

DENTAL CARIES PREVALENCE AND DISPARITIES IN
NOVA SCOTIA CHILDREN AGED SEVEN TO EIGHT YEARS

by

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Submitted in partial fulfilment of the requirements
for the degree of Master of Science

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DALHOUSIE UNIVERSITY

DEPARTMENT OF COMMUNITY HEALTH AND EPIDEMIOLOGY

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ABSTRACT

Dental caries is a widespread global public health problem with significant health and financial implications. The purpose of this study was to determine dental caries prevalence, experience and severity, as well as to investigate disparities by geographic (urban/rural) location, dental health care utilization and oral hygiene practices in seven to eight year old Nova Scotia school children in 2006-2007.

The study results demonstrated that over half (57.3%) of the seven to eight year old population was afflicted by dental caries in the overall dentition. Primary dentition caries prevalence was 55%, with a mean deft score of 2.58 ± 0.08 SE. Prevalence of permanent dentition caries was 14%, with a mean DMFT score of 0.26 ± 0.02 SE. The mean defs score was 6.86 ± 0.28 SE and the average DMFS score was 0.47 ± 0.04 SE.

Geographic location was not found to have a major influence on dental caries prevalence, experience and severity in this population. However, a significant relationship was observed between dental caries and dental visit frequency, with higher overall caries prevalence and severity among those who visited the dentist less than once per year. Disparities in dental caries were also found by frequency of brushing, with significantly lower caries rates in those who brushed at least twice per day.

Health promotion measures such as pit and fissure sealants and topical fluoride application in susceptible and high-risk children, and appropriate health education regarding recommended frequency of brushing twice per day using fluoridated toothpaste, as well as preventive and regular dental visits are merited to help promote children's overall health and well-being.

LIST OF ABBREVIATIONS USED

Adj.	Adjusted
BC	British Columbia
CDC	Centers for Disease Control
CHMS	Canadian Health Measures Survey
95% CI	95% confidence interval
deft	Decayed, extracted/missing, or filled primary teeth
dmft	Decayed, extracted/missing, or filled primary teeth
defs	Decayed, extracted/missing, or filled primary teeth surfaces
dmfs	Decayed, extracted/missing, or filled primary teeth surfaces
DMFT	Decayed, missing, or filled permanent teeth
DMFS	Decayed, missing, or filled permanent teeth surfaces
FMSEI	Evaluation of the Fluoride Mouth Rinse School Eligibility Index and Baseline Information for Oral Health Programs
NHANES	National Health and Nutrition Examination Survey
NSOHS	Nova Scotia Oral Health Survey of Children and Adolescents
OR	Odds ratio
SAS	Statistical Analysis Software
SD	Standard deviation
SE	Standard error
SES	Socio-economic status
Unadj.	Unadjusted
U.S.	United States of America

GLOSSARY OF TERMS

The following definitions have been excerpted from *Mosby's Dental Dictionary* (1):

A:

Abscess: a localized accumulation of suppuration in a confined space formed by tissue disintegration.

Anesthesia: the loss of feeling or sensation, especially loss of tactile sensibility, with or without loss of consciousness, resulting from the use of certain drugs or gases that serve as inhibitory neurotransmitters.

Anti-cariogenic: describing foods, chemicals, or other agents that tend to contribute favorably to dental health by remineralizing teeth and discouraging the acid that causes dental caries.

C:

Cavity: a carious lesion or hole in a tooth.

Carious: pertaining to caries or decay.

Cariogenic: contributing to the advancement of caries.

Cariostatic: pertaining to the oils in fats that provide a protective coating for teeth to keep food particles from sticking and to prevent sugars and acids from entering or leaving plaque.

Carious lesion: also known as dental caries or tooth cavities. Typically caused by acid-producing bacteria which lowers the pH of the oral cavity, causing demineralization.

Cellulitis: a diffuse inflammatory process that spreads along fascial planes and through tissue spaces without gross suppuration.

Cementum: a specialized, calcified connective tissue that covers the anatomic root of a tooth, giving attachment to the periodontal ligament.

D:

Deciduous (*synonym: primary*): that which will be shed (exfoliated). Older term pertaining specifically to the first dentition. Preferred term is primary.

Deciduous dentition (*synonym: primary dentition*): the 12 teeth present that erupt first and are usually replaced by the permanent teeth. This term is currently preferred over deciduous

Deciduous teeth: See primary teeth

Demineralization: a measurable decrease in the level of inorganic salts or minerals such as bone or enamel. Older term is decalcification

Dental: relating to the teeth

Dental arch: the composite structure of the dentition and alveolar ridge or the remains thereof after the loss of some or all of the natural teeth.

