimize their negative effects however as with most complex health problems, no single strategy is a panacea for addressing access to dental services and inequities in oral health. The deep exploration of the literature for practical, innovative, and alternate models to improve dental health access in rural communities is thus crucial for addressing this situation. While Canada has seen the design and creation of various innovative models to overcome oral health inequities (19,20), it has not generally been seen as a leader in rural health research or innovation (150). As such, to inform the development of policies and

programs more fully in Canada, it is essential to thoroughly examine all aspects of oral health care disparities and to consider the evidence from similar countries. This led us to conduct a statistical study on patterns of dental health utilization and provision in rural residents of Ontario based on data from the 2018 Canadian Community Health Survey, combined with geographic “Index of Remoteness” classifications.

On the basis of these findings, the purpose of this present paper was to describe oral health interventions implemented in rural populations in Canada, Australia and New Zealand.

Many countries worldwide provide dental health care to rural populations, but these three countries have been selected because they have universal or financially subsidized health care programs that offset some or all of the costs associated with health care. They also share similar geographical regions with a substantial rural population (e.g. in 2021, 17.8% of Canadians and 13.6% of Australians live in rural communities, whereas in 2018, 16.3% of New Zealanders reside in rural settings). Lastly, researchers within these countries consistently collaborate to study rural populations. See Table 1

To fulfill the above objective, a preliminary search of PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews, and *JBIR Evidence Synthesis* was conducted in August 2021 for existing systematic or scoping reviews on dental interventions in rural communities in highly developed nations, and no current or in-progress reviews were identified. There is evidence that each country included has implemented different approaches to improve access to dental care. Unfortunately, their characteristics, setting, target population, and outcomes are vague, dispersed or not clearly described in the literature. In most cases, there is no summary and comparison of policies or interventions

in the context of rural dental health, thus limiting the applicability of available research for implementation in rural settings.

By understanding the gaps in knowledge and challenges in implementing rural dental care strategies, mainstream dental health care services may be able to improve the accessibility of oral health care services in these countries. It also examined rural oral health care services in terms of access and accessibility based on the framework developed by Levesque and colleagues, which is, to our knowledge, the first comprehensive examination of dental services and interventions.

4.3 Methods

A scoping review method has been selected as it is a valuable approach in knowledge synthesis. It collects, summarizes, and disseminates findings and evidence from diverse study designs and grey literature, which facilitates identifying research gaps and finding new research areas

As detailed below, we conducted a scoping review using the five-stage framework outlined by Arksey and O'Malley.

4.3.1 Identifying the research question

One specific research question guided the selection of relevant literature for this scoping review: What interventions and policies have the strongest evidence for reducing oral health disparities and improving rural access for rural and remote communities of Canada, Australia and New Zealand?

To help frame the research question, the PICO method is used to identify the population, intervention, comparison population, and outcomes of interest for the scoping review. The PICO method for the research questions is:

P Rural residents in highly developed nations with public health systems (Australia, Canada, New Zealand)

I Oral health interventions (policies, programs, coverage)

C Comparison by different inequities (Rural vs. Urban, Income, Indigenous, Immigrant, other SES)

O Access to oral health services and positive oral health outcomes

4.3.2 Identifying relevant studies and eligibility criteria

In order to identify possible "text" keywords in titles and abstracts of relevant results, a systematic scoping search was conducted in Medline (Pubmed) by (MM), refined by Health and Biosciences Librarian (HM) and reviewed by other members of the research team, then adapted for other databases CINAHL (EBSCO) and Scopus (Elsevier) with index terms to develop the full-text search. See Appendix C.

In addition to the electronic search, a manual review of the references was conducted to snowball retrieve additional relevant documents. Data were also obtained from various websites, including relevant universities and professional, government, rural, and remote oral health organizations. This search was conducted from inception to date. Only English publications addressing rural oral health care initiatives and published from 2000 to the present were included. The term oral health intervention is defined as a program initiated by an external agency in a target community to improve oral health outcomes. The reviewers selected papers reporting the design or implementation of an oral health program or intervention tailored to rural communities needs. Additionally, the effects of these interventions on oral health outcomes were examined.

The following tracked four vocabulary groups were used to develop a detailed search strategy, which included specific MeSH terms, subject headings, keywords, and index terms: a. geographic area (Canada, Australia, New Zealand); b. population (rural, remote); c. field (oral health, dental); and d. access (intervention, health policy, service).

Upon screening and extracting data from candidate articles, new search terms were incorporated into the search strategy [MT], and the search was updated on 24 April 2019, 16 July 2020 and 29 December 2021. Figure 2 PRISMA Flow Diagram illustrates the results of the final search strategy. Covidence was used to deduplicate records.

Most scoping reviews lack an appraisal of the quality of the included studies (151). However, some researchers suggest that a quality appraisal may be included in a scoping review even though it is not a mandatory element (152). Indeed, a scoping review of scoping reviews found that a lack of quality appraisal is often cited as a limitation of scoping reviews with negative implications for interpretation (151).

4.3.3 Selecting studies and charting the data

The identified citations were extracted from the databases and imported into Mendeley VX.X (Mendeley Ltd., Elsevier, Netherlands) to create a reference file. The retrieved titles and abstracts uploaded into Covidence (Cochrane), which is an online review management tool that facilitates this screening process.

The two researchers (MT and AF) performed two screening levels. Initially, titles and abstracts of the (439) references retrieved were reviewed for eligibility. If titles met the eligibility criteria or were unclear, abstracts were read. In certain instances, the citations were considered for the second level to prevent any misunderstandings. The second step consisted of obtaining and evaluating the relevant full text of the remaining

(295) references independently by the two authors based upon the eligibility criteria, who then agreed on whether an article should be included. The full-text papers that fail to meet the inclusion criteria were excluded, and the reasons are outlined in. In the event of a disagreement between the reviewers, a discussion or participation of a third reviewer resolved the matter. Despite the exclusion of editorials, commentaries, and reviews, the references to the original studies were searched and included in our study.

Each reviewer then extracted 50% of the included from the full texts (approximately each). Discrepancies were addressed through discussion between the two reviewers, or a third project team member was available to make the final decision (PP), but this did not prove necessary.

4.3.4 Inclusion criteria

Inclusion criteria for the search were 1) reports published between 2000 and 2022; 2) studies reporting oral health prevention interventions for any age group, including children, adults, pregnant women, and elderly; 3) studies conducted in rural or remote areas; 4) studies that examined oral health-related outcomes, whether they were clinical or behavioural in nature, 5) studies published in English.

4.3.5 Critical appraisal of included studies

Qualitative, quantitative, and mixed methods reviews are increasingly popular due to the potential for addressing complex interventions and phenomena, particularly assessing and improving clinical practice. However, given the heterogeneity of the designs of the studies and the scoping review nature represent a challenge to judge the quality of individual studies.

Two critical appraisal checklists were used to appraise the quality of the included studies to overcome this situation. As Levac et al. (176) stated, a lack of quality appraisal made it difficult to interpret the results of scoping reviews, especially concerning policy and practice implications. Similarly, Pham et al. (151) recommend that scoping reviews assess study quality, but this should not be used as a criterion to select which studies to include since the purpose of a scoping review is to provide a broad overview of the evidence, which may be limited by rejecting studies for quality reasons. A quality appraisal element is more likely to assist in identifying gaps in the literature when included in scoping reviews. Consequently, this review included an assessment of quality, but the results were not used to exclude studies.

One is known as the Mixed-Methods Appraisal Tool, which is designed to facilitate the evaluation of qualitative, quantitative, and mixed-methods studies concurrently. It is useful because it allows for simultaneously evaluating different types of empirical studies. (153). After two screening questions, each included study was rated in the appropriate category of criteria as 'yes', 'no' or 'not sure'. Although an overall score is discouraged, the MMAT provides a more detailed analysis of each criterion to better inform the quality of included studies.

The second method is called the Measurement tool to assess systematic reviews (AMSTAR), which is used to validate and assess the methodological quality of systematic reviews of RCTs [26]. Like the first method, it does not produce an overall score. Information for quality assessment was incorporated into the data extraction form.

4.3.6 Charting the data

Using Mendeley, both authors independently extracted relevant data from the final (number) articles as follows: 1) Macro descriptive study information: authors, year of publication, Origin/country of origin, aim/purpose, design and methodology 2) The micro descriptive information varies depending on how the article addresses oral health: target population and sample size, oral health service, program setting and date, challenges and barriers, results, conclusion, and whether Levesque's Conceptual Framework for Access Evaluation is used. This process was repeated for the four additional articles gleaned from later search reruns.

4.3.7 Collating, summarizing, and reporting the results

The charted data was analyzed and refined through the use of descriptive, numerical summaries, and qualitative thematic analysis, as proposed by Thomas and Harden (28). The data extraction tool identified and highlighted meaningful concepts relevant to the research objectives and assigned codes. Next, similar codes were grouped and categorized and descriptive themes were created.

The last step of the process consisted of developing an analytical framework using the Levesque et al. access conceptual framework, where each intervention was mapped according to the dimensions of care addressed (approachability, acceptability, availability/accommodation, affordability, and appropriateness), considering that an intervention could cover more than one dimension of the access framework. This model's strength is that access does not stop when the health care intervention is reached. Rather, it examines how rural residents can access and stay involved with dental care initiatives over time (29, 30).

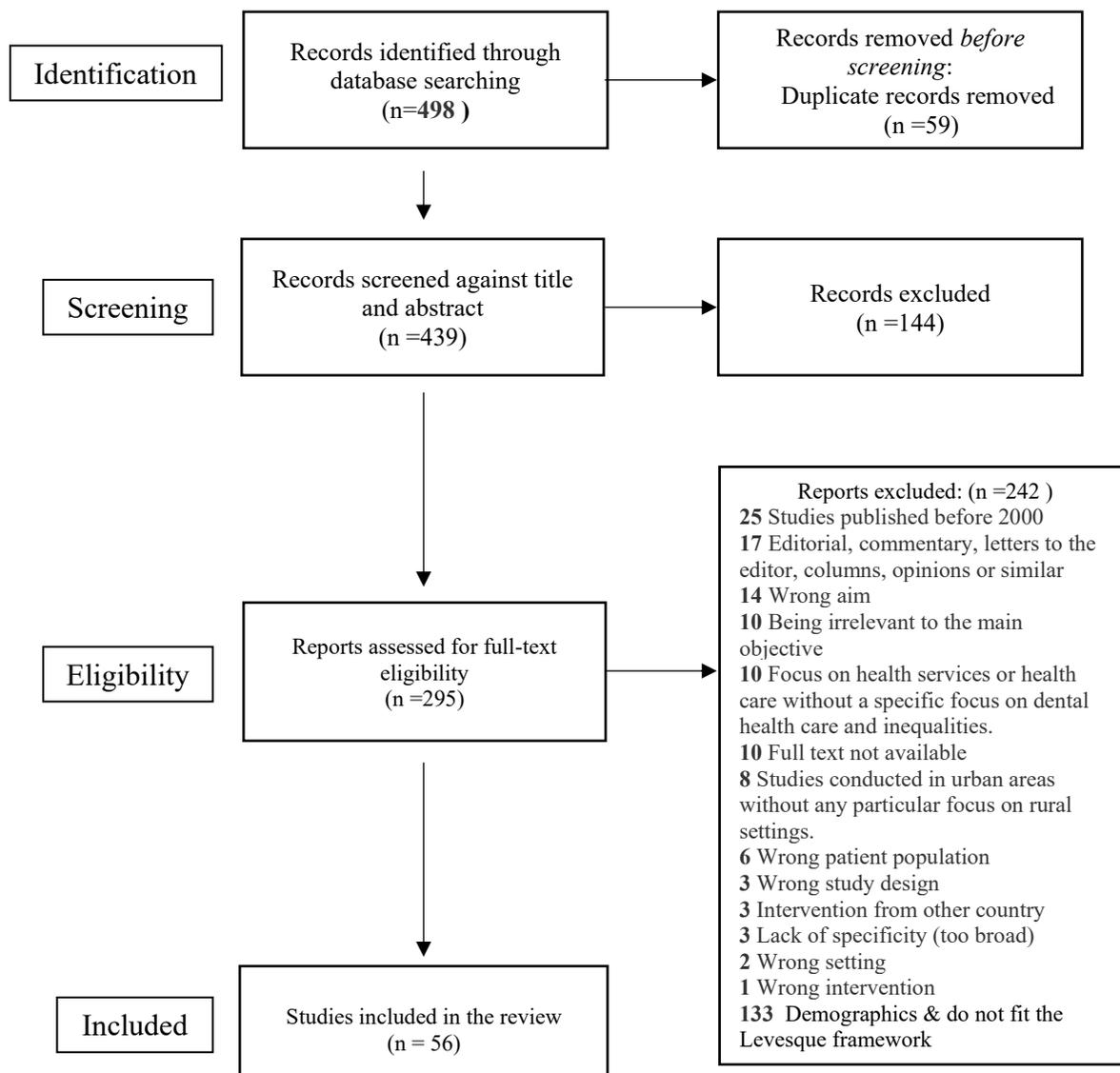
An Excel spreadsheet was used to facilitate and analyze themes and to compare data in a systematic manner. The scoping review team (MT, EP, PP) conducted investigator triangulation by examining the charts, results, and outcome measures.

4.4 Results

4.4.1 Flow of studies

As a result of electronic and hand searches, 498 records were identified. Following the removal of duplicate citations, 439 citations were screened for title and abstract, out of which 295 were selected for full-text review. A total of 56 publications met the eligibility criteria for the scoping review and were consistent with the Levesque framework. In 2022, four were added as a result of the snowball process. See Figure 2.

Figure 2 PRISMA Flow Diagram



4.4.2 Characteristics of the included publications

An overview of the characteristics of the programs included in Table 6 can be found below. This review included 60 papers that fit the Levesque framework: 33 quantitative, 19 qualitative, four mixed-methods, and four structured reviews. The quantitative studies included a wide variety of study designs, including fourteen quantitative descriptive studies, seven randomized controlled trials and twelve non-randomized studies.

Studies were conducted primarily in Australia (18,154,163–172,155,173–182,156,183–192,157,193–200,158–162), but also in Canada (201–210) and New Zealand(211,212) in the last two decades. The included studies covered a wide range of years, starting in 2002 and ending in 2022. With six publications, 2020 was the year with the greatest number of publications. This was followed by 2012, 2013, 2016, 2018 and 2021 each with five publications. Distribution years are as follows: 2002 (179), 2004 (201,209), 2005 (191), 2007 (181,194), 2008 (184,210), 2009 (167), 2010 (185), 2011 (156,160,182), 2012 (18,165,172,188,204), 2013 (169,173,178,183,186), 2014 (200), 2015 (154,189,202,211), 2016 (157,166,195,196,198), 2017 (171,177,192,208), 2018 (161,187,197,205,207), 2019 (155,162,190), 2020 (159,163,175,180,203,212), 2021 (158,164,168,170,176) and 2022 (174,193,199,206)

The majority of initiatives identified in the scoping review focused on children (n=24), followed by programs serving mixed populations (n=13), which encompass a broad range of subpopulations, including children, adults and older adults. Only one program targets adolescents (n=1), five programs target adults (n=5), and two programs target seniors (n=2). In addition, a significant number of interventions do not have specific targets and have been identified as non-applicable due to their nature (n=15). See Table 8 for a summary of the research classification.

Table 6 Summary of Research Classification

Characteristics	Number of References
<i>Mixed Methods Appraisal</i>	
Qualitative	19
Randomized controlled trials	7
Non-randomized studies	11
Quantitative descriptive studies	15
Mixed methods	4
<i>AMSTAR 2 Appraisal</i>	
Other Structured Review	4
<i>Location/Region of Focus</i>	
Australia	50
Canada	8
New Zealand	2
<i>Target Population</i>	
Pediatric	24
Adolescents	1
Adult	5
Older Adults	2
Mixed	13
Not Applicable	15
<i>Publication years</i>	
2002	1
2004	2
2005	1
2007	2
2008	2
2009	1
2010	1
2011	3
2012	5
2013	5
2014	1
2015	4
2016	5
2017	4
2018	5
2019	3
2020	6
2021	5
2022	4
<i>Total References</i>	60

4.4.3 Quality assessment results

Mixed methods appraisal tool (MMAT)

Studies with low quality received scores below 40%, those with the average quality received scores between 60% and 80%, and those with high quality received scores between 80% and 100%. Among the 56 studies included in the MMAT critical appraisal analysis, the majority (n = 37) was rated as having a high quality, while the number of studies rated as average (n = 11) and low (n = 12) was almost evenly distributed. Studies with high MMAT scores (80% - 100%) have contributed to the integrity of the current scoping review.

Fourteen out of 19 qualitative studies were regarded as high quality, three received were considered to be of average quality, and two were of low quality. See Table 9. Methodological problems in the identified studies included: incomplete or poor reporting of methodology; unclear methods of data collection or forms of data; and insufficient study context and relationships between findings and characteristics. Three of the seven randomized control trials were rated as high-quality studies, two as average-quality studies, and two as low-quality studies. See Table 10. The most common problem was a disparity in baseline data. The following 12 studies are not randomized; six were deemed high-quality studies, three were deemed average-quality studies, and three were deemed low-quality studies See Table 12. Most scored low for confounding bias or inappropriate methods for controlling confounders. There were instances in which participants were not treated according to the planned intervention for contamination or unplanned co-interventions as well as changes in participant exposure. Among the quantitative descriptive studies, eleven out of fourteen were of high quality, one is of average quality,

and two were of low quality. See Table 13. The majority of quality concerns were related to unmatched respondents and target populations, unclear descriptions of target populations and samples, and non-response bias. Lastly, when it comes to mixed methods studies, one article was regarded as high quality, two as average quality, and one as low quality. See Table 11

The most common problems include poor component integration, insufficient identification or explanation of conflicts, and insufficient quality of the components.

Assessment of multiple systematic and scoping reviews tool (AMSTAR)

Due to the existence of four literature reviews in the included studies, the methodological quality of the evidence was assessed using version 2 of the measurement tool for systematic reviews (AMSTAR 2), which is composed of a sixteen-item checklist. Two of the four reviews were rated as high quality, one of them was evaluated as low in quality and the last one as critically low quality. See Table 11 Summary of Mixed methods appraisal tool – Mixed methods studies

Type of study	Methodological quality criteria	Studies		
		Anderson 2015	Skinner 2020	Tynan 2015
Screening questions	Are there clear research question(s)?	Y	Y	Y
	Do the data address the research question?	Y	Y	Y
Mixed methods studies	Is there an adequate rationale for using a mixed methods design to address the research question?	Y	N	Y
	Are the different components of the study effectively integrated to answer the research question?	Y	UN	Y
	Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	N	Y	Y
	Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Y	UN	N
	Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Y	Y	N
Score		80%	40%	60%

Table 12. A review was considered low quality if the review has a critical flaw and critical low quality if it contained more than one critical flaw, either with or without non-

critical weaknesses. Most downgrades were caused by a lack of a protocol and a list of full-text exclusions.

Table 7 Summary of Mixed methods appraisal tool – Qualitative studies

Type of study	Methodological quality criteria	Studies																		
		Abuzar 2016	Barnett 2017	Bazen 2007	Cane 2004	Dimitropoulos 2019	Farmer 2018	Greenhill 2015	Howey 2022	Johnson 2013	Kruger 2010	Kyoon-Achan 2020	Mariño 2021	Parker 2005	Parker 2012	Portland District Health 2012	Schoo 2008	Skapetis 2018	Skinner 2021	Taylor 2018
Screening questions	Are there clear research question(s)?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Do the data address the research question?	UN	Y	UN	UN	Y	Y	Y	Y	Y	UN	Y	Y	UN	Y	UN	Y	Y	Y	Y
Qualitative	Is the qualitative approach appropriate to answer the research question?	Y	Y	UN	UN	Y	Y	Y	Y	Y	UN	Y	Y	UN	Y	UN	Y	Y	Y	Y
	Are the qualitative data collection methods adequate to address the research question?	Y	Y	UN	UN	Y	Y	Y	Y	Y	UN	Y	Y	UN	Y	UN	Y	Y	Y	Y
	Are the findings adequately derived from the data?	Y	Y	Y	Y	Y	Y	Y	Y	Y	UN	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Is the interpretation of results sufficiently substantiated by data?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Is there coherence between qualitative data sources, collection, analysis and interpretation?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	UN	Y	Y	Y	Y	Y	Y
Score		100%	100%	60%	60%	100%	100%	100%	100%	100%	40%	100%	100%	40%	100%	60%	100%	100%	100%	100%

Table 8 Summary of Mixed methods appraisal tool – Randomized control trial

Type of study	Methodological quality criteria	Studies						
		Arrow 2021	Ju 2017	Kapellas 2013	Parker 2012	Piggott 2021	Roberts-Thomson 2019	Slade 2011
Screening questions	Are there clear research question(s)?	Y	Y	Y	Y	Y	Y	Y
	Do the data address the research question?	Y	Y	Y	N	Y	Y	Y
Randomized control trial	Is randomization appropriately performed?	N	Y	Y	Y	Y	Y	Y
	Are the groups comparable at baseline?	Y	Y	N	Y	Y	UN	UN
	Are there complete outcome data?	Y	Y	N	N	Y	Y	Y
	Are outcome assessors blinded to the intervention provided?	N	Y	Y	N	Y	N	Y
	Did the participants adhere to the assigned intervention?	Y	UN	N	N	Y	Y	Y
Score		60%	80%	40%	40%	100%	60%	80%

Table 9 Summary of Mixed methods appraisal tool – Non-randomized control trials

Type of study	Methodological quality criteria	Studies											
		Binguis 2004	Dimitropoulos 2020	Estai 2016	Hobbs 2020	Kroon 2019	Lalloo 2013	Lalloo 2021	Macnab 2008	Mariño 2017	Mathu-Muju 2018	Neumann 2011	Tadakamadla 2020
Screening questions	Are there clear research question(s)?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Do the data address the research question?	Y	Y	Y	Y	Y	Y	Y	UN	UC	Y	Y	UC
Non-randomized studies	Are the participants representative of the target population?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Are measurements appropriate regarding both the outcome and intervention (or exposure)?	Y	Y	UN	Y	Y	Y	UN	Y	N	Y	Y	Y
	Are there complete outcome data?	Y	Y	UN	UN	Y	Y	Y	N	Y	Y	Y	Y
	Are the confounders accounted for in the design and analysis?	Y	N	UN	UN	Y	UN	Y	UN	Y	Y	N	Y
	During the study period, is the intervention administered (or exposure occurred) as intended?	Y	N	Y	UN	Y	Y	N	N	N	Y	Y	Y
Score		100%	60%	40%	40%	100%	80%	60%	40%	60%	100%	80%	80%

Table 10 Summary of Mixed methods appraisal tool – Quantitative studies

Type of study	Methodological quality criteria	Studies													
		Abuzar 2009	Abuzar 2020	Crocombe 2015	Crocombe 2016	Johnson 2011	Johnson 2012	Kruger 2007	Lalloo 2013	Lalloo 2013	Mariño 2016	Ragade 2022	Richards 2002	Schroth 2015	Skapetis 2012
Screening questions	Are there clear research question(s)?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Do the data address the research question?	Y	Y	Y	Y	Y	Y	UC	Y	Y	Y	Y	Y	Y	Y
Quantitative descriptive studies	Is the sampling strategy relevant to address the research question?	Y	Y	Y	Y	Y	Y	Y	Y	UN	UN	Y	Y	Y	Y
	Is the sample representative of the target population?	Y	Y	Y	Y	Y	Y	UN	Y	UN	UN	Y	N	Y	Y
	Are the measurements appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Is the risk of nonresponse bias low?	Y	Y	Y	Y	Y	Y	UN	Y	N	N	Y	UN	Y	Y
	Is the statistical analysis appropriate to answer the research question? collection, analysis and interpretation?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Score		100%	100%	100%	100%	100%	100%	60%	100%	40%	40%	100%	80%	100%	100%

Table 11 Summary of Mixed methods appraisal tool – Mixed methods studies

Type of study	Methodological quality criteria	Studies			
		Anderson 2015	Skinner 2020	Tynan 2018	Willder, 2014
Screening questions	Are there clear research question(s)?	Y	Y	Y	Y
	Do the data address the research question?	Y	Y	Y	Y
Mixed methods studies	Is there an adequate rationale for using a mixed methods design to address the research question?	Y	N	Y	Y
	Are the different components of the study effectively integrated to answer the research question?	Y	UN	Y	N
	Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	N	Y	Y	Y
	Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Y	UN	N	Y
	Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Y	Y	N	N
Score		80%	40%	60%	60%

Table 12 Summary of Measurement tool to assess the methodological quality of systematic review

Study ID	AMSTAR II items																
	1	2*	3	4*	5	6	7*	8	9*	10	11	12	13	14	15*	16	
Estai 2016	P/Y	Y	N	Y	N	Y	N	Y	N/A	Y	N/A	N/A	N/A	Y	N/A	Y	Low
Grant 2017	P/Y	N	N	Y	N	N	N	Y	N/A	N	N/A	N/A	N/A	Y	N/A	N	Critically low
Poirier 2022	Y	Y	Y	Y	Y	Y	Y	Y	N/A	Y	N/A	N/A	N/A	Y	N/A	Y	High
Vance 2022	Y	Y	Y	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y	Y	Y	High

For AMSTAR II items, 1 = covering PICO (participants, intervention, comparator group, outcome) in inclusion criteria; 2 = following review protocol; 3 = study design selection; 4 = literature search strategy; 5 = duplicated coding for study selection; 6 = duplicated coding for data extraction; 7 = justification of excluded papers; 8 = description of included studies; 9 = assessment of risk of bias of RCT or NRSI; 10 = reporting study funding source; 11 = using appropriate statistical combination method in RCT or NRSI; 12 = ROB impact on meta-analysis; 13 = discussing of ROB impact; 14 = addressing heterogeneity; 15 = consideration of publication bias; 16 = reporting conflict of interest

*AMSTAR 2 critical flaw —reasons for downgrading the quality of the review: 2 No protocol; 4 Search strategy not comprehensive; 7 No list of excluded studies with reasons; 9 Risk of bias not assessed; 11 Inappropriate meta-analysis methods; 13 Risk of bias assessments not included in the interpretation of the results; 15 Publication bias not explored in the meta-analysis. The other are considered non-critical weaknesses.

4.4.4 Themes and categories identified in the reviewed literature

The following four categories of programs emerged from the analysis and represented the synthesis of the data: oral health promotion and prevention programs ($n = 19$), educational programs ($n = 19$), Community engagement, shared responsibility, and partnership ($n = 16$), fly in, fly out dental services ($n = 1$), and teledentistry ($n = 5$). See Table 15.

4.4.3.1 Oral health promotion and prevention programs

Nineteen articles published between 2004 and 2022 described health promotion programs, which mainly focus on providing information and supporting positive personal oral health habits in various settings, including schools, community groups, and dental clinics, to prevent oral diseases.

The oral health promotion and prevention approach can be implemented in several ways through culturally relevant oral health education, distribution of oral health aids, and dental visits to local hospitals and schools.

Combination of active and passive preventive approaches

Several preventive measures have been demonstrated to be effective in preventing or reducing oral diseases and promoting good oral health, including active approaches such as fluoridated varnish, povidone-iodine, and fissure sealants and passive ones such as community water fluoridation.

According to a comparative effectiveness study in caries prevention delivery models conducted in children from a remote Indigenous community in Queensland, Australia, in 2019, it was demonstrated that the active intervention had greater effectiveness, but the passive intervention was more realistically implemented, with dmft decreasing by 14.3% and mean DMFT dropping by 7.1% after two years of AP (155).

Another study conducted in first nations communities of British Columbia, Canada, in 2008 reported a decrease in dmfs/DMFT rates from 8% to 32% of cavity-free children after an oral health promotion intervention involving fluoride varnish application, among other preventive measures such as daily in-school tooth brushing after lunch, weekly fluoride rinse, dental health guidance, and classroom presentations (210).

Additionally, two recent Australian non-randomized controlled trials published between 2020 and 2021 showed that Indigenous children who received annual topical interventions including fissure sealants, povidone-iodine, and fluoride varnish had fewer cases of advanced caries in their permanent dentition compared to children in the control group. (163,164). Furthermore, the intervention was effective in preventing advanced caries on occlusal surfaces and halting the progression of caries on occlusal and smooth surfaces but not on approximal caries (163).

Passive prevention

Dentists have used fluoride in various forms for decades. Water fluoridation has been identified as one of the most effective and socially equitable public health measure to prevent and treat early carious lesions (213). Nonetheless, many people do not have access to fluoridated water, particularly in remote areas (214,215). Water fluoridation may be an attractive solution in these communities, considering the difficulty of changing oral health

behaviours and providing dental services in rural settings. In support of this, two Australian studies from 2015 and 2016 about lifetime fluoridation found that residents of capital cities experienced greater exposure than those living outside the capital, and those living in rural areas experienced a higher DMFT mean (154,157). Additionally, fluoridation of community water significantly reduced dental ambulatory sensitive hospitalization rates for children living in the most deprived areas (212).

Active prevention (fluoride varnish application, povidone-iodine application, fissure sealant)

Atraumatic restorative treatment (Silver diamine fluoride and the Hall Technique)

Atraumatic restorative treatment (ART) involves using hand instruments to remove decay without using local anesthetics. Recent studies have demonstrated that silver diamine fluoride (SDF) is a promising treatment for active dental caries in primary teeth in children and adults. This combines the antibacterial effects of silver and the remineralizing properties of fluoride to inhibit bacterial growth with a possible dark stain after carious arrest and ART-HT, which removes only gross debris from the tooth and cements a stainless-steel crown over it. The approaches are considered suitable for remote locations as they require little "high-tech" equipment, are inexpensive, and require little time and personnel, especially when there are limited facilities such as clinical space, water, electricity, transportation, and storage of sensitive dental equipment. For example, a community trial of silver fluoride treatment has demonstrated its effectiveness as a caries arrest tool in primary molars in a remote indigenous population of South Australia in 2019. This technique was acceptable when used on very young or anxious patients and does not have the ammonium odour of SDF (162). In the same way, a participatory case

study from 2020 explored Indigenous community members' views on SDF treatment for ECC where it was found that parents were worried about blackening treated lesions product of this approach. Therefore, a more informative approach was recommended to help Indigenous parents accept SDF as a minimally invasive treatment option for ECC (203).

Complementary to this, a different minimally invasive atraumatic restorative treatment with the Hall technique approaches (ART-HT) was evaluated in a cluster-randomized trial among remote Aboriginal communities in Western Australia to manage early childhood dental caries. The model enabled effective dental care for young children, improved oral health and resulted in higher levels of care. After following up with 231 children (68% retention), those in the test group had more filled teeth and fewer decayed teeth (158). In addition, a complementary qualitative study based on the early intervention was conducted to explore the experiences and perceptions of parents and carers who participated in the project that tested the ART-HT . Service providers, communities, and families were well engaged and satisfied in providing child- and family-centred services that were well supported by culturally appropriate communication (170).

Fluoride varnish application

The use of fluoride varnish to prevent cavities in both primary and permanent teeth was discussed in three articles published in 2011 and 2020. It was indicated that aboriginal dental assistants could safely and effectively apply Fluoride varnish applications under remote supervision (159) using existing resources in rural practices. In addition, numerous studies have revealed their effectiveness in preventing and reducing dental caries in young children (156,175). Specifically, in a clinical study of 543 preschool children in remote

Aboriginal communities in Australia's Northern Territory, the adjusted dmfs increment was 3.0 surfaces lower in the intervention group compared to the control group after two years of intervention (156).

Other programs

Seven articles published between 2004 and 2022 described other types of oral health promotion and preventive activities. For example, studies evaluating scaling and root planning intervention showed significant improvement in the periodontal status of Indigenous Australians without requiring changes to oral hygiene practices. These non-surgical treatments can be efficiently provided by 4th-year students, as was the case with the dental service learning rotation from Brewarrina, Australia (178). Besides, Australian researchers also compared non-surgical, single-visit periodontal therapy with scaling and root planning to no treatment in a randomized controlled trial. Compared to the control group without treatment, experimental participants demonstrated statistically significant decreases in gingival bleeding and the extent of shallow pockets as measured by PD \geq 4 mm (173). Equally important, community outreach programs focusing on prenatal nutrition have been shown to improve caregivers' knowledge of ECC and its effects by providing oral health education covering basic healthy dietary and oral hygiene practices (201). Likewise, face-to-face behavioural counselling and cessation seem promising to increase rural settlers' knowledge of the dangers of tobacco use and prevent a higher burden of smoking-related diseases (174). Oral health professionals can also play an essential role in promoting good health behaviours such as blood sugar management in those living with diabetes, screening or facilitating the diagnosis of many chronic diseases such as diabetes

(176), Cancer (177) and making referrals accordingly. Furthermore, patients' participation in workshops improved oral health literacy (171).

4.4.3.2 Educational programs

It has been demonstrated that professional education and practice opportunities will contribute to reducing dental care gaps through programs such as electives, training, and rotations in oral health at several health schools and rural communities. Consequently, this approach may contribute to closing one of the most commonly cited gaps in the provision of dental care in rural and remote areas: the shortage of dental and oral health professionals. This could be achieved by encouraging students and personnel to pursue careers in these areas after graduation. Three types of training and educational programs have been identified in the studies discussed. Programs in the first category target dental and allied health students and professionals; programs in the second category target rural and remote community members and non-dental primary care providers; and programs in the third category offer oral health education and services to schools in these areas.