Dental care: the treatment of the teeth and their supporting structures.

Dental caries (synonyms: Caries, dental decay, tooth decay): in dentistry, the decay of a tooth. Colloquial term is cavity

Dental fluorosis: an abnormal condition resulting from the ingestion of too much fluoride, causing a white or brown mottled appearance to the enamel of developing teeth

Dental health services: the sum of the diagnostic, preventive, consultative, supportive, and therapeutic dental care offered by the dental profession or that portion provided a member of a dental health plan.

Dental health survey: the use of questionnaires and oral examinations of a target population to determine the need or demand for dental care or the opinions or attitudes of patients or consumers.

Dental hygienist: a licensed dental professional who specializes in preventive care. Professional prophylaxis, radiographs, sealants, and nonsurgical periodontal therapy are among the procedures performed by a hygienist. Most are licensed to administer local anesthesia, depending on applicable regulations in their area. They usually work for a dentist in a dental office or clinic under a form of supervision. In some locations hygienists are allowed to practice without a dentist's supervision.

Dental instrument: a tool or implement, especially one used for delicate or scientific work

Dental insurance: a policy that insures against the expense of treatment and care of dental disease and accident to teeth.

Dental occlusion: the act of closure or state of being closed; a contact between the incising or masticating surfaces of the maxillary and mandibular teeth.

Dental pathology: that branch of dentistry that deals with all aspects of dental disease

Dental plaque (Plaque): in dentistry, a biofilm noted in the oral cavity. It consists of salivary proteins, microorganisms, and other byproducts of the microorganism. A type of intercellular matrix is also present. It forms on the oral cavity surface after the formation

of the salivary pellicle using selective attachment factors. It is a factor in initiation and continuation of dental caries and periodontal disease. Older terms: mucin plaque, bacterial plaque.

Dental public health: may also be called public health dentistry. The science and art of preventing and controlling dental diseases and promoting dental health through organized community efforts. It is that form of dental practice that serves the community as a patient rather than the individual. It is concerned with the dental health education of the public, with applied dental research, and with the administration of group dental care programs as well as prevention and control of dental diseases on a community basis

Dental pulp: the tissue in the central portion of the tooth, made up of blood vessels, nerves, and cellular elements, including odontoblasts that forms dentin and is covered by it. Also called tooth pulp.

Dentin: the portion of the tooth that lies subjacent to the enamel and cementum. Consists of an organic matrix on which mineral (calcific) salts are deposited; pierced by tubules containing the processes of the odontoblasts that line the pulpal chamber and canal. It is of mesodermal origin. Older term is dentine.

Dentition: the natural teeth in position in the dental arches.

Dental floss: a waxed or plain thread of nylon or silk used to clean the interdental areas.

Dentulous: (dentulism), having the natural teeth present in the oral cavity. Opposite term: edentulous

E:

Early childhood caries (EEC) (synonyms: *baby bottle caries*, *baby bottle tooth decay*, *nursing caries*): a form of severe dental decay occurring in young children that is caused by long and frequent exposure to liquids that are high in sugar, such as milk or juice. Because this form can damage the underlying bone structure, it may affect the development of permanent teeth.

Edentulous: without teeth; lacking teeth

Enamel: the outermost layer or covering of the coronal portion of the tooth that overlies and protects the dentin.

Etiology: causative factors; the factors implicated in the causation of disease; the study of the factors causing disease.

Extraction: the removal of a tooth from the oral cavity by means of elevators and/or forceps.

F:

Failure to thrive: the abnormal retardation of the growth and development of an infant resulting from conditions that interfere with normal metabolism, appetite, and activity.

Fermentable: the ability to undergo a chemical reaction in the presence of an enzyme that results in the creation of either acid or alcohol; in the oral cavity, the ability to create acid in plaque.

Fissure: a deep groove or cleft; commonly the result of the imperfect fusion of the enamel or adjoining dental lobes.

Fluoride(s): a salt of hydrofluoric acid, commonly sodium or stannous (tin).

Fluoride dietary supplements: the orally administered nutritional additives of the chemical fluoride; often taken by individuals without regular access to a fluoridated water supply; available as chewable tablets, drops, pills, and in combination with vitamin supplements.