Programs for training and education of dental and allied health students and professionals

Fourteen studies describe programs for training and education of dental and allied health students and professionals. These studies were published between 2002 and 2020, mainly in Australia, except for one conducted in New Zealand. The evidence presented in this section suggests that the participants gained a deeper understanding of community culture and an enhanced understanding of the community's dental needs, thereby making dental services more accessible (166,178,180,185). Rural clinical placements also have been found to be positive and enjoyable experiences, which have increased dental students'

clinical experience and social skills, provided them with positive experiences, and enhanced their satisfaction (166,181,183,204,211). Most of the studies reviewed here support the hypothesis that rural rotation contributes to the potential of starting practice in a rural setting after graduation (180,182,184,185). It was also reported a decreased in waitlist times (179).

Staff and supervisors also praised programs for their effectiveness and feasibility (181,183,211) and it has been suggested that incorporating a rural clinical programme into a university curriculum would be helpful to educators' planning (183). Evidence has reported higher salaries, travel costs, accommodations, and subsistence costs associated with remote rural placements (compared to university dental clinics). However, some advantages may outweigh the disadvantages, making this an attractive, cost-effective option for both students and the local community (179,186). Due to the high cost of rural student clinical placements, it is imperative that local councils, state and territory governments, as well as the Commonwealth government provide financial support to ensure their establishment and sustainability (186).

Despite the fact that most placement programs are directed to undergraduate students, the literature also described one International Dental Graduate (IDG) program implemented in New South Wales, Australia between 2007 and 2008 that tested patient satisfaction as an indicator of program's and effectiveness. The patient satisfaction of both IDGs and mentors was similar and positively skewed. Interestingly, the results favoured treatment provided by IDGs over mentors (187).

Programs for education and training of rural and remote non-dental primary providers

One article published in Australia described education and training of rural and remote dental health for non-dental primary providers. Researchers have found that non-dental primary care providers trained in oral health curriculum have resulted in greater action capacity and more flexible service delivery practices, ultimately improving rural dental health provision and outcomes. In addition, oral health training could likely increase understanding of the oral-systemic connection, engaging health care teams to collaborate to support patients with chronic diseases and environmental challenges due to social determinants of health. Equally important, non-dental primary providers could deliver specific, high-value, preventive services to underserved rural populations.

For example, a workshop was designed to support primary health care personnel handling emergent dental cases in three Australian states in 2012. As a result, clinicians were surveyed at a six-month check-in, and they felt more competent in providing dental care and used local oral *anesthesia more frequently* (188).

School-based oral health program

Four services and culturally-sensitive oral health care programs with community-led dentists, dental hygienists, and health workers providing preventive dental care have been found in the literature search. The first was a Canadian school-based, collaborative oral health program that benefited a remote First Nations community and provided educational opportunities for pediatric trainees in 2008. Prior to the intervention, 8% of children had no cavities. Three years later, 32% were cavity-free. The DMF/DMFS improved significantly among the 13 children assessed pre-and post-intervention. The visitor

hygienist also noted increased knowledge of oral health (210). Similarly, a Canadian Cross-Sectional Study that studied the prevalence of early childhood caries (ECC) in children attending preschools that are enrolled in the Smiles 4 Miles health promotion program in Victoria found out that

Adopting a similar approach, there was a rural program in Port Augusta in 2012 where the South Australian Dental Service, Spencer Gulf Rural Health School, and University of Adelaide School of Dentistry worked together to provide culturally appropriate dental care for Aboriginal children. Thanks to integrating health workers and health promotion activities, children's dental participation rates increased from 54% to 70% (172). Australia's Rural clinical and regional medical schools from 2015 revealed several benefits for rural and regional communities, including curriculum innovation and community engagement. Small rural towns have been improved with teaching facilities, information technology, video-conferencing, and student accommodation. The strategy has created many new clinical academics in rural areas, retaining and expanding the clinical workforce (189). Lastly, an Australian qualitative study in 2019 suggests that providing training and facilitation of school leadership are important enabling factors for sustainable oral health promotion, including in-school toothbrushing programs, among Aboriginal people (190).

4.4.3.3 Community engagement, shared responsibility, and partnership

The findings demonstrate the importance of community participation and partnerships with private and public health organizations, government entities, and academic institutions in implementing successful dental community services.

Joint programs with the public health sector, organizations, and community platform

In eight studies, partnerships with public health agencies, organizations, and community platforms have been established, enabling dental care linkages and coordinated care. Those were conducted between 2005 and 2019, primarily in Australia (8%) and some of them in Canada (18%). Participation and partnerships with the community were vital elements of these programs (172,191,200,205). A thriving community participation program demonstrated sustained engagement of some stakeholders over time, personal commitment and motivation, and involvement of the appropriate network of people in relationship building and activity development (161). Community, private and public sectors were also involved in the management and decision-making process regarding the ongoing programs (172,205), which have improved the knowledge and acceptance of rural dental services and have decreased caries cases (202). Other community members, such as teachers and community health workers, were also incorporated into some programs. These have been vital in promoting programme enrollment and enhancing preventive dental services (205). In some programs, health staff received cultural safety, and holistic health training since incorporating cultural values and beliefs was considered necessary in most programs (165–169,191,200); as a result, the rates of avoiding public health facilities due to fear or mistrust decreased.

Interdisciplinary collaboration

In recent times, health workers from different professional backgrounds have worked closely in teams, increasing program coverage and reaching patients, their families, and communities that other health practitioners serve through efforts such as interprofessional collaborations. In this study, seven studies described interprofessional collaborative

practices conducted between 2004 and 2022, mainly in Australia and some in Canada. For example, the partnership between maternal and child health nurses (160), obstetric trained general practitioners and midwives(193), non-working and working dental therapists (194,197), primary care providers and dental practitioners (192,209) and dental hygienists and other rural health professionals (206–209). Overall, these studies have illustrated how health workers from different specialties can play a crucial role in disseminating oral health information, making referrals, preventing oral disease, participating in health promotion, increasing oral health admission rates and early identification of dental and chronic diseases.

4.4.3.4 Service delivery models

Portable/mobile care models - Fly in, fly out services

A mobile dental clinic has the potential to minimize geographical barriers to access, such as for people living in rural areas where transportation to dental clinics can be challenging, as well as having access to dental clinics that accept public assistance insurance. For instance, a non-randomized controlled trial exploring annual caries preventive intervention among Indigenous children in a remote Australian community from 2021 found that Indigenous children exposed to the intervention had less advanced dental caries in their permanent dentition than those who were not (164). The fly-in clinical team performed the preventative intervention of placing fissure sealants, applying povidone-iodine and fluoride varnish, and then completing individual treatment plans at a mobile unit at one primary school and the other hospital's dental clinic.

Teledentistry

Five Australian articles explained the teledentistry approach, three published in 2016, one in 2018 and one in 2022 . The use of teledentistry has shown some promise as a strategy for supporting rural, isolated dental health care workers, increasing access to advice, education, and specialists that may have been unavailable before. This platform included programs focusing on oral health services offered through video consultation with dental specialists for risk assessment, preventive and operative services, and follow-ups that can be operated in rural settings such as aged facilities, schools and dental clinics (195–199). Modern teledentistry was considered an efficient and cost-effective model to provide access to care as well as support consultation and continuing education for dental providers in rural areas (196). In fact, the net cost of store-and-forward teleconsulting was cheaper (AU\$32.35) than the total cost of real-time consultation (AU\$41.28) per resident (198). In addition, this strategy utilizes daily-integrated technologies such as remotely sourced photographic records to detect dental caries and diseases (195). Finally, a very recent scoping review has found that teledentistry offers multiple advantages, including decreased travel expenses, reduced school absences, and reduced isolation for dental teams in remote areas (199).

Table 13 Coding and themes

THEMES	CODES	
Oral health promotion and prevention programs	Combination of active and passive preventive approaches (155,163)	
	Passive prevention	Community water fluoridation (154,157,212)
	Active prevention	ART/ Silver diamine fluoride (162,203)
		ART/Hall Technique (158,170) Fluoride varnish application (156,159,175)
	Other programs	Periodontal health (173) Community-based Prenatal Nutrition Program(201) Oral health literacy(18,171) Smoking cessation (174) Diabetes screening (176) Cancer screening (177)
Educational programs	Programs for training and education of dental and allied health students and professionals	Undergraduate placement programs (166,169,186,204,211,178–185), International dental graduates(187)
	Programs for education and training of rural and remote for non-dental primary providers	Dental emergencies - multimodal educational intervention for primary care providers (188)
	School-based oral health education and services	Oral health promotion and prevention (172,210) School teachers' training (189,190)
Community engagement, shared responsibility, and partnership	Joint programs with the public health sector, organizations, and community platform	Community developed collaborative project (161,191,200,202,205) Provision of culturally sensitive oral health care (165,167,168)
	Interprofessional Collaborative Practice	Dental hygienists and other rural health professionals:(206–208) Primary care providers to dental practitioners:(192,209) Maternal and child health nurses:(160) obstetric trained general practitioners and midwives (193) Non-working dental therapists:(194)
Service delivery models	Portable/mobile care models - Fly in fly out services (164) Teledentistry(195–199)	

4.4.5 Levesque framework

See Tables 16 and 17 for Levesque framework summaries.

4.4.4.1 Stage One: Perceptions of Needs and Desire for Health Care

Patients' ability to perceive – 13 papers

There is evidence that oral literacy programs have contributed to community awareness of major oral health problems among the rural population (158,165,171). Furthermore, community members were comfortable with dental care, including educational approaches (166,170,182,183,191,204,209). Those educational initiatives allowed patients to identify dental services available and increased their enrolment and use of those services(200,205). Also, education of patients about preventative procedures, such as silver diamine fluoride for the treatment of early childhood caries, has assisted them in overcoming their fears of oral surgery under general anesthesia, fear of pain after surgery, and cosmetic concerns regarding black staining after treatment (203).

Services' Approachability – 21 papers

A key component of Approachability is the provision of information services to those who are eligible. For example, oral health promotion messages were provided to patients, their families, and their local communities to improve patient awareness (160,172,193,210). In some cases, community representatives formed advisory groups to increase awareness about oral health services available (208). In other cases, community health care workers were sent into communities to raise awareness and educate people about oral health; all this community involvement has resulted in building capacities within existing programs to ensure sustainable promotion and education, which led to increased program participation (202,205). Additionally, one workforce program with International

Dental Graduates reported that they had spent more time answering patient questions than their mentor clinicians (18).

In addition, screening processes have been implemented in rural communities to promote awareness of oral health problems, which is followed by an explanation of possible treatment options and eventual referral to a specialist or interprofessional (161,163,168,174,176,177,193,195,197,202). Such strategies have the potential to save a substantial amount of economic and human resources, as well as reduce disparities in oral health between rural and metropolitan areas (195,199).

Further, education and training programs for dental care students and other allied health care professionals have enhanced their awareness of the potential benefits of working in rural areas and have motivated them to consider working in rural areas after graduation (180,182,184,185).

4.4.4.2 Stage Two: Health Care Seeking

Patients' ability to seek– 22 papers

It has been shown that offering culturally appropriate dental health care services (165–170,185,200) and individual counselling could increase the willingness of patients to access and utilize dental health care services (174,193,201). With these types of services, the dental healthcare team could understand each patient's unique social history, cultural needs, and clinical expectations (155,170,203). As well as this, several programs have demonstrated the integration of respect, social justice, equality, participation, and collaboration in dental health interventions to enhance patients' ability to seek dental health (161,172,191,196,200,202,205–207). Moreover, developing a trusting relationship between people and health organization structures seems to play a crucial role in adopting

dental-seeking behaviours and acceptance and support of dental programs (161,170,193,202,208).

Services' acceptability – 11 papers

It is imperative that dental care services were acceptable to Indigenous peoples in order to improve access to dental care. One way to provide acceptable dental health care is to employ culturally appropriate staff that understands and respects a community's cultural values and beliefs. Accordingly, integrating dental health providers from the local community to provide dental care, such as aboriginal dental assistants, was the preferred option for applying varnish in an aboriginal rural community and increasing acceptability (156,159). Additionally, dental students have received cultural training through rural placements (166,178,180,185), generally regarded as positive vocational experiences offering acceptable clinical and personal development later to serve rural communities (166,179,181,183,186,204,211).

4.4.4.3 Stage Three: Health Care Reaching

Patients' Ability to Reach – 21 papers

In rural areas, transport is one of the primary obstacles to accessing dental services; thus, integrating dental services into existing facilities eliminated the need for extra travel and improved access (166,182,183,199,204). Some services have also provided transport services for patients in order to enhance the availability of services (164,172,191). A further strategy has been to provide outreach services in a variety of settings, such as at home (201), at schools (156,170,175) or in hospitals (193,201), to avoid long-distance travel (199,203).

As an alternative, passive prevention methods such as water fluoridation reach rural settlers directly through their water systems – plants (154,157,210,212).

One program has reported a reduction in waiting times. For example, teledentistry services have also helped reduce waiting lists and unnecessary travel by enabling referrals to a dental consultant to support locally based treatment (197).

Services' Availability and Accommodation – 15 papers

The provision of outreach services was considered an essential component of a comprehensive dental care plan. In rural communities, these initiatives may make oral healthcare more accessible by increasing the dental workforce's capacity in areas with a shortage of dental personnel or where people lack transportation and reside far from dental healthcare facilities. Examples of outreach services are fly-in, fly-out services(164), or mobile teledentistry models (195,199).

Additional approaches can be utilized to increase the number of dental and primary care workers in these areas, including the international dental graduate workforce program (187), graduate oral health therapist program (168) and primary health clinical teams (188,192,209) or the establishment of programs such as rural Indigenous outplacement programme (166). In addition, different facilities were available to the dental personnel under these programs to enhance workforce retention in those rural settings, such as travel assistance with the provision of vehicles (171) and rent-free or subsidized accommodation for providers (155,164,203,208).

As a final measure, some services strived to improve access to dental health care by providing flexible service delivery, such as electronic health records, which can be

accessed independently outside of scheduled appointments through emerging technology approaches such as teledentistry(195–199).

4.4.4.4 Stage Four: Health Care Utilization

Patients' ability to pay– 9 papers

The provision of cost-effective dental health care measures played an important role in ensuring rural settlers' access to dental health care. As an example, passive preventive measures such as community water fluoridation can benefit the general rural population and are cost-free for individuals (154,157,212). The use of active prevention programs, such as silver diamine fluoride and ART-HT, can also be viewed as a relatively inexpensive alternative to restorative dentistry (162,170,185,203). Cost-effective care might also include the provision of free toothbrushes and toothpaste (190). As a result of these preventive measures, the caries burden is reduced, as well as the need for surgeries under general anesthesia, resulting in a reduction in dental care treatment expenditures (201).

Services' affordability– 8 papers

Patients' ability to access and afford dental care is directly related to the availability of public financing dental programs. Some federally funded programs have contributed to the accessibility of dental care for rural residents. Several rural clinical schools receive funding from the federal government to provide free or low-cost dental services in rural and remote areas, such as the Australian federal rural clinical placement programs for graduate dental students (183,189), and the Western Australian State-funded integrated service, education, and research program of the Centre for rural and remote oral health (185). Other financed dental programs involve former dental professionals, such as the federally funded community-based preventive dental programme Children's Oral Health Initiative (205).

It has also been suggested that dental therapists and dental care students can provide preventive and less complex restorative treatments rather than dentists due to the fact that they receive a reduced salary or no salary, resulting in a cost-effective alternative to dentists in delivering oral health prevention services in remote communities (159,168,179,194). Furthermore, other programs provided increased salaries, financial assistance, and support to the dental workforce (171).

Interestingly, one cost analysis study of rural dental training facilities revealed that a remote rural placement incurs additional costs (compared to the usual university dental clinic) in terms of salary incentives, travel, accommodation, and subsistence aid. Even so, the benefits of the placement to both students and the local community could outweigh its additional costs (186).

4.4.4.5 Stage Five: Consequences of Accessing Health Care

Patients' Ability to Engage– 12 papers

An empowered community with a sense of ownership over the dental health care service is more likely to be engaged and, most importantly, to remain engaged with the dental health care service (161,166,170,202). Additionally, patients reported feeling more comfortable and confident with the service provided by rural dental health personnel (166,168,173,208). In general, cross-cultural engagement is essential for maintaining patient engagement and providing appropriate and effective treatment according to individual needs (170,183,204,207,211).

Services' appropriateness–11 papers

It has been found that remote rural clinical placements have allowed students to engage in dialogue with community patients and caregivers to explore their needs, thereby

ensuring that the services are acceptable to them (178). Similar to this, these clinical experiences and rural exposure have increased participants' clinical expertise, confidence, and competence to deliver appropriate dental care based on social values (166,167,182,183,203,204,211). There have also been efforts to hire rural personnel for cultural appropriateness (175) and to increase the capacity of the existing programs and communities to assist with the sustainability of the promotional and educational dental care programs (193,202).