Fluorides, topical: the salts of hydrofluoric acid (usually sodium or tin salts) that may be applied in solution to the exposed dental surfaces to prevent dental caries and promote remineralization. They can be applied by trays or mouthrinses or by techniques such as paint-on.

Fluoridate: to add fluoride to a water sup

H:

Health behavior: an action taken by a person to maintain, attain, or regain good health and to prevent illness. Health behavior reflects a person's health beliefs.

Health care professional: a person who by education, training, certification, or licensure is qualified to and is engaged in providing health care.

Hypoplasia (hypoplastic enamel): the defective or incomplete development of a tissue or structure

I:

Incisor(s): a cutting tooth, one of the four anterior teeth of either jaw.

Incisor, central: the first incisor.

Incisor, lateral: the second incisor

L:

Lesion: a pathologic disturbance of a tissue, with loss of continuity, enlargement, and/or function

M:

Malocclusion: (relationship of teeth in occlusion), a deviation in intramaxillary and/or intermaxillary relations of teeth that presents a hazard to the individual's oral health. Often associated with other orofacial deformities.

Maxillary: pertaining to the superior jaw.

Maxillary arch: the upper dental arch and its supporting bone.

Mandibular: pertaining to the lower jaw.

Mixed dentition: the teeth in the jaws after the eruption of some of the permanent teeth but before all the primary teeth are exfoliated. This period usually begins with the eruption of the first permanent molars and ends with the exfoliation of the last primary tooth. Also called the transitional dentition.

Molar: a tooth adapted for grinding by having a broad, somewhat ridged surface. It is one of the 12 teeth located in the posterior aspect of the maxillary and mandibular arches.

O:

Oral: pertaining to the oral cavity.

Oral cavity: the mouth.

Oral environment: all oral conditions present and their influences.

Oral health index: a statistical measure that quantifies one or more aspects of a person's or group's oral health status.

Oral hygiene: the practice of personal maintenance of oral cleanliness.

Oral manifestation: the presence of the signs, symptoms, and lesions of a systemic disease in and around the oral cavity.

Orofacial: of or related to the face and oral cavity

Orofacial pain: pain within the structures of the oral cavity and face, usually of a diffuse pattern.

P:

Pathology: the branch of science that deals with disease in all its relations, especially with its nature and the functional and material changes it causes; in medical jurisprudence, the science of disease; the part of medicine that deals with the nature of disease, its causes, and its symptoms.

Pathogenesis: the course of an illness or condition, from its origin to manifestation and outbreak.

Periodontal: relating to the periodontium.

Periodontium: the tissues that support the teeth, which include the gingivae (gums), cementum of the tooth, periodontal ligament, and alveolar bone).

Permanent dentition (synonyms: *Secondary dentition*, *Permanent teeth*): the 32 teeth of adulthood that either replace or are added to with the shedding (exfoliation) of the primary teeth.

Pit: a small depression in enamel, usually located in a developmental groove where two or more enamel lobes are joined.

Pit-and-fissure caries (synonym: *Pit and fissure cavity*): a cavity that begins in microscopic faults in the enamel. Caused by imperfect closure of the enamel.

Plaque (dental): in dentistry, a biofilm noted in the oral cavity. It consists of salivary proteins, microorganisms, and other byproducts of the microorganism. A type of intercellular matrix is also present. It forms on the oral cavity surface after the formation of the salivary pellicle using selective attachment factors. It is a factor in initiation and continuation of dental caries and periodontal disease. Older terms: mucin plaque, bacterial plaque.

Posterior: situated behind.

Ppm (parts per million): a standardized measurement used to describe the level of fluoride in products that contain it (e.g., toothpaste, mouthrinse, and water).

Premolar: (bicuspid), one of the 8 teeth, 4 in each jaw, between the canines and first molars; usually has 2 cusps; replaces the molars of the primary dentition. Older term: bicuspid.

Prevalence: in epidemiology, all the new and old cases of a disease or occurrence of an event during a particular period. It is expressed as a ratio in which the number of events is the numerator and the population at risk is the denominator.

Primary dentition (synonym: deciduous dentition): the 12 teeth present that erupt first and are usually replaced by the permanent teeth. This term is currently preferred over deciduous

Primary teeth (synonym: deciduous teeth): term used by some in preference to deciduous teeth;

Prognosis of dentition: an evaluation by the dental professional of the prospect of recovery from dental disease, combined with a forecast of the probability of maintaining the dentition and its associated structures in function and health.