Table 14: Summary of use of Levesque framework and dimensions/abilities explored

Author, year	N	Access focus	Approach ability	Accept ability	Availability/ accommodation	Affordability	Appropriateness	To perceive	To seek	To reach	To pay	To engage
Anderson 2015	3	Both		YES			YES					YES
Abuzar 2009	3	Both					YES		YES			
Abuzar 2016	7	Both		YES	YES		YES	YES	YES	YES		YES
Abuzar 2020	7	D	YES	YES								
Arrow 2020	1	A						YES				
Barnett 2017	1	D			YES							
Bazen 2007	1	D		YES								
Binguis 2004	3	A							YES	YES	YES	
Cane 2004	2	Both			YES			YES				
Crocombe 2015	2	A								YES	YES	
Crocombe 2016	2	A								YES	YES	
Dimitropoulos 2019	1	A									YES	
Dimitropoulos 2020	2	Both					YES			YES		
Estai 2013	2	Both			YES				YES			
Estai 2016	3	Both	YES		YES					YES		
Farmer 2018	2	A							YES			YES
Grant 2017	4	Both	YES		YES				YES			YES
Greenhill 2015	1	D				YES						
Hobbs 2020	2	Both				YES				YES		
Howey 2022	1	A							YES			
Johnson 2011	4	Both	YES				YES	YES		YES		
Johnson 2012	5	Both		YES			YES	YES		YES		YES
Johnson 2012	3	Both			YES	YES		YES				
Johnson 2013	6	Both		YES		YES	YES	YES		YES		YES
Ju 2017	3	Both			YES	YES		YES				
Kapellas	1	A										YES
Kroon 2019	2	Both			YES				YES			
Kruger 2007	1	D				YES						
Kruger 2010	4	Both	YES	YES					YES		YES	
Kyoon-Achan 2020	6	Both			YES		YES	YES	YES	YES	YES	
Laloo 2013	2	D		YES			YES					
Laloo 2013	1	A							YES			
Laloo 2013	1	D				YES						

Author, year	N	Access focus	Approachability	Acceptability	Availability/ accommodation	Affordability	Appropriateness	To perceive	To seek	To reach	To pay	To engage
Laloo 2021	2	Both			YES					YES		
Macnab 2008	2	Both	YES							YES		
Mariño 2016	1	D			YES							
Mariño 2017	1	D	YES									
Mariño 2021	1	D	YES									
Mathu-Muju 2018	3	Both	YES					YES	YES			
Neumann 2011	1	D	YES									
Parker 2005	3	A						YES	YES	YES		
Parker 2012	3	Both	YES						YES	YES		
Parker 2012	3	Both	YES						YES	YES		
Piggott 2021	5	A	YES					YES	YES	YES	YES	YES
Poirier 2022	3	Both	YES		YES					YES		
Portland District Health 2012	2	A						YES	YES			
Ragade 2022	4	Both	YES				YES		YES			YES
Richards 2002	2	D		YES		YES						
Roberts-Thomson 2019	1	A									YES	
Schoo 2008	1	D	YES									
Schroth 2015	4	Both	YES				YES		YES			YES
Skapetis 2012	1	D			YES							
Skapetis 2018	1	Both			YES					YES		
Skinner 2020	1	D				YES						
Skinner 2021	5	Both		YES	YES	YES			YES			YES
Slade 2011	2	Both		YES						YES		
Tadakamadla 2020	1	D	YES									
Taylor 2018	3	Both	YES						YES			YES
Tynan 2018	3	Both	YES		YES					YES		
Vance 2022	2	Both	YES						YES			
Willder, 2014	2	A						YES	YES			

A: Abilities, D: Dimensions, B: Both

Table 15 Summary of Levesque Classification

Characteristics	Number of References
<i>Supply side</i>	
Approachability	20
Acceptability	11
Availability and accommodation	17
Affordability	10
Appropriateness	11
<i>Demand side</i>	
To perceive	14
To seek	22
To reach	20
To pay	8
To engage	12
<i>Access focus</i>	
Dimensions (Provider)	16
Abilities (Patient)	14
Both	30
<i>Total References</i>	60

4.4.6 Outcome variables

In thirty studies, specific, measurable outcomes were described; the most frequently reported were caries-related outcomes with fourteen articles. Eight articles describe a change in dmft/DMFT or the number of decayed, missing or filled tooth surfaces (154–159,200,210). Six additional studies reported a decline in caries prevalence; however, this was not tested for statistical significance (160,162–164,201,202). Outcomes associated with changes in provider behaviours took the second position with ten articles related to confidence from health providers, readiness for working in remote areas and cultural appropriateness service (108,198,201–205,207,208,211). Followed by eight articles related

to oral health knowledge and/or behaviour, such as oral health literacy(171,200,201,210), child's oral hygiene - the frequency of brushing(172,202,211) and patient satisfaction and attitudes (18). Next, two studies described periodontal oral health outcomes: plaque or calculus index(173,200), gingival bleeding on probing depth(173) and clinical attachment loss(173). Finally, two studies reported health-related outcomes: body mass index (201) and self-reported or biochemically validated smoking cessation (174).

4.5 Discussion

Rural Ontario residents represent a diverse group with significant dental health care needs, which are not adequately met by the Canadian dental health care system and social care services at present. It is clear from the evidence that rural-urban dental health disparities are primarily caused by the disproportionate distribution of health care providers in isolated areas, which results in transportation and accommodation challenges, as well as the high cost of oral health care.

While several government agencies, non-governmental organizations, and academic institutions around the globe have made efforts to improve access to rural dental care, the findings of this scoping review indicate that Canadian research is limited when compared to similar high developed countries, such as Australia.

Rural-based interventions have been shown to have positive psychological and physical effects on patients and healthcare providers. For example, dental students and health care providers benefited from university initiatives by having opportunities to work in realistic situations that inspired them to learn and enhanced their self-confidence while increasing treated patient rates and decreasing caries and periodontal conditions with culturally appropriate dental approaches.

It should be noted, however, that most of these rural dental care interventions are temporary and short-term and are usually sponsored by educational or voluntary institutions, making evaluation difficult. Such dental services should also be recognized for their perceived value. Further research is urgently needed to support these dental schools and organizations in designing and delivering high quality dental services. Strong multidisciplinary approaches must be adopted in this field, utilizing the expertise of medical, social work, and dental professionals.

4.5.1 Summary of evidence

This scoping review was conducted to provide a broad overview of oral health interventions in oral health in rural communities. The review demonstrates that little has been developed in order to improve oral care for people living in rural settings, even though this is an important topic that influences all aspects of quality of life. Sixty studies were included that reported interventions focusing on prevention and oral health promotion, educational, community-professionals partnership, service delivery interventions or a combination of these factors. Half of the studies (n=30) described specific outcomes or a combination of those, showing a positive effect on: a) decrease of caries related outcomes 1) DMFT/ dmfs (n=8) and 2) unspecific caries experiences (n=6), b) provider behavioral outcomes: b) provider behavioural outcomes, e.g. health providers confidence and readiness for working in remote areas and cultural appropriateness preparation (n=10), c) oral health knowledge and/or behaviour outcomes: oral health literacy (n=4), changes of frequency of brushing (n=3) and patient satisfaction and attitudes (n =1), d) physical oral health outcomes: periodontal related e.g. plaque or calculus index, gingival bleeding on probing depth and clinical attachment loss (n =2), and e) health-related outcome, e.g. 1)

body mass index (n=1), self-reported or biochemically validated smoking cessation (n=1). Thirty studies did show any specific outcome.

4.5.2 Quality of Included studies

The scoping review incorporated well-validated and published assessment tools, such as the AMSTAR 2 checklist and the MMAT18 tool, to minimize bias and capture the characteristics of interest in the targeted studies. The approach is especially important given the substantial heterogeneity in study designs and reports. In general, the MMAT and AMSTAR 2 rated most of the studies as high quality.

Among the 56 studies evaluated with the MMAT18 tool, 11 did not completely answer the research question as a result of unclear data collection. A number of other quality issues were observed, such as incomplete documentation of methodology and data collection, disparities in baseline data, inadequate management of confounding, and an unacceptably low response rate. In the AMSTAR 2 critical appraisal, a lack of comprehensive search strategies, insufficient justification for the exclusion of studies, and duplicate screening/data extraction may have contributed to a number of missing studies and safety data issues.

4.5.3 Strengths and limitations

An appropriate and focused research question was created, and comprehensive research was conducted in accordance with a protocol, which identified a number of titles and abstracts relevant to the research question. Additionally, the inclusion and exclusion criteria for screening the studies were clearly stated. In addition, the study benefited from the analysis of the CCHS data, which identified significant gaps in dental care provision in rural communities. In a similar manner, the Levesque framework was incorporated during

the program analysis to ensure that dental healthcare service access for rural residents is constructed both between individuals and the services/infrastructure, taking into account both the providers and the patients. These publications were specifically evaluated for scientific quality, which indicates that the results of this scoping review are of high quality.

The literature has also identified a significant knowledge gap. There is a lack of information on the economic aspects of most dental care interventions, with the exception of telemedicine and water fluoridation. Therefore, further research is highly recommended in order to assess the economic aspects of rural dentistry programs and to provide strategies for maximizing their cost-effectiveness.

Researchers should also examine legislative bodies in specific provinces in order to understand how their potential roles could facilitate dental practices. Indeed, these many governments could prioritize these essential services because they benefit vulnerable subgroups in rural communities, such as aboriginal people and children.

Chapter 5 – Conclusion

5.1 Taking a closer look at the main findings: What are the contributions?

The oral health of Canadians has been relatively well studied; however, only a few studies have examined the oral health status of Canadian rural settlers. An analysis of the Canadian community health survey's nationally representative sample was conducted in order to investigate the patterns and factors associated with dental care utilization among Ontarians, as well as a scoping review to explore access in rural areas to provide a comprehensive review of dental policy and intervention to fill those previously identified gaps.

This study had three main objectives. These were to investigate:

- I. Overview of Inequities in oral health care and access to dental services and supplementary insurance.
- II. Inequities by sex, age, socioeconomic factors, and rural and remote communities.
- III. Dental policies and practices to meet the above gaps

Even though chapter 2 did not reflect any of the above thesis objectives, it was considered extremely valuable as a starting point that allowed readers to understand the main concepts under study in this thesis, such as dental health disparities, inequities, and associated determinants of health. Overall, Canada's oral health measures are better than most countries worldwide. However, there are still inequities in oral health care that can be addressed by targeting critical determinants of health. Additionally, this section discusses the close relationship between dental health care and general health, mental health, and overall well-being. As a first step in determining how best to deal with these

oral health disparities, it is imperative to assess how poor oral health care can affect individuals, the entire population and even governments, as well as the potential benefits of addressing them. In short, poor oral health is associated with pain, missing school and working hours, poor school and work performance (21). It also leads to low self-esteem and socialization issues (62). Oral health also bears out in government and health care systems by inefficient and ineffective allocation of resources through the use of hospital emergency departments for dental conditions or hospitalizations (217). Another important consideration is that oral (particularly periodontal) health is linked in a causal relationship with a number of diseases such as diabetes (218). This chapter also contributes by examining the characteristics of Canada's oral health care system, including its funding. This is accomplished by comparing it with similar systems in Australia and New Zealand, which later served as sources of successful dental care interventions in rural communities in the literature review search. All three countries have upsides and drawbacks in their dental care system provision. In New Zealand, for example, the School Dental Service provides a comprehensive, wide-ranging, and free dental service for all children under the age of 18, but the proportion and mean number of untreated decays were higher than in any of the other three countries. Most likely, this is due to the lack of dental health services available to adults over the age of 18. On the other hand, Australia and Canada have mainly private-funded dental care systems with extensive public coverage for a subset of the population that is subject to strict eligibility requirements (141).

5.1.1 Inequities in oral health care and access to dental services

Chapter 3 examines a large regionally representative sample of data collected by the Canadian Community Health Survey (CCHS) and data from the index of the remoteness of Statistics Canada to identify common predisposing and enabling factors associated with dental utilization in urban and rural communities of Ontario. Several factors were identified as contributing to oral health disparities between urban and rural settlers. For example, household income and dental insurance. A possible explanation for this might be the marked differences in employment earnings between urban and rural populations in Canada. According to some studies, the earnings of individuals living in large metropolitan areas are about 25% higher than those living in rural areas (219). Therefore, rural settlers may face even greater financial challenges in paying for dental care treatments since it is not included in the Canadian universal healthcare system. Further examination of dental insurance availability was considered particularly pertinent to evaluate dental care utilization. The availability of dental insurance was found to be a significant predictor of dental care utilization. Evidence suggests that dental insurance can be critically limited in rural workers who are already struggling with employment issues. Indeed, an article published in 2010 found that employers in rural areas are less likely to offer dental insurance compared to their counterparts in more populated areas (220). Further, diseases such as edentulism and diabetes were also associated with poor dental care attendance patterns, which can significantly impact patients' quality of life, particularly the elderly. Seniors are particularly affected by the consequences of edentulism and associated comorbid conditions such as diabetes, which have significant physical, economic, social, and psychological consequences. (221). Furthermore, participants with unhealthy

behaviours such as smoking and inadequate brushing conditions also reported deficient dental care utilization patterns, making small contributions to inequities in oral health. Although these behavioural factors play a role in determining the health of people's teeth and gums, a vast body of evidence suggests that socioeconomic, environmental, and health-system factors play a more important role in determining people's oral health status and utilization (21). Consequently, interventions aimed at reducing disparities in oral health and oral health care in Canada should extend beyond individual behaviour modifications and focus more on the delivery system of oral health care and broad socioeconomic factors.

5.1.2 Rural dental policies and practices

The purpose of chapter four is to contribute to the literature by describing the evidence for oral health care services, particularly rural dental interventions that can improve oral health and access to oral health care in Canada. Key learning from this project is that oral health is a complex area requiring multiple components and analyses in order to implement successful solutions to improve it. Besides analyzing the CCHS data, the selected dental care interventions were mapped against the Levesque framework in order to explore potential dimensions and factors associated with the demand for and supply of dental care that could facilitate its operationalization. All selected interventions fall under one or more of the access' concepts related to approachability, acceptability, availability, accommodation, affordability, or appropriateness, either from a provider's or patient's perspective or both. For example, 30 out of 60 programs addressed dental healthcare equity in access visions, dimensions (providers) and abilities (patients).

Furthermore, approximately two-thirds of the interventions (n=42) address more than one aspect of access. The access characteristic most commonly identified on the supply

side was approachability (n=20); these features relate to the fact that people can identify that dental services exist, are easily accessible and have a positive effect on oral health. In order to make services more or less approachable, various factors can contribute, such as transparency, information regarding available treatments and services, and outreach activities. The ability to seek (n=22) was the most assessed on demand. Their sense of autonomy determines a person's ability to seek health care, capacity to choose to seek health care, knowledge concerning health care options, and individual rights that influence the expression of their intention to seek care. A multi-component intervention design that takes into account both primary providers involved in the provision of dental care and that addresses several aspects of access to dental care is likely to result in wide action capacity and dynamic healthcare service that facilitates access based on the understanding of individual needs and the factors that affect providers as well. In most cases, the published initiatives were small-scale/local programs driven at least in part by highly motivated researchers, academics and dental students and often developed in partnership with rural communities. It is important to note that most of these programs were pilots and did not become part of the mainstream the oral health funding system.

5.1.2.1 Prevention and dental health promotion

The scoping review of rural dental care interventions identified four predominant themes

The first theme focuses on prevention methods. Various oral health promotion and disease prevention strategies can be described. There are active prevention interventions, such as placing resin-based sealants on permanent molars of children and adolescents and fluoride varnish applications, passive prevention interventions such as community water fluoridation, as well as programs promoting health literacy, nutritional coaching, smoking

cessation, diabetes and cancer diagnostics, and preventative periodontal services among others. There is consistent evidence that this series of interventions effectively prevents or reduces the risk of oral conditions, especially tooth decay. Meanwhile, this thesis identifies, however, it remains unclear whether the other prevention interventions are cost-effective, and further cost-effectiveness analyses are recommended.

5.1.2.2 Dental Education

The second theme identified relates to professional dental education. Cultural factors play a role in oral health access (222,223). Dentists, like other professions, have cultures and care models geared towards privileged patients with dental insurance. Dentists need to be educated to address the specific challenges that these rural groups face, and their cultural indoctrination needs to be changed to improve their willingness to treat in rural settings. Therefore, rural curricula at the undergraduate and postgraduate levels can inform dental and allied health students about the specific concerns, challenges, and cultures associated with dental practices in these rural areas. It is also possible to expose participants to rural clinical dental practices through outreach programs or teaching clinics at dental schools. Additionally, nondental programs such as medicine and nursing may benefit from exposure and training in oral health care. Programs of this type can enhance the willingness of students and practitioners to practice in rural areas after completing rotations or placements. A different type of intervention that falls under the educational category, but has a greater focus on the patients, is the provision of comprehensive dental care and health promotion to children through school-based oral health programmes. When services are delivered in a setting where children are grouped together and regularly attend (e.g., day

care), many of the barriers (e.g., transportation, economic) faced by rural children and their parents are removed.

5.1.2.3 Collaborative action and partnership

As part of the third theme, dental staff, community members, other health care providers, and government entities participated in collaborative initiatives. By including other health and social service providers, it is possible to improve consultation and referral processes and establish cross-disciplinary health services that address common risk factors (e.g., smoking, high consumption of fats and sugars, alcohol) for dental diseases and other chronic diseases in order to promote general health and reduce dental and chronic diseases incidence. In addition, the diversification of the oral health care workforce in programs, such as the delivery of fluoride and sealants by dental therapists and hygienists, can improve the access of oral healthcare for rural residents. Similarly, engaging the community in the design and decision-making process of programs can empower them and build trust between them and the service, which increases compliance and accessibility to services. Finally, collaborating with state dental societies can be an effective method of obtaining funding and support for clinical and research activities.

5.1.2.3 Alternative service delivery models

Lastly, other service delivery models involve mobile units and teledentistry to extend dental services in hard-to-reach environments. Among the benefits, it can be found shorter time to specialty treatment initiation, lowered costs and helping provide preventive services.

5.2 Combined results of quantitative and qualitative data

A number of interventions identified in Chapter 4 are likely to effectively reduce inequalities in dental care provision previously identified in Chapter 3.

5.2.1 Socioeconomic and cultural gaps

Age: In the previously conducted CCHS data analysis, it was found that people younger than 35 were positively associated with insufficient dental health care utilization. Although most rural interventions targeted children or are typically not explicitly designed to tackle age gaps, some of them were considered adequate for these population age groups. For example, community water fluoridation (154,157), periodontal health (173), oral health literacy intervention (171), undergraduate placement programs (166,178), and teledentistry (196,199). The evidence also highlights an important point regarding children's oral health interventions. As poor oral health habits can persist into adulthood, it would seem logical to provide oral health education and early preventive treatment to the entire family, particularly the primary caregivers.

Education: Education level and frequency of dental visits were also significantly associated, with poorly educated individuals reporting poor dental care use. Adults with less education may be unable to interpret and act on the dental health information that may reduce their symptoms and risk factors due to limited oral literacy skills. Therefore, adult health literacy programs can help close such gaps. (202). Additionally, programs that empower children with proper knowledge about routine dental health maintenance and oral disease will improve their current and future dental health outcomes as adults (156,175).

Income and dental insurance: One of the biggest challenges that need to be addressed is ensuring access to oral healthcare for low-income adults who do not have insurance or who do not qualify for government support. Undoubtedly, prevention at the community or population level is the most cost-effective and can have the greatest impact on a community or population, whether it be a school, neighbourhood or nation. Prevention of dental diseases can be accomplished through various approaches, but health education is the most cost-effective one. Other examples include the water fluoridation community (i.e., it saves money from a societal perspective and reduces caries) despite varying costs of implementation and maintenance (154,157). In addition, the distribution of free fluoride toothpaste and toothbrushes to rural communities may promote better oral hygiene practices in those who are unable to afford these dental kits (197). Also, teledentistry offers a cost-effective alternative to traditional face-to-face dental clinics, where low-income families are provided free preventive and treatment dental services or at a reduced cost. This is an affordable model for patients and governments where risk assessment, diagnosis and intervention are promoted at the earliest possible stage, and the patient is also monitored continuously (179,198,199). It is also possible for patients to receive free or low-cost dental services through dental providers who have received financial incentives or scholarships in exchange for their commitment to work in rural communities (159). Similarly, those financed or free dental services can be accessed in government-funded outreach clinics of dental faculties and other dental training institutions (183,185,205).

5.2.2. Disease outcomes

Diabetes: Ontarian patients with diabetes were more likely to have infrequent dental appointments. A medical screening program for prediabetes and diabetes can be adequately

conducted in an oral healthcare setting; such an intervention will require collaboration between oral health professionals, training, patient acceptance, formal referral systems, and sustainable health policies. Clarification of legal and reimbursement issues is also required (176). The CCHS data analysis previously conducted also shows awareness about the chronic complications from Diabetes, especially Cancer. One cancer-related screening practice of oral health professionals has been found in the literature search and can be implemented to enhance oral cancer prevention and early detection (177).

Dentate status: Participants without natural teeth reported higher odds of poor dental visits. Fortunately, the majority of oral health promotion programs, dental preventive measures, and service delivery models described in this publication can prevent or delay tooth loss caused by dental disease. However, no interventions were found for specific dental prosthetic services in the adult rural population.

5.2.3 Health behaviours

Smoking cessation: The prevalence and severity of periodontal disease are strongly associated with smoking. Smoking is also associated with lower dental care utilization, making it a significant risk factor. Regardless of limited resources in rural and remote areas, it may be possible to provide face-to-face smoking cessation advice and counselling to patients by dental care teams and/or to delegate certain tasks to prevention auxiliary personnel and dental hygienists (174). The literature search also found interventions specific to tackle periodontal diseases primarily associated with smoking behaviours (173,178).

Brushing and flossing frequency: Most oral health promotion and prevention programs found in the literature can effectively improve brushing and flossing behaviour with an educational approach.

5.3 Promising practices for Canada based on learned lessons from international dental interventions

5.3.1 Water fluoridation

Over 90 national and international governments and health organizations, such as the World Health Organization (WHO), endorse the fluoridation of drinking water to prevent tooth decay (224). However, in many countries, including Australia, Canada and New Zealand, natural fluoride levels in water are not high enough to provide health benefits. The percentage of the population with access to fluoridated water in Australia was higher than that. In Australia, for example, it was estimated that 89% of the Australian population in 2017 had access to optimally fluoridated water (137). Around 60% of New Zealanders on community water supplies have access to fluoridated water (225). However, Health Canada reported in 2017 that around 39% of Canadians lived in a community with fluoridated water. (214). One reason for these differences is the controversy about their toxicity and pervasive in the environment. Canadians repeatedly rejected water fluoridation in municipal referendums; however, it is kept as safe practice in lower concentrations as other topical fluorides are less universally affordable (214).

5.3.2 Dental therapists

New Zealand's biggest advantage is access to more elementary school-aged children due to its better oral health infrastructure. This infrastructure consists of a publicly funded system with school- and community-based health centers staffed by care staff and dental therapists collaborating with dentists on call for a consultation (226). While dental therapists are not as familiar in Australia as in New Zealand, nor is their use integral to the culture of dental care, there are still interventions that include these allied dental care providers around the country (194). In Canada, only approximately 300 dental therapists practice in Canada; most works in rural and remote communities in Saskatchewan, and all training schools for dental therapy closed in 2011 (91). Dental therapists can provide care to people in rural Canadian communities where dentists are scarce and do not serve children. Having these practitioners on the team could save costs and also improve efficiency within the dental team, allowing dentists to focus on more advanced procedures. Those seeking to improve children's oral health in Canada can consider New Zealand's experience as a model for policy improvements.

5.4 Policy implications

5.4.1 Shifts in dental care insurance policy in Canada.

The results of this thesis may also be used to influence future rural dental health policy development. Since dental services are primarily provided privately with out-of-pocket or insurance payments, populations with limited incomes and insurance coverage have fewer options in accessing dental services, resulting in adverse oral health outcomes in urban and rural areas.

The national government is aware of the issues at hand and has recognized both the economic implications as well as the detrimental effects lack of access has on both oral health and overall health, resulting in solutions being sought. After being rejected in past years, a new national dental program has been approved under the new Liberal-NDP agreement. This may have been the largest expansion of dental health care in decades. This was a surprising and positive development for all patients and researchers advocating for oral health equity, particularly given the current political and economic climates following COVID-19. The new program will provide coverage to families without dental coverage and with an income of less than \$90,000. There is also a provision for flat-rate fees, which may be charged whenever a claim is made and apply to people earning less than \$70,000 a year. Co-payments will apply for those earning between \$70,000 and \$90,000, but they should be proportional to income. This is intended to be a phased program that will allow Canadian families with children under 12 to obtain coverage for dental care before the end of 2022 - if their annual income is less than \$70,000. The initiative will extend dental care to those under 18, senior citizens, and people with disabilities by 2023. After that, the proposed program will be fully implemented by 2025 - although anyone in a household with an annual income exceeding \$90,000 will not be eligible to participate.

The plan is believed to be accessible to approximately 6.5 million Canadians. By 2025, this figure was projected to decrease slightly to 6.3 million due to demographic changes and an improving labour market. From an economic perspective, the plan will entail funding of \$5.3 billion over five years for the promised program (approximately \$1.7 billion annually), beginning this year, 2022.

Despite the multibillion-dollar cost of such a program, its benefits may outweigh its costs in the long run. There can be substantial costs associated with dental problems for the Canadian healthcare system and the Canadian government. Examples include expenditures for emergency room visits, physician visits, and lost productivity as a result of time away from work or school. Public dollars may be saved by early intervention for what are largely preventable conditions.

In spite of this success, there remain dentist shortages in rural and remote areas of Ontario as well as Canada as a whole. Further, there has not yet been any improvement in the accessibility of dental services in rural areas. These partial successes are, however, paving the way for establishing dental services in rural areas, which will assist in increasing access to dental services and ensuring that residents receive quality dental care.

5.4.2 Surveillance of Oral Health Data

A future recommendation this thesis could make to the upcoming dental care program managers would be to promote investments in surveillance and/or population health assessment. This investment will facilitate the evaluation and findings report during the accountability measurement, thereby increasing the infrastructure for collecting, analyzing, and sharing data on oral health, which is not yet well developed in Canada.

In Canada, there is no ongoing surveillance system for measuring the oral health status of the population, the barriers to care, or the inequities in oral health. The CHMS is the first nationally representative study to examine two of the most prevalent oral diseases, dental caries and periodontal disease since the Nutrition Canada Survey was conducted in the early 1970s. In the absence of this information, it is impossible to develop dental health policy based on evidence and best practices. In the future, it will be necessary to support

oral health research, particularly to prevent a gap in clinical data on oral health. The federal and provincial/territorial governments should fund oral health data collection regularly, including information regarding access issues and clinical oral health assessments of all Canadians, including those excluded from the CHMS.

5.5 Future Direction of Research

Our findings will likely be of interest to rural communities throughout the world seeking to improve their oral health and overall well-being.

First, the present review contributes to developing and operationalizing reliable and effective oral health models for rural populations. However, there are still many areas within these findings where future research could be conducted to expand existing knowledge. Additionally, the descriptions of some programs did not include performance evaluations, preventing a comprehensive assessment of the extent and impact of the programs. Therefore, longitudinal evaluations of oral health care interventions is necessary. Similarly, various outcome measures have been used in selected program evaluations. It is apparent from the above that it is imperative to develop uniform and validated measurement tools to assess the performance of a rural dental health care intervention.

Secondly, one of this thesis's key findings involved exploring inequities in dental care utilization and access in Ontarian rural areas. It would be useful to investigate these gaps using a sub-regional scale to determine more closely which areas within the region are experiencing barriers in access to dental services. Since this study would explore comparisons between urban and rural areas, using a smaller sub-region would make this comparison more straightforward. Including qualitative analysis in future studies involving

this topic would also be beneficial. This would provide a more detailed analysis on the experience of accessing dental services in rural areas, differences in perceptions involving space and place, and more specific information on the exact barriers faced.

The majority of rural dental programs identified in the literature are either preventive or restorative. Future studies should investigate whether any specialized dental programs are available in rural areas around the world, such as orthodontics, prosthodontics, pathology, or oral surgery.

5.6 Strengths and limitations

This thesis, to our knowledge, is the first study to incorporate statistical data from the CCHS merged with the index of remoteness, which allow exploring variables in different remoteness subgroups. Additionally, this thesis includes qualitative data from a systematically performed scoping review using a robust methodology that ensures the transparency of the findings. In addition, it was conducted a critical appraisal in all selected articles, and most of them have being regarded as high-quality; these findings suggested that the selected programs may be transferable or replicable and may serve as valuable models for other countries to promote the oral health of rural and remote populations.

There were also a few limitations in this thesis. First, the scoping review could not include publications in languages other than English and unpublished data, limiting the number of evidence.

In the case of the CCHS data analysis, since this is a secondary national survey analysis, it is impossible to distinguish errors made in the original survey methods or errors made during the data entry process. Due to the cross-sectional nature of the CCHS, only associations are able to be assessed. Since the measurements are made at a single point in

time, causal inferences cannot be drawn from this study design as there is no ability to establish a temporal relationship between independent and dependent variables. Additionally, this study excluded individuals living on First Nations reserves or Crown lands, residents of institutions, full-time members of the Canadian Armed Forces, and residents of certain remote regions, which may weaken the generalizability of the results. Additionally, some variables are self-reported, which introduces recall bias and may not be as accurate as observed variables.

5.7 Conclusion

In the Canadian population, structural inequities were observed in the access to dental care services in rural areas. These inequities are partly a product of the exclusion of the dental health care system from the Canadian health system to universal coverage. In the particular case of Ontario, the results showed differences in dental service utilization patterns between the populations studied due to several geographic, compositional and contextual factors.

The evidence provided by the CCHS data analysis showed a positive correlation in most of the variables investigated, with socioeconomic status as the primary determinant for access to dental care. These figures are relevant for designing strategies and policies to improve oral health at the population level, specifically for rural residents.

On the other hand, the scoping review indicates that the differences among rural dental care approaches implemented in Australia, Canada and New Zealand are determined by government priorities, funding, culture and the population's specific needs, among others. Hence, the collaboration of government, health policymakers, community and oral health

care professionals are needed to carry out public dental services, educational interventions and other needs-based tailored strategies for rural populations. Further research is needed in several areas, prioritizing evaluating and monitoring the results in larger samples with measurable terms.

Appendices

6.1 Appendix A

Appendix A: Government and compulsory insurance spending as proportion of total health spending by function of care. OECD Countries. 2019

	Total	Hospital care	Outpatient medical care	Dental care	Pharmaceuticals
OECD32	73%	88%	77%	29%	57%
Australia	69%	68%	81%	23%	53%
Austria	74%	87%	78%	45%	68%
Belgium	77%	76%	76%	39%	71%
Canada	70%	91%	87%	6%	36%
Czech Republic	82%	95%	90%	48%	58%
Denmark	84%	91%	92%	19%	43%
Estonia	75%	98%	84%	25%	53%
Finland	75%	91%	82%	30%	55%
France	83%	96%	77%	n.a	80%
Germany	84%	96%	89%	68%	84%
Greece	61%	66%	62%	0%	54%
Hungary	69%	91%	61%	36%	50%
Iceland	82%	99%	78%	24%	35%
Ireland	73%	70%	74%	n.a	78%
Israel	63%	94%	62%	2%	n.a
Italy	74%	96%	58%	n.a	62%
Japan	84%	93%	85%	78%	72%
Korea	59%	65%	58%	33%	54%
Latvia	57%	80%	61%	18%	37%
Lithuania	67%	91%	77%	16%	34%
Luxembourg	84%	92%	88%	43%	68%
Mexico	52%	66%	85%	7%	n.a
Netherlands	82%	91%	84%	11%	68%
Norway	85%	99%	86%	29%	56%
Poland	69%	93%	67%	24%	36%
Portugal	66%	85%	63%	n.a	55%
Slovak Republic	80%	87%	98%	53%	71%
Slovenia	72%	86%	76%	50%	51%
Spain	71%	91%	76%	1%	58%
Sweden	84%	99%	86%	40%	53%
Switzerland	64%	84%	62%	6%	55%
United Kingdom	79%	94%	85%	n.a	66%
Costa Rica	75%	88%	59%	11%	42%
Russian Federation	57%	82%	55%	n.a	12%

Source: OECD Health Statistics 2019 (73)

6.2 Appendix B

Appendix B: Disability-adjusted Life-years Ranks for Oral Conditions in 1990 and 2010

Rank	Condition Name	Overall		Men		Women	
		n ^a	%	n ^a	%	n ^a	%
1	Untreated caries of permanent teeth	2,431,636	35.29	1,194,051	34.37	1,237,585	36.23
2	Tension-type headache	1,431,067	20.77	655,937	18.88	775,131	22.69
3	Migraine	1,012,944	14.70	371,072	10.68	641,873	18.79
4	Fungal skin diseases	985,457	14.30	516,167	14.86	469,291	13.74
5	Other skin and subcutaneous diseases	803,597	11.66	417,129	12.01	386,468	11.32
6	Severe periodontitis	743,187	10.79	378,407	10.89	364,780	10.68
7	Mild hearing loss	724,689	10.52	386,147	11.11	338,543	9.91
8	Acne vulgaris	646,488	9.38	311,349	8.96	335,140	9.81
9	Low back pain	632,045	9.17	334,793	9.64	297,252	8.7
10	Untreated caries of deciduous teeth	621,507	9.02	352,085	10.13	269,421	7.89
36	Severe tooth loss	158,284	2.3	67,264	1.94	91,020	2.66

^aNumbers of cases reported in thousands.