Prophylaxis: the prevention of disease.

Prophylaxis, oral: a series of procedures where plaque, calculus, and stain are removed from the teeth. This procedure is not the same as coronal polishing because the clinician can work subgingivally if needed. Only a licensed dental hygienist or dental professional is qualified to determine the need for oral prophylaxis and to perform the procedure. The colloquial term is prophylaxis

Proximal caries: decay occurring in the mesial or distal surface of a tooth.

Pulpal: relating to the pulp or the pulp cavity

Pulp cavity: the space in a tooth surrounded by the dentin; contains the dental pulp. The part of the pulp cavity within the coronal portion of the tooth is the pulp chamber, and the part found within the root is the pulp canal, or root canal.

R:

Rampant caries: a suddenly appearing, widespread, rapidly progressing type of caries.

Recurrent caries (synonym: recurrent tooth decay): the extension of the carious process beyond the margin of a restoration. Also called secondary caries.

Restoration: (prosthetic restoration), broad term applied to any filling, inlay, crown, bridge, partial denture, or complete denture that restores or replaces lost tooth structure, teeth, or oral tissues; a prosthesis

Restorative: promoting a return to health or consciousness; a remedy that aids in restoring health, vigor, or consciousness; pertaining to rebuilding, repairing, or reforming.

Restorative dentistry: the branch of dentistry that deals with the reconstruction of the hard tissues of a tooth or group of teeth injured or destroyed by trauma or disease.

S:

Secondary dentition (synonym: permanent dentition): the 32 teeth of adulthood that either replace or are added to with the shedding (exfoliation) of the primary teeth.

Sealant (older term: Pit and fissure sealant): a resinous material designed for application to the occlusal surfaces of posterior teeth to seal the surface irregularities and prevent the carious process.

Smooth tooth surface: a surface of a tooth on which pits and fissures are not found normally.

Smooth surface caries - the decay that occurs on the smooth surfaces of the tooth

Surface, occlusal: the anatomic superior surface of the mandibular posterior teeth and the inferior surface of the maxillary posterior teeth. These surfaces are limited mesially and distally by marginal ridges, and buccally and lingually by the buccal and lingual boundaries of the cusp eminences

Surface, proximal: the surface of a tooth or the portion of a cavity that is nearest to the adjacent tooth; the mesial or distal surface of a tooth.

Surface, working occlusal: the surface or surfaces of the teeth on which chewing can occur

Succedaneous: replacing or substituting for something else; often used when referring to the permanent teeth that erupt to replace the milk teeth.

Succedaneous tooth: a permanent tooth with primary predecessors (i.e., premolars, canines, and incisors).

Susceptible: the opposite of immune; having little resistance to disease

T:

Tooth (plural: teeth): one of the hard bodies or processes usually protruding from and attached to the alveolar process of the maxillae and the mandible; designed for the mastication of food.

Tooth, hypoplasia of: a reduction in the amount of enamel formed, resulting in irregular pits and grooves of the enamel.

Teeth, anterior: the incisor or canine front teeth

Teeth, posterior: the maxillary and mandibular premolars and molars of the permanent dentition or the premolars and molars of prostheses

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CHAPTER ONE: INTRODUCTION

Dental caries, often referred to as tooth decay or dental decay, is a significant and widespread global public health problem. It is one of the most common oral diseases, afflicting individuals of almost all age groups. According to the World Health Organization, about 60 to 90% of school-aged children and most of the adult population suffer from dental decay, thereby confirming its high prevalence across the world (1b). While Canada and the United States have witnessed a reduction in the overall caries levels over the last few decades, the disease still remains a major health issue in both nations, particularly among children (2,3,3b). Furthermore, caries prevalence in the primary dentition is on the rise (4,5). Besides, the disease unequally affects children from high-risk groups, who tend to show persistently increased caries rates (2,3).

Dental caries is associated with significant health and financial consequences. In affected children, it may result in oro-facial pain (6-9), loss of grossly involved teeth (10-14), malocclusion (15,16), impairment of normal functioning (17), compromised overall health, development and well-being (18, 19), as well as loss of productive school time (3b,20). In 2006, the total annual cost of dental care in Canada was estimated at approximately \$9.9 billion (21), compared to \$6.8 billion in 1999 (22). Nova Scotia alone incurred almost \$154 million in oral health care expenditures in 1999 (22). According to the 2007-2009 Canadian Health Measures Survey, over 40 million hours of productive school and work time were lost due to oral health issues (3b).