Source: Global Burden of Oral Conditions in 1990-2010: A Systematic Analysis (227)

6.3 Appendix C

Appendix C: Search strategies

- Scopus: Comprehensive database for scientific, technical and medical information

(TITLE-ABS-KEY (canad* OR "british columbia" OR "colombie britannique" OR alberta* OR saskatchewan OR manitoba* OR ontario OR quebec OR "nouveau brunswick" OR "nova scotia" OR "nouvelle ecosse" OR pei OR "prince edward island" OR newfoundland OR labrador OR nunavut OR nwt OR "northwest territories" OR yukon OR nunavik OR inuvialuit OR nunangat OR nunatsiavut OR australia* OR queensland OR "new south wales" OR victoria OR "northern territory" OR "western australia" OR "south australia" OR tasmania OR "new zealand")

AND TITLE-ABS-KEY (circumpolar OR rural OR remote OR "rural health" OR "rural health services" OR "rural population")

AND TITLE-ABS-KEY ("oral health" OR dentist* OR dental OR "dental health services" OR "dental caries")

AND TITLE-ABS-KEY (access* OR insurance OR coverage OR service* OR intervention* OR treatment OR "health policy" OR "health services accessibility" OR clinic*))

- PUBMED

"canad*"[Title/Abstract] OR "british columbia"[Title/Abstract] OR "Colombie britannique"[Title/Abstract] OR "alberta*"[Title/Abstract] OR "saskatchewan"[Title/Abstract] OR "manitoba*"[Title/Abstract] OR "ontario"[Title/Abstract] OR "quebec"[Title/Abstract] OR "nouveau brunswick"[Title/Abstract] OR "nova scotia"[Title/Abstract] OR "nouvelle ecosse"[Title/Abstract] OR "PEI"[Title/Abstract] OR "prince edward island"[Title/Abstract] OR "newfoundland"[Title/Abstract] OR "labrador"[Title/Abstract] OR "nunavut"[Title/Abstract] OR "nwt"[Title/Abstract] OR "northwest territories"[Title/Abstract] OR "yukon"[Title/Abstract] OR "nunavik"[Title/Abstract] OR "inuvialuit"[Title/Abstract] OR "nunangat"[Title/Abstract] OR "nunatsiavut"[Title/Abstract] OR "australia*"[Title/Abstract] OR "queensland"[Title/Abstract] OR "New South Wales"[Title/Abstract] OR "victoria"[Title/Abstract] OR "Northern Territory"[Title/Abstract] OR "Western Australia"[Title/Abstract] OR "South Australia"[Title/Abstract] OR "tasmania"[Title/Abstract] OR "iceland"[Title/Abstract] OR "norway"[Title/Abstract] OR "sweden"[Title/Abstract]

AND "circumpolar"[Title/Abstract] OR "rural"[Title/Abstract] OR "remote"[Title/Abstract] OR "Rural Health"[MeSH Terms] OR "Rural Health Services"[MeSH Terms] OR "Rural Population"[MeSH Terms]

AND "access*"[Title/Abstract] OR "insurance"[Title/Abstract] OR
"coverage"[Title/Abstract] OR "service*"[Title/Abstract] OR
"intervention*"[Title/Abstract] OR "treatment"[Title/Abstract] OR "health
policy"[Title/Abstract] OR "Health Services Accessibility"[Mesh] OR
"clinic*"[Title/Abstract]

AND "oral health"[Title/Abstract] OR "dentist*"[Title/Abstract] OR
"dental"[Title/Abstract] OR "Dental Health Services"[MeSH Terms] OR "Dental
Caries"[Mesh]

- CINAHL: Cumulative Index to Nursing & Allied Health Literature

(canad* OR "british columbia" OR "Colombie britannique" OR alberta* OR
saskatchewan OR manitoba* OR ontario OR quebec OR "nouveau brunswick" OR "nova
scotia" OR "nouvelle ecosse" OR PEI OR "prince edward island" OR newfoundland OR
labrador OR nunavut OR nwt OR "northwest territories" OR yukon OR nunavik OR
inuvialuit OR nunangat OR nunatsiavut OR australia* OR queensland OR "New South
Wales" OR victoria OR "Northern Territory" OR "Western Australia" OR "South
Australia" OR tasmania OR "New Zealand") AND (circumpolar OR rural OR remote OR
(MH "Rural Health") OR (MH "Rural Health Personnel") OR (MH "Rural Health Centers")
OR (MH "Rural Health Services") OR (MH "Hospitals, Rural") OR (MH "Rural
Population") AND ("oral health" OR dentist* OR dental OR (MH "Dental Health
Services+") OR (MH "Dental Caries") AND (access* OR insurance OR coverage OR
service* OR intervention* OR treatment OR "health policy" OR (MH "Health Services
Accessibility+") OR (MH "Health Services Needs and Demand+") OR clinic*)

7 References

1. Constitution of the World Health Organization. World Health Organization: Basic documents. 45th ed. Geneva World Heal Organ. 2005;
2. Blaizot AV -N. Periodontal diseases and cardiovascular events: meta-analysis of observational studies. *Int Dent J*. 2009;59(4):197–209.
3. Salme E Lavigne JLF. An umbrella review of systematic reviews of the evidence. *Can J Dent Hyg*. 2020;54(2):92–100.
4. Kim J, Amar S. Periodontal disease and systemic conditions: a bidirectional relationship. *Odontology*. 2006;94(1):10–21.
5. Azarpazhooh A, Leake JL. Systematic Review of the Association Between Respiratory Diseases and Oral Health. *J Periodontol*. 2006 Sep;77(9):1465–82.
6. Locker D, Quiñonez C. Functional and psychosocial impacts of oral disorders in Canadian adults: a national population survey. *J Can Dent Assoc*. 2009 Sep;75(7):521.
7. Kandelman D, Petersen PE, Ueda H. Oral health, general health, and quality of life in older people. *Spec Care Dent*. 2008 Oct 23;28(6):224–36.
8. Statistics Canada. Population growth in Canada’s rural areas, 2016 to 2021 [Internet]. 2022. Available from: <https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-x/2021002/98-200-x2021002-eng.cfm>
9. Jean G, Kruger E, Tennant M. The distribution of dentists in Australia socio-economic profile as an indicator of access to services. *Community Dent Health*. 2020;37(1):5–11.
10. CDHA. Addressing Dental Hygiene Labour Shortages in Rural and Remote Areas. 2012;1–6.
11. Shiikha Y, Kruger E, Tennant M. Rural and remote dental services shortages: Filling the gaps through geo-spatial analysis evidence-based targeting. *Heal Inf Manag J*. 2015;44(3):39–44.
12. Bourke L, Humphreys JS, Wakerman J, Taylor J. Understanding rural and remote health: A framework for analysis in Australia. *Health Place*. 2012 May;18(3):496–503.
13. Canadian Institute for Health Information. Distribution and Internal Migration of Canada’s Dentist Workforce. Ottawa CIHI. 2007;
14. Huot S, Ho H, Ko A, Lam S, Tactay P, MacLachlan J, et al. Identifying barriers to healthcare delivery and access in the Circumpolar North: important insights for health professionals. *Int J Circumpolar Health*. 2019 Jan 1;78(1):1571385.
15. Hanlon N, Halseth G. The greying of resource communities in northern British Columbia: implications for health care delivery in already-underserved communities. *Can Geogr G?ographe Can*. 2005 Mar;49(1):1–24.
16. Canadian Dental Association. The State of Oral Health in Canada [Internet]. Canadian Dental Association. 2017 [cited 2021 Oct 25]. p. 1–25. Available from: https://www.cda-adc.ca/stateoforalhealth/_files/TheStateofOralHealthinCanada.pdf
17. Peerson A, Saunders M. Health literacy revisited: what do we mean and why does it matter? *Health Promot Int*. 2009 Sep 1;24(3):285–96.

18. Parker EJ, Misan G, Chong A, Mills H, Roberts-Thomson K, Horowitz AM, et al. An oral health literacy intervention for Indigenous adults in a rural setting in Australia. *BMC Public Health*. 2012 Dec 20;12(1):461.
19. Navdeep Kaur. et al. Oral Health Literacy: Findings of A Scoping Review. *EC Dent Sci* 23. 2015;293–306.
20. Alsharif AT, Kruger E, Tennant M. Disparities in dental insurance coverage among hospitalised Western Australian children. *Int Dent J*. 2014 Oct;64(5):252–9.
21. The Canadian Academy of Health Sciences, Canadian Academy of Health Sciences, The Canadian Academy of Health Sciences, Canadian Academy of Health Sciences. Improving access to oral health care for vulnerable people living in Canada [Internet]. Canadian Academy of Health Sciences. 2014 [cited 2021 Oct 25]. Available from: https://www.cda-adc.ca/stateoforalhealth/_files/TheStateofOralHealthinCanada.pdf
22. Bhatti T, Rana Z, Grootendorst P. Dental insurance, income and the use of dental care in Canada. *J Can Dent Assoc*. 2007 Feb;73(1):57.
23. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) [Internet]. Seattle: Institute of Health Metrics and Evaluation (IHME). 2020. Available from: <http://ghdx.healthdata.org/gbd-results-tool>.
24. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century - the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol*. 2003 Dec;31:3–24.
25. Romanow R. Building on Values [Internet]. Ottawa: Commission on the Future of Health Care in Canada. 2002 [cited 2021 Oct 25]. Available from: <https://publications.gc.ca/collections/Collection/CP32-85-2002E.pdf>
26. Deber RB. Health Care Reform: Lessons From Canada. *Am J Public Health*. 2003 Jan;93(1):20–4.
27. Quiñonez C., Quinonez C. Why was dental care excluded from Canadian Medicare? *NCOHR Work Pap Ser*. 2013;1(1):1–5.
28. CIHI CIFHI, Canadian Institute for Health Information. National Health Expenditure Trends 1975-2018 [Internet]. Ottawa. 2019 [cited 2021 Oct 25]. p. 1–163. Available from: https://secure.cihi.ca/free_products/NHEX-trends-narrativereport-2018-en-web.pdf
29. Quinonez C, Grootendorst P, Quiñonez C, Grootendorst P, Quiñonez C, Grootendorst P, et al. Equity in dental care among Canadian households. *Int J Equity Health*. 2011;10(1):1–9.
30. Ramji S, Quinonez C. Government spending on dental care: is it a public priority? *J Pub Heal Dent*. 2012;72:246–51.
31. Canadian Agency for Drugs and Technologies in Health. Periodic Dental Examinations for Oral Health: A Review of Clinical Effectiveness, Cost Effectiveness, and Guidelines. 2014;
32. Statistics Canada. Dental Care. 2018;
33. Ramraj C, Sadeghi L, Lawrence HP, Dempster L, Quiñonez C. Is Accessing Dental Care Becoming More Difficult? Evidence from Canada’s Middle-Income Population. Burne RA, editor. *PLoS One*. 2013 Feb 20;8(2):e57377.
34. Sadeghi L, Manson H, Quinonez CR, Laleh S, Heather M CQ, Sadeghi L, Manson

- H, et al. Report on access to dental care and oral health inequalities in Ontario. Public Heal Ontario. 2012;(July 2012):21.
35. Committee HDTG of the FA, Security on PH and H. Reducing Health Disparities – Roles of the Health Sector: Discussion Paper. Public Heal Agency Canada Ottawa,. 2005;
 36. Butler-Jones D. The Chief Public Health Officer’s report on the state of public health in Canada: 2008. Ottawa, Public Heal Agency Canada. 2008;
 37. Canadian Institute for Health Information. Trends in income-related health inequalities in Canada: technical report: revised July 2016. 2016;
 38. Bernabe E, Marcenes W, Hernandez CR, Bailey J, Abreu LG, Alipour V, et al. Global, Regional, and National Levels and Trends in Burden of Oral Conditions from 1990 to 2017: A Systematic Analysis for the Global Burden of Disease 2017 Study. *J Dent Res.* 2020 Apr 2;99(4):362–73.
 39. Kawachi I, Subramanian S V, Almeida-Filho N. A glossary for health inequalities. *J Epidemiol \& Community Heal.* 2002;56(9):647–52.
 40. National Collaborating Centre for Determinants of Health. Let’s Talk: Health equity. Antigonish, NS Natl Collab Cent Determ Heal. 2013;
 41. Shengelia B, Murray CJ AO. Beyond access and utilization: defining and measuring health system coverage. Health systems performance assessment: debates, methods and empiricism. Geneva: World Health Organization. 2003. 221-34. p.
 42. Levesque J-F, Harris MF, Russell G. Patient-centred access to health care: conceptualising access at the interface of health systems and populations. *Int J Equity Health.* 2013;12(1):18.
 43. Asad F, Nur F, Morris J, Bobiak J. Report: Defining Rural. Ottawa; 2021 Jul.
 44. Alasia, A., F. Bédard, J. Bélanger, E. Guimond and CP. Measuring Remoteness and Accessibility: A Set of Indices for Canadian Communities. Reports Spec Bus Prod. 2017;Statistics.
 45. Glick M, Williams DM, Kleinman D V., Vujicic M, Watt RG, Weyant RJ. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *J Am Dent Assoc.* 2016 Dec 1;147(12):915–7.
 46. Raphael D. Narrative review of affinities and differences between the social determinants of oral and general health in Canada: establishing a common agenda. *J Public Health (Bangkok).* 2019 Sep 30;41(3):e218–25.
 47. Quiñonez C. The determinants of oral health and access to dental care. In: *The Politics of Dental Care in Canada.* 2021. p. 14–5.
 48. Gomaa N, Nicolau B, Siddiqi A, Tenenbaum H, Glogauer M, Quiñonez C. How does the social “get under the gums”? The role of socio-economic position in the oral-systemic health link. *Can J Public Heal.* 2017 May 4;108(3):e224–8.
 49. Park L, Gomaa N, Quinonez C. Racial/ethnic inequality in the association of allostatic load and dental caries in children. *J Public Health Dent.* 2021 Jul 13;jphd.12470.
 50. Gomaa N, Glogauer M, Nicolau B, Tenenbaum H, Siddiqi A, Fine N, et al. Stressed-Out Oral Immunity: A Gateway From Socioeconomic Adversity to Periodontal Disease. *Psychosom Med.* 2020 Feb;82(2):126–37.

51. Sabbah W, Gomaa N, Gireesh A. Stress, allostatic load, and periodontal diseases. *Periodontol* 2000. 2018 Oct;78(1):154–61.
52. Vasiliou A, Shankardass K, Nisenbaum R, Quiñonez C. Current stress and poor oral health. *BMC Oral Health*. 2016;16(1):1–8.
53. Borgnakke W; Genco R. Associations between periodontal disease and hyperglycemia/diabetes. In: M. Glick, editor. *The oral health-systemic health connection: A guide to patients*. 2nd edition. Quintessence Publishing Co. Inc.; 2019. p. 135–63.
54. Kaura Parbhakar K, Rosella LC, Singhal S, Quiñonez CR. Risk of complications among diabetics self-reporting oral health status in Canada: A population-based cohort study. Borrell LN, editor. *PLoS One*. 2020 Jan 9;15(1):e0218056.
55. Tonetti MS, D’Aiuto F, Nibali L, Donald A, Storry C, Parkar M, et al. Treatment of Periodontitis and Endothelial Function. *N Engl J Med*. 2007 Mar;356(9):911–20.
56. Lavigne SE, Forrest JL. An umbrella review of systematic reviews of the evidence of a causal relationship between periodontal microbes and respiratory diseases: Position paper from the Canadian Dental Hygienists Association. *Can J Dent Hyg CJDH = J Can l’hygiene Dent JCHD*. 2020 Feb 1;54(1):32–41.
57. Mojon P. Oral health and respiratory infection. *J Can Dent Assoc*. 2002 Jun;68(6):340–5.
58. Lee S, Lighvan NL, McCredie V, Pechlivanoglou P, Krahn M, Quiñonez C, et al. Chlorhexidine-Related Mortality Rate in Critically Ill Subjects in Intensive Care Units: A Systematic Review and Meta-Analysis. *Respir Care*. 2019 Mar 8;64(3):337–49.
59. El-Rabbany M, Zaghlol N, Bhandari M, Azarpazhooh A. Prophylactic oral health procedures to prevent hospital-acquired and ventilator-associated pneumonia: A systematic review. *Int J Nurs Stud*. 2015 Jan;52(1):452–64.
60. Locker D, Clarke M, Payne B. Self-perceived Oral Health Status, Psychological Well-being, and Life Satisfaction in an Older Adult Population. *J Dent Res*. 2000 Apr 8;79(4):970–5.
61. Brennan DS, Spencer AJ, Roberts-Thomson KF. Tooth loss, chewing ability and quality of life. *Qual Life Res*. 2008 Mar 14;17(2):227–35.
62. Kisely S. No Mental Health without Oral Health. *Can J Psychiatry*. 2016 May 10;61(5):277–82.
63. Donnelly LR, Clarke LH, Phinney A, MacEntee MI. The impact of oral health on body image and social interactions among elders in long-term care. *Gerodontology*. 2016 Dec;33(4):480–9.
64. Kisely S, Sawyer E, Siskind D, Laloo R. The oral health of people with anxiety and depressive disorders – a systematic review and meta-analysis. *J Affect Disord*. 2016 Aug;200:119–32.
65. Moeller J, Singhal S, Al-Dajani M, Gomaa N, Quiñonez C. Assessing the relationship between dental appearance and the potential for discrimination in Ontario, Canada. *SSM - Popul Heal*. 2015 Dec;1:26–31.
66. Bernabé E, Masood M, Vujicic M. The impact of out-of-pocket payments for dental care on household finances in low and middle income countries. *BMC Public Health*. 2017 Dec 23;17(1):109.

67. Hayes A, Azarpazhooh A, Dempster L, Ravaghi V, Quiñonez C. Time loss due to dental problems and treatment in the Canadian population: analysis of a nationwide cross-sectional survey. *BMC Oral Health*. 2013 Dec 15;13(1):17.
68. Australian Research Centre for Popu. Productivity losses from dental problems. *Aust Dent J*. 2012 Sep;57(3):393–7.
69. Singhal S, Quiñonez C, Manson H. Visits for Nontraumatic Dental Conditions in Ontario’s Health Care System. *JDR Clin Transl Res*. 2019 Jan 20;4(1):86–95.
70. Figueiredo R, Dempster L, Quiñonez C, Hwang SW. Emergency Department Use for Dental Problems among Homeless Individuals: A Population-Based Cohort Study. *J Health Care Poor Underserved*. 2016;27(2):860–8.
71. Figueiredo R, Fournier K, Levin L. Emergency department visits for dental problems not associated with trauma in Alberta, Canada. *Int Dent J*. 2017 Dec;67(6):378–83.
72. Singhal S, McLaren L, Quiñonez C. Trends in emergency department visits for non-traumatic dental conditions in ontario from 2006 to 2014. *Can J Public Heal*. 2017;108(3):e246–50.
73. OCDE. Health at a Glance 2021. OECD Publishing. OECD; 2021. 204–215 p. (Health at a Glance).
74. Marchildon GP, Allin S, Merkur S. Canada: Health System Review. *Health Syst Transit*. 2020;22(3):1–194.
75. Shaw J, Farmer J. An environmental scan of publicly financed dental care in Canada: 2015 Update. 2016.
76. Sourang D, Worswick A. Cost estimate of a federal dental care program for uninsured Canadians. Ottawa; 2020.
77. Health Canada. Report on the Findings of the Oral Health Component of the Canadian Health Measures Survey 2007-2009. Health Canada. 2010. 124p p.
78. Canadian Academy of Health Sciences. Improving access to oral health care for vulnerable and underserved populations. *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*. 2012. 1–279 p.
79. Dudko Y, Kruger E, Tennant M. Shortage of dentists in Outer Regional and Remote areas and long public dental waiting lists: Changes over the past decade. *Aust J Rural Health*. 2018 Aug 4;26(4):284–9.
80. Duckett S, Cowgill M, Swerissen HS. Filling the gap: a universal dental care scheme for Australia. 2019.
81. Thomson WM. Use of dental services by 26-year-old New Zealanders. *N Z Dent J*. 2001 Jun;97(428):44–8.
82. Australian Institute of Health and Welfare. Health expenditure Australia 2013–14. Canberra: AIHW; 2015.
83. Chrisopoulos S, Beckwith K, Harford J. Oral health and dental care in Australia: Key facts and figures,2011. Australian Institute of Health and Welfare. 2011.
84. Ministry of Health. Our Oral Health: Key findings of the 2009 New Zealand Oral Health Survey. Wellington; 2010.
85. Thompson B, Cooney P, Lawrence H, Ravaghi V, Quiñonez C. Cost as a barrier to accessing dental care: Findings from a Canadian population-based study. *J Public Health Dent*. 2014;74(3):210–8.
86. Thompson B. Cost barriers to dental care in Canada. *Univ Toronto*. 2012;1–77.

87. Barnett T, Hoang H, Stuart J, Crocombe L, Bell E. Utilisation of oral health services provided by non-dental health practitioners in developed countries: A review of the literature. *Community Dent Health*. 2014;31(4):224–33.
88. Statistics Canada. Health fact sheets: Dental care [Internet]. Catalogue no.82-625-X. 2018. Available from: <https://www150.statcan.gc.ca/n1/en/pub/82-625-x/2019001/article/00010-eng.pdf?st=6erBcLjX>
89. Muirhead VE, Quiñonez C, Figueiredo R, Locker D. Predictors of dental care utilization among working poor Canadians. *Community Dent Oral Epidemiol*. 2009 Jun;37(3):199–208.
90. Locker D, Maggiras J, Quiñonez C. Income, dental insurance coverage, and financial barriers to dental care among Canadian adults. *J Public Health Dent*. 2011 Sep;71(4):327–34.
91. Leck V, Randall GE. The rise and fall of dental therapy in Canada: A policy analysis and assessment of equity of access to oral health care for Inuit and First Nations communities. *Int J Equity Health*. 2017 Jul;16(1):1–10.
92. Zangiabadi S, Costanian C, Tamim H. Dental care use in Ontario: The Canadian community health survey (CCHS). *BMC Oral Health*. 2017;17(1):1–8.
93. Hahn, T. W., Kraus, C., & Hooper-Lane C. Clinical Inquiries: What is the optimal frequency for dental checkups for children and adults? *J Fam Pract*. 2017;66(11):699–700.
94. Public Health Infobase. Health inequalities data tool [Internet]. Available from: <https://health-infobase.canada.ca/healthinequalities/>.
95. Baghaie H, Kisely S, Forbes M, Sawyer E, Siskind DJ. A systematic review and meta-analysis of the association between poor oral health and substance abuse. *Addiction*. 2017 May;112(5):765–79.
96. Scrine C, Durey A, Slack-Smith L. Enhancing oral health for better mental health: Exploring the views of mental health professionals. *Int J Ment Health Nurs*. 2018 Feb;27(1):178–86.
97. Meldrum R, Ho H, Satur J. The role of community mental health services in supporting oral health outcomes among consumers. *Aust J Prim Health*. 2018;24(3):216.
98. Jamieson LM, Paradies YC, Gunthorpe W, Cairney SJ, Sayers SM. Oral health and social and emotional well-being in a birth cohort of Aboriginal Australian young adults. *BMC Public Health*. 2011 Dec 19;11(1):656.
99. Li X, Kolltveit KM, Tronstad L, Olsen I. Systemic Diseases Caused by Oral Infection. *Clin Microbiol Rev*. 2000 Oct 1;13(4):547–58.
100. World Health Organization. Global health risks : mortality and burden of disease attributable to selected major risks. 2009;
101. Lavigne SE, Forrest JL. An umbrella review of systematic reviews examining the relationship between type 2 diabetes and periodontitis: Position paper from the Canadian Dental Hygienists Association. *Can J Dent Hyg CJDH = J Can l'hygiene Dent JCHD*. 2021 Feb;55(1):57–67.
102. Alhozgi A, Feine JS, Tanwir F, Shrivastava R, Galarneau C, Emami E. Rural–urban disparities in patient satisfaction with oral health care: a provincial survey. *BMC Oral Health*. 2021 Dec 15;21(1):261.
103. Emami E, Khiyani MF, Habra CP, Chassé V, Rompré PH. Mapping the Quebec

- dental workforce: Ranking rural oral health disparities. *Rural Remote Health*. 2016;16(1):3630.
104. Mehra VM, Costanian C, Khanna S, Tamim H. Dental care use by immigrant Canadians in Ontario: A cross-sectional analysis of the 2014 Canadian Community Health Survey (CCHS). *BMC Oral Health*. 2019;19(1):1–9.
 105. Australian Institute of Health and Welfare. Oral health and dental care in Australia. Canberra; 2022.
 106. Kruger E, Tennant M, George R. Application of geographic information systems to the analysis of private dental practices distribution in Western Australia. *Rural Remote Health*. 2011 Aug 10;11(3).
 107. Ahmad A, Quiñonez C. Disparities in the availability of dental care in metropolitan toronto. *J Can Dent Assoc (Tor)*. 2014;80.
 108. Meyer SP. A spatial assessment of dentist supply in Ontario, Canada. *Can Geogr*. 2014;58(4):481–98.
 109. Kruger E, Whyman R, Tennant M. High acuity GIS comparison of dentist and doctor surgery locations in Auckland, New Zealand. *Community Dent Health*. 2013;30(2):83–7.
 110. Ju X, Brennan DS, Spencer AJ. Age, period and cohort analysis of patient dental visits in Australia. *BMC Health Serv Res*. 2014 Dec 10;14(1):13.
 111. Poudel P, Griffiths R, Arora A, Wong VW, Flack JR, Barker G, et al. Oral Health Status, Knowledge, and Behaviours of People with Diabetes in Sydney, Australia. *Int J Environ Res Public Health*. 2021 Mar 26;18(7):3464.
 112. Tomar SL, Lester A. Dental and other health care visits among U.S. adults with diabetes. *Diabetes Care*. 2000 Oct 1;23(10):1505–10.
 113. Parbhakar KK, Rosella LC, Singhal S, Quiñonez CR. Dental and medical care visits among persons with diabetes in Ontario, Canada, who self-report oral health status. *Can J Dent Hyg CJDH = J Can l'hygiene Dent JCHD*. 2022;56(1):42–5.
 114. Emami E, de Souza RF, Kabawat M, Feine JS. The Impact of Edentulism on Oral and General Health. *Int J Dent*. 2013;2013:1–7.
 115. Badri P, Baracos V, Ganatra S, Lai H, Samim F, Amin M. Retrospective study of factors associated with late detection of oral cancer in alberta: A qualitative study. Sabol I, editor. *PLoS One*. 2022 Apr 26;17(4):e0266558.
 116. Sbaraglia M, Turnbull RS, Locker D. Risk Indicators for Periodontal Disease in a Remote Canadian Community? a Dental Practice-based Study. *J Public Health Dent*. 2002 Mar;62(1):51–6.
 117. Mehra VM, Ali-Hassan Y, Tamim H, Costanian C. Prevalence and Factors Associated with Visiting the Dentist Only for Emergency Care Among Indigenous People in Ontario. *J Immigr Minor Heal*. 2020 Feb 28;22(1):96–101.
 118. Mucci LA, Brooks DR. Lower use of dental services among long term cigarette smokers. *J Epidemiol Community Health*. 2001 Jun 1;55(6):389 LP – 393.
 119. Dasanayake AP, Warnakulasuriya S, Harris CK, Cooper DJ, Peters TJ, Gelbier S. Tooth Decay in Alcohol Abusers Compared to Alcohol and Drug Abusers. *Int J Dent*. 2010;2010:1–6.
 120. Sadeghi L, Quinonez C. Trends in Access to Dental Care among Middle-Class Canadians. 2012;MR85824:98.
 121. Farmer J, Phillips RC, Singhal S, Quiñonez C. Inequalities in oral health:

- Understanding the contributions of education and income. *Can J Public Heal.* 2017;108(3):e240–5.
122. Duncan L, Bonner A. Effects of income and dental insurance coverage on need for dental care in Canada. *J Can Dent Assoc (Tor)*. 2014;
 123. Zivkovic N, Aldossri M, Gomaa N, Farmer JW, Singhal S, Quiñonez C, et al. Providing dental insurance can positively impact oral health outcomes in Ontario. *BMC Health Serv Res.* 2020;20(1):1–9.
 124. Korda RJ, Banks E, Clements MS, Young AF. Is inequity undermining Australia’s ‘universal’ health care system? Socio-economic inequalities in the use of specialist medical and non-medical ambulatory health care. *Aust N Z J Public Health.* 2009 Oct;33(5):458–65.
 125. Sabbahi DA, Lawrence HP, Limeback H, Rootman I. Development and evaluation of an oral health literacy instrument for adults. *Community Dent Oral Epidemiol.* 2009 Oct;37(5):451–62.
 126. Jamieson LM, Divaris K, Parker EJ, Lee JY. Oral health literacy comparisons between Indigenous Australians and American Indians. *Community Dent Health.* 2013 Mar;30(1):52–7.
 127. Braveman P, Egerter S, Williams DR. The Social Determinants of Health: Coming of Age. *Annu Rev Public Health.* 2011 Apr 21;32(1):381–98.
 128. Locker D. Self-Esteem and Socioeconomic Disparities in Self-Perceived Oral Health. *J Public Health Dent.* 2009 Jan;69(1):1–8.
 129. Hujoel PP, Cunha-Cruz J, Banting DW, Loesche WJ. Dental Flossing and Interproximal Caries: a Systematic Review. *J Dent Res.* 2006 Apr 13;85(4):298–305.
 130. Salas M, McClellan A, MacNeill S, Satheesh K, Cobb C. Interproximal cervical lesions caused by incorrect flossing technique. *Int J Dent Hyg.* 2012 May;10(2):83–5.
 131. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. *Am J Mens Health.* 2021 May 15;15(3):155798832110163.
 132. Bennett CC. A healthier future for all Australians: An overview of the final report of the National Health and Hospitals Reform Commission. *Med J Aust.* 2009;191(7):383–7.
 133. Tynan A, Walker D, Tucker T, Fisher B, Fisher T. Factors influencing the perceived importance of oral health within a rural Aboriginal and Torres Strait Islander community in Australia. *BMC Public Health.* 2020 Dec 17;20(1):514.
 134. Slack-Smith L, Hearn L, Scrine C, Durey A. Barriers and enablers for oral health care for people affected by mental health disorders. *Aust Dent J.* 2017 Mar;62(1):6–13.
 135. Zajacova A, Lawrence EM. The Relationship Between Education and Health: Reducing Disparities Through a Contextual Approach. *Annu Rev Public Health.* 2018 Apr 1;39(1):273–89.
 136. Mc Grath C, Bedi R. Can dental attendance improve quality of life? *Br Dent J.* 2001 Mar 10;190(5):262–5.
 137. COAG (Council of Australian Governments) Health Council. *Healthy Mouths, Healthy Lives: Australia’s National Oral Health Plan 2015–2024.* Adelaide South

- Aust Dent Serv. 2015;
138. National Advisory Committee on Health and Disability (National Health Committee). Improving child oral health and reducing child oral health inequalities. 2003.
 139. Slade GD, Rozier RG, Zeldin LP, Margolis PA. Training pediatric health care providers in prevention of dental decay: results from a randomized controlled trial. *BMC Health Serv Res.* 2007 Dec 2;7(1):176.
 140. DesMeules M, Pong R, Lagacé C, Heng D, Manuel D, Pitblado R, et al. How Healthy Are Rural Canadians? An Assessment of Their Health Status and Health Determinants. 2006.
 141. Mejia GC, Elani HW, Harper S, Murray Thomson W, Ju X, Kawachi I, et al. Socioeconomic status, oral health and dental disease in Australia, Canada, New Zealand and the United States. *BMC Oral Health.* 2018 Dec 26;18(1):176.
 142. Crowley SJ, Campain AC, Morgan M V. An economic evaluation of a publicly funded dental prevention programme in regional and rural Victoria: an extrapolated analysis. *Community Dent Health.* 2000 Sep;17(3):145–51.
 143. Bishop LM, Lavery MJ. Filling the gap: disparities in oral health access and outcomes between metropolitan and remote and rural Australia. Canberra: Royal Flying Doctor Service of Australia. 2015.
 144. Jamieson LM, Thomson WM. Dental health of Chatham Islanders: an investigation of the oral health of Chatham Islands residents. *N Z Dent J.* 2003 Dec;99(4):90–7.
 145. Viggers H, Amore K, Howden-Chapman P. Housing that Lacks Basic Amenities in Aotearoa New Zealand, 2018: A supplement to the 2018 Census Estimate of Severe Housing. 2021.
 146. Broadbent JM, Theodore RF, Te ML, Thomson WM, Brunton PA, Te Morenga L, et al. Ethnic and socioeconomic inequalities in dental treatment at a school of dentistry. *N Z Dent J.* 2016 Jun;112(2):55–61.
 147. de Silva AM, Martin-Kerry J, Geale A, Cole D. Flying blind: trying to find solutions to Indigenous oral health. *Aust Health Rev.* 2016;40(5):570–83.
 148. Hong CL, Broadbent JM, Thomson WM, Poulton R. The Dunedin Multidisciplinary Health and Development Study: oral health findings and their implications. *J R Soc New Zeal.* 2020 Jan 2;50(1):35–46.
 149. Australian Institute of Health and Welfare. The Health and Welfare of Australia's Aboriginal and Torres Strait Islander peoples 2015. 2015.
 150. Health Canada. Unleashing Innovation: Excellent Healthcare for Canada [Internet]. Ottawa, ON: Health Canada. 2015 [cited 2021 Oct 25]. Available from: <https://healthycanadians.gc.ca/publications/health-system-systeme-sante/report-healthcare-innovation-rapport-soins/alt/report-healthcare-innovation-rapport-soins-eng.pdf>
 151. Pham MT, Rajić A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Res Synth Methods.* 2014 Dec 24;5(4):371–85.
 152. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol.* 2018 Dec