Despite the fact that dental caries is a major oral health concern, it has been over a decade since caries prevalence estimates have been updated for Nova Scotia children. Moreover, in spite of the emphasis placed on the influence of sociodemographic

and behavioral risk factors on the caries susceptibility of individuals, there has been little recent exploration of disparities in childhood caries prevalence, experience and severity by geographic (urban/rural) location, dental health care utilization and routine oral hygiene practices.

The main purpose of this investigation was to determine dental caries prevalence and disparities in seven to eight year old Nova Scotia children. Employing aggregate-level (de-identified) data from a 2006 oral health survey (23), this study of seven to eight year old Nova Scotia children aimed to:

1. Determine dental caries prevalence, experience and severity, and
2. Investigate disparities in dental caries prevalence, experience and severity by
 - (a) geographic (urban/rural) location,
 - (b) dental health care utilization, and
 - (c) oral hygiene practices.

The proposed research study utilized the 2006 “*Evaluation of the Fluoride Mouth Rinse School Eligibility Index and Baseline Information for Oral Health Programs*” provincial survey (23) data in order to fulfill the research objectives.

CHAPTER TWO: BACKGROUND LITERATURE

This review of the literature provides a description of dental caries epidemiology as follows:

- a) Discussion of caries etiology, pathogenesis, and its public health and economic impact;
- b) Caries prevalence trends in Canada, the United States and internationally, as well as in the province of Nova Scotia;
- c) Overview of risk factors and determinants associated with dental caries, with an in-depth analysis of the impact of rural/urban residence, dental care utilization and oral health care habits in children.

2.1 DENTAL CARIES

Dental caries is the most common chronic oral health problem, affecting individuals of almost all age groups. The term dental caries is used to describe an infectious disease process of bacterial origin, resulting in the demineralization and destruction of the hard tooth tissues (24).

The etiology of dental caries fundamentally entails a triad of three crucial factors: susceptible tooth, diet (fermentable carbohydrates) and dental plaque consisting of cariogenic bacteria (24b). The caries triad was put forward by Keyes in the 1960's (24b), following which several other influencing factors have been identified as being involved in the development of dental decay. Notably, the element of time has been added in the Venn diagram to emphasize the importance of caries development over time.

The pathological process of caries development involves the demineralization of calcified tissues of the tooth by the acids produced from metabolism of fermentable dietary carbohydrates by cariogenic microorganisms present in dental

plaque (25). This process of tooth dissolution by bacteria eventually results in the formation of a dental cavity that characterizes the clinical carious lesion. While the *Streptococcus mutans* has been implicated as the most significant microbial species associated with dental caries development (26), *Lactobacilli* (25) and *Actinomyces* (27) are also known to be involved with the disease process.

Dental caries may involve either the pits and fissures (grooves and depressions on the occlusal/chewing surfaces) or the smooth surfaces of teeth. The disease is amenable to preventive intervention. The carious process itself can be reversed before the formation of frank cavities. However, once a structural cavity has been formed, the disease is irreversible at this stage and may necessitate complex dental treatment procedures.

2.2 DENTAL CARIES - HEALTH AND FINANCIAL IMPLICATIONS

Dental caries is a major public health concern and has significant negative impacts on the health and well-being of the affected individuals and communities. Those with untreated dental caries often suffer from severe pain in the involved teeth and jaws.

In Canada, about nine percent of the overall population reports having experienced severe dental pain in the previous month (21). A study of preschoolers from the Northwest Territories, found that parents having children with high caries levels more frequently reported their preschoolers as experiencing a toothache, compared to those parents whose children had low or no caries at all (6). In an American study involving 482 three to five year old children at Head Start Centers in the Maryland state area, 17% of those having tooth decay complained of dental pain and about nine percent of preschoolers with the disease had cried due to the pain (7). Toothache prevalence rates as

high as 34% are not unheard of, with the likelihood of experiencing such an ache to be almost 2.9 times higher in children having high dental decay rates (i.e. decayed, missing or filled permanent teeth score, DMFT score, was above 1) (8). Similar associations between dental decay and presence of dental pain have been documented by other research studies (9).

Untreated tooth decay may progressively involve the deeper tissues of teeth resulting in pulpal pathology, dental abscesses, cellulitis (a diffuse infection of soft tissue spaces) and at times, the spread of infection systemically. A review of children's emergency hospital visits due to dental caries, noted that several cases of cellulitis in young children were a consequence of decayed primary maxillary posterior teeth (14). Untreated early childhood caries (ECC) alone accounted for 19% of all emergency dental visits (14).

Dental caries can severely undermine the general health and well-being of individuals and their quality of life, by interfering with normal daily functioning (18). Pain and abscesses arising due to caries can impair everyday activities such as eating, chewing of food or even speaking. In a Canadian study of young children aged 2.9 to 5.5 years, dental decay significantly affected children's overall well-being (17). Nearly half of the examined children complained of dental pain and many had problems with eating and sleeping. However, upon caries treatment, there was a considerable improvement in the amount of food the children consumed and in their sleeping habits (17). This was accompanied by a decrease in pain complaints (17). Similar findings have been reported by other epidemiological studies (6). In cases of nursing bottle caries, also known as early childhood caries (ECC), which often affects very young children, the disease may be

associated with a failure to thrive (i.e. failure in child's normal growth and development). A study conducted by Acs et al. found that approximately 14% of those children affected by ECC demonstrated a failure to thrive, manifesting as having body weight that was 80% below the normal value for the child's age (19). A significant improvement in the growth rate of affected children occurred after completion of dental therapy (19).

Treatment of dental caries generally involves restorations (28) or the extraction of involved teeth under anesthesia. Furthermore, high caries levels may necessitate replacement of existing dental restorations due to either recurring tooth decay beneath fillings or involvement of unaffected tooth surfaces (10). Dental caries is also a major cause for tooth extractions (11). While the deciduous first molars are the most frequently extracted primary teeth (12), the permanent first and second molar and premolar teeth are the most commonly extracted among the permanent dentition (13). Extraction of several teeth due to ECC is not an uncommon finding in children seeking emergency dental treatment (14). By definition, extractions result in a loss of teeth. Premature loss of deciduous teeth may, in turn, contribute to the development of malocclusion resulting from the closure of extraction spaces in the upper and/or lower dental arches (15,16).

Dental caries in the primary dentition predisposes to the development of caries in the succeeding permanent dentition. A longitudinal study of dental decay patterns in children at five and ten year age intervals demonstrated a significant link between decay in deciduous teeth and that in permanent teeth (correlation coefficient $r = 0.5$) (29). Carious second deciduous molars were identified as the most important risk indicators for developing decay in permanent teeth (29). Furthermore, in the mixed

dentition stage, cariously involved deciduous teeth can potentially increase the rate of dental decay development in the adjacent permanent teeth (30).

Not surprisingly, dental caries is an expensive oral health issue, both in terms of the direct financial costs incurred and indirectly in the form of productive time lost. In 1999, the total cost of dental care was estimated at \$6.77 billion per year in Canada, of which 94% was accounted for by private expenditures (22). The average out-of-pocket dental spending was \$214 per household (22). While the private sector disbursements rose by 3.3% between 1990 and 1999, public sector contribution for dental care decreased by about the same proportion (22). In the late 1990's, treatment costs for dental ailments ranked second, just behind that for cardiovascular disorders (22). The expenses incurred in the treatment of early childhood tooth decay alone have been estimated to range from \$700 to \$3000 per child (31). In 2006, oral health care costs accounted for 6.7% of the country's overall health care expenses (21). The estimated national spending on oral health care that year was \$9.94 billion, a significant proportion (\$9.45 billion) of which came from private funds (21). In 2007, dental care costs in Canada further rose to 7.1% of overall health care spending, a net increase of 0.4% from the previous year (21).

Provincial oral health care expenditures are also substantial. In 1999, the total economic burden of dental disease was highest in Ontario (\$2.92 billion), followed by Quebec (\$1.28 billion) (22). Nova Scotia spent approximately \$154 million, while the lowest amount was expended in Nunavut (\$3.6 million) (22). Likewise, considerable dental health care expenditures are observed in other parts of the world. In 1998, 4.7 %

(\$53.8 billion) of the total health care costs incurred in the United States were accounted for by oral health expenditures (3).

Severe dental caries may also result in time taken off from school or work, either due to restricted activity from the problem condition or due to the need to seek treatment. It has been estimated that each year in the U.S, adults with oral health problems lose approximately 164 million work hours, while affected children lose over 51 million hours of school time (20). According to the 2007-2009 Canadian Health Measures Survey, 4.15 million work days and 2.26 million school days are lost each year owing to oral health problems, totaling up to over 40 million hours of productive time lost (3b).