- 19;18(1):143.
153. Pace R, Pluye P, Bartlett G, Macaulay AC, Salsberg J, Jagosh J, et al. Testing the reliability and efficiency of the pilot Mixed Methods Appraisal Tool (MMAT) for systematic mixed studies review. *Int J Nurs Stud.* 2012 Jan;49(1):47–53.
 154. Crocombe LA, Brennan DS, Slade GD, Stewart JF, Spencer AJ. The effect of lifetime fluoridation exposure on dental caries experience of younger rural adults. *Aust Dent J.* 2015 Mar;60(1):30–7.
 155. Kroon J, Lalloo R, Tadakamadla SK, Johnson NW. Dental caries experience in children of a remote Australian Indigenous community following passive and active preventive interventions. *Community Dent Oral Epidemiol.* 2019 Dec 21;47(6):470–6.
 156. Slade GD, Bailie RS, Roberts-Thomson K, Leach AJ, Raye I, Endean C, et al. Effect of health promotion and fluoride varnish on dental caries among Australian Aboriginal children: results from a community-randomized controlled trial. *Community Dent Oral Epidemiol.* 2011 Feb;39(1):29–43.
 157. Crocombe LA, Brennan DS, Slade GD. Does lower lifetime fluoridation exposure explain why people outside capital cities have poor clinical oral health? *Aust Dent J.* 2016 Mar;61(1):93–101.
 158. Arrow P, Piggott S, Carter S, McPhee R, Atkinson D, Mackean T, et al. Atraumatic Restorative Treatments in Australian Aboriginal Communities: A Cluster-randomized Trial. *JDR Clin Transl Res.* 2021 Oct 3;6(4):430–9.
 159. Skinner J, Dimitropoulos Y, Masoe A, Yaacoub A, Byun R, Rambaldini B, et al. Aboriginal dental assistants can safely apply fluoride varnish in regional, rural and remote primary schools in New South Wales, Australia. *Aust J Rural Health.* 2020 Oct 23;28(5):500–5.
 160. Neumann AS, Lee KJ, Gussy MG, Waters EB, Carlin JB, Riggs E, et al. Impact of an oral health intervention on pre-school children <3 years of age in a rural setting in Australia. *J Paediatr Child Health.* 2011 Jun;47(6):367–72.
 161. Taylor J, Carlisle K, Farmer J, Larkins S, Dickson-Swift V, Kenny A. Implementation of oral health initiatives by Australian rural communities: Factors for success. *Health Soc Care Community.* 2018 Jan;26(1):e102–10.
 162. Roberts-Thomson KF, Ha DH, Wooley S, Meihubers S, Do LG. Community trial of silver fluoride treatment for deciduous dentition caries in remote Indigenous communities. *Aust Dent J.* 2019;64(2):175–80.
 163. Tadakamadla SK, Lalloo R, Kroon J, Johnson NW. Surface-Specific Caries Preventive Effect of an Intervention Comprising Fissure Sealant, Povidone-Iodine and Fluoride Varnish in a Remote Indigenous Community in Australia. *Int J Environ Res Public Health.* 2020 Mar 23;17(6):2114.
 164. Lalloo R, Tadakamadla SK, Kroon J, Jamieson LM, Ware RS, Johnson NW. Carious lesions in permanent dentitions are reduced in remote Indigenous Australian children taking part in a non-randomised preventive trial. *PLoS One.* 2021;16(1 January).
 165. Portland District Health W-MAC. Deadly teeth: promoting oral health in Gunitjmarra country- project report (phase 1). *Portl Dist Heal.* 2012;
 166. Abuzar MA, Owen J. A Community Engaged Dental Curriculum: A Rural Indigenous Outplacement Programme. *J Public health Res.* 2016 Apr

- 26;5(1):jphr.2016.668.
167. Abuzar MA, Burrow MF, Morgan M. Development of a rural outplacement programme for dental undergraduates: students' perceptions. *Eur J Dent Educ*. 2009 Nov;13(4):233–9.
 168. Skinner J, Dimitropoulos Y, Moir R, Johnson G, McCowen D, Rambaldini B, et al. A graduate oral health therapist program to support dental service delivery and oral health promotion in Aboriginal communities in New South Wales, Australia. *Rural Remote Health*. 2021 Jan 27;21(1):5789.
 169. Lalloo R, Evans JL, Johnson NW. Dental students' reflections on clinical placement in a rural and indigenous community in Australia. *J Dent Educ*. 2013;77(9):1193–201.
 170. Piggott, Carter, Forrest, Atkinson, Mackean, Mcphee, et al. Parent perceptions of minimally invasive dental treatment of Australian Aboriginal pre-school children in rural and remote communities. *Rural Remote Health*. 2021 Nov 18;
 171. Ju X, Brennan D, Parker E, Mills H, Kapellas K, Jamieson L. Efficacy of an oral health literacy intervention among Indigenous Australian adults. *Community Dent Oral Epidemiol*. 2017 Oct;45(5):413–26.
 172. Parker EJ, Misan G, Shearer M, Richards L, Russell A, Mills H, et al. Planning, Implementing, and Evaluating a Program to Address the Oral Health Needs of Aboriginal Children in Port Augusta, Australia. *Int J Pediatr*. 2012;2012:1–10.
 173. Kapellas K, Do LG, Mark Bartold P, Skilton MR, Maple-Brown LJ, O'Dea K, et al. Effects of full-mouth scaling on the periodontal health of Indigenous Australians: a randomized controlled trial. *J Clin Periodontol*. 2013 Nov;40(11):1016–24.
 174. Vance L, Glanville B, Ramkumar K, Chambers J, Tzelepis F. The effectiveness of smoking cessation interventions in rural and remote populations: Systematic review and meta-analyses. *Int J Drug Policy*. 2022;106:103775.
 175. Dimitropoulos Y, Gwynne K, Blinkhorn A, Holden A. A school fluoride varnish program for Aboriginal children in rural New South Wales, Australia. *Heal Promot J Aust*. 2020 Apr;31(2):172–6.
 176. Mariño R, Priede A, King M, Adams GG, Lopez D. Attitudes and opinions of Oral healthcare professionals on screening for Type-2 diabetes. *BMC Health Serv Res*. 2021 Jul 27;21(1):743.
 177. Mariño R, Haresaku S, McGrath R, Bailey D, Mccullough M, Musolino R, et al. Oral cancer screening practices of oral health professionals in Australia. *BMC Oral Health*. 2017 Dec 15;17(1):151.
 178. Lalloo R, Evans JL, Johnson NW. Dental care provision by students on a remote rural clinical placement. *Aust N Z J Public Health*. 2013 Feb;37(1):47–51.
 179. Richards L, Symon B, Burrow D, Chartier A, Misan G, Wilkinson D. Undergraduate Student Experience in Dental Service Delivery in Rural South Australia: An Analysis of Costs and Benefits. *Aust Dent J*. 2002 Sep;47(3):254–8.
 180. Abuzar M, Crombie F, Bishara K, Bryan A, Chan K, Chang B, et al. Pre-Outplacement Perceptions of Dental Students Regarding Rural Oral Health Practice and Associated Factors. *Dent J*. 2020 Feb 23;8(1):22.
 181. Bazen JJ, Kruger E, Dyson K, Tennant M. An innovation in Australian dental education: rural, remote and Indigenous pre-graduation placements. *Rural Remote*

- Health. 2007;7(3):703.
182. Johnson GE, Blinkhorn AS. Student opinions on a rural placement program in New South Wales, Australia. *Rural Remote Health*. 2011;11(2):1703.
 183. Johnson G, Blinkhorn A. Faculty staff and rural placement supervisors' pre- and post-placement perceptions of a clinical rural placement programme in NSW Australia. *Eur J Dent Educ*. 2013 Feb;17(1):e100-8.
 184. Schoo A, McNamara K, Stagnitti K. Clinical placement and rurality of career commencement: a pilot study. *Rural Remote Health*. 2008 Jul 23;
 185. Kruger E, Tennant M. Short-stay rural and remote placements in dental education, an effective model for rural exposure: A review of eight-year experience in Western Australia. *Aust J Rural Health*. 2010 Aug 2;18(4):148–52.
 186. Lalloo R, Massey W. Simple cost analysis of a rural dental training facility in Australia. *Aust J Rural Health*. 2013 Jun;21(3):158–62.
 187. Skapetis T, Ajwani S, Bhole S. Patient satisfaction and an international dental graduate workforce programme. *Int J Heal Gov*. 2018 Aug 13;23(3):243–51.
 188. Skapetis T, Gerzina T, Hu W. Managing dental emergencies: A descriptive study of the effects of a multimodal educational intervention for primary care providers at six months. *BMC Med Educ*. 2012;12(1).
 189. Greenhill JA, Walker J, Playford D. Outcomes of Australian rural clinical schools: a decade of success building the rural medical workforce through the education and training continuum. *Rural Remote Health*. 2015;15(3):2991.
 190. Dimitropoulos Y, Holden A, Sohn W. In-school toothbrushing programs in Aboriginal communities in New South Wales, Australia: A thematic analysis of teachers' perspectives. *Community Dent Health*. 2019 May 30;36(2):106–10.
 191. Parker EJ, Misan G, Richards LC, Russell A. Planning and implementing the first stage of an oral health program for the Pika Wiya Health Service Incorporated Aboriginal community in Port Augusta, South Australia. *Rural Remote Health*. 2005;5(2):254.
 192. Barnett T, Hoang H, Stuart J, Crocombe L. The relationship of primary care providers to dental practitioners in rural and remote Australia. *BMC Health Serv Res*. 2017 Dec 1;17(1):515.
 193. Ragade A, Yiannis C, Opie CA. Oral healthcare attendance and the effectiveness of referrals for rural antenatal women. *Aust J Rural Health*. 2022 Jul 14;
 194. Kruger E, Smith K, Tennant M. Non-working dental therapists: opportunities to ameliorate workforce shortages. *Aust Dent J*. 2007 Mar;52(1):22–5.
 195. Estai M, Kanagasingam Y, Huang B, Checker H, Steele L, Kruger E, et al. The efficacy of remote screening for dental caries by mid-level dental providers using a mobile teledentistry model. *Community Dent Oral Epidemiol*. 2016 Oct;44(5):435–41.
 196. Estai M, Kruger E, Tennant M. Role of telemedicine and mid-level dental providers in expanding dental-care access: potential application in rural Australia. *Int Dent J*. 2016 Aug;66(4):195–200.
 197. Tynan A, Deeth L, McKenzie D. An integrated oral health program for rural residential aged care facilities: a mixed methods comparative study. *BMC Health Serv Res*. 2018 Dec 3;18(1):515.
 198. Mariño R, Tonmukayakul U, Manton D, Stranieri A, Clarke K. Cost-analysis of

- teledentistry in residential aged care facilities. *J Telemed Telecare*. 2016;22(6):326–32.
199. Poirier B, Jensen E, Sethi S. The evolution of the teledentistry landscape in Australia: A scoping review. *Aust J Rural Health*. 2022 May 14;
 200. Willder S, Nelson J, Morgan M, Mariño AR. ‘ Indigie-Grins ’: an Indigenous youth oral health research project. *Aust Indig Heal*. 2014;14(2):1–9.
 201. Binguis D, Cappel L, Lawrence HP, Rogers JB, Romanetz M RL. Effects of a Community-based Prenatal Nutrition Program on the Oral health of Aboriginal Preschool Children in Northern Ontario. *Probe (Lond)*. 2004;38(4):172–90.
 202. Schroth RJ, Edwards JM, Brothwell DJ, Yakiwchuk CA, Bertone MF, Mellon B, et al. Evaluating the impact of a community developed collaborative project for the prevention of early childhood caries: the Healthy Smile Happy Child project. *Rural Remote Health*. 2015;15(4):3566.
 203. Kyoon-Achan G, Schroth RJ, DeMaré D, Sturym M, Edwards J, Lavoie JG, et al. Indigenous community members’ views on silver diamine fluoride to manage early childhood caries. *J Public Health Dent*. 2020 Sep 13;80(3):208–16.
 204. Johnson G, Blinkhorn A. Assessment of a dental rural teaching program. *Eur J Dent*. 2012 Jul;6(3):235–43.
 205. Mathu-Muju KR, Kong X, Brancato C, McLeod J, Bush HM. Utilization of community health workers in Canada’s Children’s Oral Health Initiative for indigenous communities. *Community Dent Oral Epidemiol*. 2018 Apr;46(2):185–93.
 206. Howey ML, Yoon MN. Insights in interprofessional education: Dental hygiene students’ suggestions for collaboration. *Can J Dent Hyg CJDH = J Can l’hygiene Dent JCHD*. 2022;56(1):9–21.
 207. Farmer J, Peressini S, Lawrence HP. Exploring the role of the dental hygienist in reducing oral health disparities in Canada: A qualitative study. *Int J Dent Hyg*. 2018 May;16(2):e1–9.
 208. Grant JC, Kanji Z. Exploring Interprofessional Relationships Between Dental Hygienists and Health Professionals in Rural Canadian Communities. *J Dent Hyg JDH*. 2017 Aug;91(4):6–11.
 209. Cane RJ, Butler DR. Developing primary health clinical teams for public oral health services in Tasmania. *Aust Dent J*. 2004 Dec;49(4):162–70.
 210. Macnab AJ, Rozmus J, Benton D, Gagnon FA. 3-year results of a collaborative school-based oral health program in a remote First Nations community. *Rural Remote Health*. 2008;8(2):882.
 211. Anderson VR, Rapana ST, Broughton JR, Seymour GJ, Rich AM. Preliminary findings from the Oranga Niho dental student outplacement project. *N Z Dent J*. 2015 Mar;111(1):6–14.
 212. Hobbs M, Wade A, Jones P, Marek L, Tomintz M, Sharma K, et al. Area-level deprivation, childhood dental ambulatory sensitive hospitalizations and community water fluoridation: evidence from New Zealand. *Int J Epidemiol*. 2020 Jun 1;49(3):908–16.
 213. Rabb-Waytowich D. Water fluoridation in Canada: past and present. *J Can Dent Assoc*. 2009 Jul;75(6):451–4.
 214. Public Health Capacity and Knowledge Management Unit. Quebec Region for the

- Office of the Chief Dental Officer of Canada. The state of community water fluoridation across Canada. Ottawa (ON): Public Health Agency of Canada. 2017.
215. Ehsani JP, Bailie R. Feasibility and costs of water fluoridation in remote Australian Aboriginal communities. *BMC Public Health*. 2007 Dec 8;7(1):100.
 216. Johnson G, Blinkhorn A. The influence of a clinical rural placement programme on the work location of new dental graduates from the University of Sydney, NSW, Australia. *Eur J Dent Educ*. 2013 Nov;17(4):229–35.
 217. Quiñonez C, Gibson D, Jokovic A, Locker D. Emergency department visits for dental care of nontraumatic origin. *Community Dent Oral Epidemiol*. 2009 Aug;37(4):366–71.
 218. Simpson TC, Clarkson JE, Worthington H V, MacDonald L, Weldon JC, Needleman I, et al. Treatment of periodontitis for glycaemic control in people with diabetes mellitus. *Cochrane Database Syst Rev*. 2022 Apr 14;2022(4).
 219. Beckstead D, Brown W, Guo Y, Newbold B. Cities and Growth: Earnings Levels Across Urban and Rural Areas: The Role of Human Capital. Stat Canada, Econ Anal Div Can Econ Transit. 2010;
 220. Manski RJ, Cooper PF. Characteristics of employers offering dental coverage in the United States. *J Am Dent Assoc*. 2010 Jun;141(6):700—711.
 221. Gil-Montoya J, Ferreira de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. *Clin Interv Aging*. 2015 Feb;461.
 222. Nash DA, Friedman JW, Kardos TB, Kardos RL, Schwarz E, Satur J, et al. Dental therapists: a global perspective. *Int Dent J*. 2008 Apr;58(2):61–70.
 223. TAYLOR-GOUBY P, SYLVESTER S, CALNAN M, MANLEY G. Knights, Knaves and Gnashers: Professional Values and Private Dentistry. *J Soc Policy*. 2000/07/01. 2000;29(3):375–95.
 224. Health Canada. Healthy Living: It's Your Health - Health Benefits of Fluorides [Internet]. 2010. Available from: <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/fluor-eng.php>
 225. Environmental Health Intelligence. Access to fluoridated drinking-water. Wellington Environ Heal Intell NZ, Massey Univ. 2021;
 226. Freeman R, Lush C, MacGillveray S, Themessl-Huber M, Richards D. Dental therapists/hygienists working in remote-rural primary care: a structured review of effectiveness, efficiency, sustainability, acceptability and affordability. *Int Dent J*. 2013 Apr;63(2):103–12.
 227. Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, et al. Global Burden of Oral Conditions in 1990-2010. *J Dent Res*. 2013 Jul 29;92(7):592–7.