Hence, it may be concluded that dental caries poses a significant burden due to its adverse health and financial consequences.

2.3 DENTAL CARIES PREVALENCE

The high global caries prevalence makes it a universal health problem, suggesting a need for appropriate measures to help alleviate this disease among the general public. According to the WHO, nearly 60 to 90% of school-aged children and most of the adult population suffer from dental decay (1b). Relatively greater disease experience is observed among industrialized nations when compared to their developing counterparts (1b).

2.3.1 CARIES DISTRIBUTION IN CANADA AND THE UNITED STATES

While dental caries prevalence has generally declined over the last few decades in Canada and the U.S., the disease continues to be an extremely common and significant health problem. In 2000, 'Oral Health in America: a report of the Surgeon

General' noted dental caries as the most prevalent chronic disease affecting children (3). More than one-half of the children aged five to nine and over three-quarter of those aged 17 were reported to have experienced tooth decay (3). When compared to other common disease conditions, the prevalence of dental caries was reported to be seven times that of hay fever and five times that of childhood asthma (3). Although a decline in permanent tooth decay rates has been reported (2,3,5), decay in primary teeth seems to be increasing (5). Furthermore, certain population groups bear most of the tooth decay burden (2,3,32).

The 2007-2009 Canadian Health Measures Survey reported that the overall prevalence of any dental caries was 57% among the six to 11 year old child population (3b). Primary dentition decay prevalence for this age group was estimated at 48%, while that for the permanent dentition was 24% (3b). The mean deft (decayed, missing, or filled primary teeth) score was found to be 1.99 and the average DMFT (decayed, missing, or filled permanent teeth) score was 0.49 (3b). For those aged 12-19, the overall dental decay prevalence was estimated at 59% with a mean DMFT score of 2.49 (3b).

Studies on dental caries demonstrate varying prevalence levels within and between Canadian provinces. Woodward and Knight examined the 1980-1994 Ontario Dental Health Indices Survey data for five and 13 year old children (33). They found a decrease in both permanent and primary dentition caries for the period between 1980 and 1988 (five year olds: deft = 1.69 in 1980 vs. 1.1 in 1988; 13 year olds: DMFT= 3.22 in 1980 vs. 2.08 in 1988), following which, there was an increase in primary tooth decay (deft = 1.22 in 1994) (33). In 2000-2001, Locker et al. conducted a study in 8,613 school children attending Kindergarten and grades two, four, six and eight in the Durham, York,

Hamilton and Thunder Bay areas of Ontario, in order to investigate the usefulness of a school oral health screening program and to identify those in need of dental treatment or preventive care (34). The research findings revealed that over one-third of children suffered from dental caries (34). Approximately 12% of children exhibited one or more affected teeth, over seven percent were in urgent need of dental care and 21% required some form of treatment or preventive intervention (34). Eighty percent of the disease affected 20% of the study participants (34).

Decay prevalence in the underserved populations of Ontario is also high. In 2000, a cross-sectional study of three and five year old Aboriginal children from Manitoulin, Ontario, found a high proportion (74%) of children with tooth decay ($dmft \geq 1$) (35). A higher proportion of five year olds (78%) than three year olds (67%) suffered from the disease. For children aged three and having one or more carious lesions, the mean decayed, missing, filled teeth score was 5.2 ± 3.9 SD and for those aged five it was 6.1 ± 3.7 SD. Early childhood tooth decay (defined for study purposes as presence of two or more decayed/filled primary upper incisor/canines or a $dmft$ score ≥ 4) affected over 50% of the children (35). Similarly, an analysis of data for seven and 13 yr old First Nations children from the same region, revealed an overall caries prevalence of 96% in 2000. High decay levels were seen in the primary dentition of seven year olds ($dft = 5.4 \pm 3.1$ SD) and permanent dentition of 13 year olds ($DEFT = 4.1 \pm 2.6$ SD) (36). The authors concluded that the severity of tooth decay in this group of children is increasing (36).

In Quebec, Payette et al. reported a decline in caries among children aged 13 and 14 during 1977-1990 (37). According to study findings, DMFT values reduced by

50% (9.0 in 1977 versus 4.5 in 1989-1990) and dental care needs arising due to tooth decay declined by 46% over the two decades (37). In 1998-99, the prevalence of dental caries in Quebec was estimated to be approximately 39% in five year olds (dmft=1.77), 46.4% in six year olds (dmft = 2.24), 52.8 % in seven year olds (dmft=2.42) and 58.2% in eight year olds (dmft=2.83) (38).

A study of 395 socioeconomically underprivileged children from Winnipeg, Manitoba found that over 30% of teeth were decayed at age six and more than 20% were involved at age nine (39). Primary dentition was the most frequently affected, with the second deciduous molars showing the greatest involvement (7.5% at age six; 5.5% at age nine) (39). For the period from 1991 to 2004, primary dentition caries scores (deft) averaged 3.7 ± 3.9 SD in the under 6-year-old age group (40). The ECC rate for these children was 71% (40). In 1999, nursing caries was prevalent in 98.9% of three to five year old children belonging to a Manitoba First Nations community (deft: 13.7 ± 3.2 SD) (41). In a study by Schroth et al. in 2005-2006, 53% of pre-school Hutterite children younger than 72 months of age were found to have experienced early childhood tooth decay (average deft: 2.8 ± 4.0 SD) and approximately 42% were found to have a more severe form of this disease (41b). Elevated disease levels in certain rural regions of the province have been noted (42).

In 1993, Ismail et al, investigated caries prevalence in school-aged children from three communities of Newfoundland and Labrador – Flower's Cove, Roddickton and Forteau (43). The study found that 82.4% of seven to 12 year old children in Forteau (DMFT = 1.6), 91.7% in Flower's Cove (DMFT = 3.4) and 92.9% in

Roddickton (DMFT = 2.7) had dental decay (43). Prevalence rates for the province of Nova Scotia are discussed in a separate section.

In British Columbia (BC), a survey of 6032 school children from grades two, three, eight and nine, determined that over six percent of the dentition was affected with pit and fissure caries (44). Between 1993-1994 and 1996-1997, caries rate in permanent teeth of BC children was approximately 43% for pit and fissure lesions and about 31% for smooth tooth surface lesions (45). Decay prevalence in Saskatchewan was estimated at 60% among six year old children in 1991 (dmft = 2.5) (46). Data for Inuit children from Northwest Territories were analyzed by Leake et al, who (6) found caries rates as high as 66% in four year olds in this population. Almost one-half of the children in this study (46%) presented with nursing bottle tooth decay (6).

Prevalence trends in the United States are similar to that observed in Canada. According to the 2000, US Oral Health Report there has been an overall reduction in caries rates in the five to 17 year old age group since the early 1970's (3). However, more than half (52%) of five to nine year old children experienced decay in at least one tooth. Caries prevalence for adolescents aged 17 was as high as 78% (3). There were also marked income-related inequalities in oral health, with deciduous dentition caries rates in the socioeconomically disadvantaged children being twice as those reported in children from wealthier backgrounds (3).

In 2005, a summary report by the Centers for Disease Control (CDC) presented data from the National Health and Nutrition Examination Survey (NHANES) for 1988-1994 and 1999-2002 (32). A decline (7.4%) in permanent dentition decay rates in the U.S. children and adolescents was documented, but there were no reductions in

primary dentition caries (32). In fact, a rise (3.7%) in the dental decay levels for two to five year old children was noted (32). This may indicate a tendency towards an increase in caries prevalence in deciduous teeth. The overall caries prevalence rates were estimated at 41% in the primary dentition of two to 11 year olds (dft = 1.4; dfs = 3.2) and 42% in the permanent dentition of six to 19 year olds (DMFT= 1.6; DMFS= 2.7) (32). Decay experience was rather high in poorer children (dfs= 5.2; DMFS= 3.3) and in those of Hispanic origin (dfs=4.6) (32). This establishes that individuals from certain high-risk groups are particularly prone to have elevated caries levels. Furthermore, 75% of primary tooth decay was witnessed in about eight percent of two to five year old children, while 75% of permanent tooth decay was observed in 33% of children aged six or older (47).

Epidemiological evidence from Canada and the U.S. demonstrates variations in dental decay prevalence rates within and between the two nations. These could result from differing demographic attributes of the study populations or due to varying data collection methodologies, study design, and study periods. But regardless of these differences, dental caries prevalence seems quite high for both countries and disparities exist in caries distribution, with certain high-risk population groups experiencing greater caries levels than others.

2.3.2 CARIES DISTRIBUTION IN THE PROVINCE OF NOVA SCOTIA

Few prevalence data have been published for Nova Scotia. Most of the available data on oral health status come from two province-wide surveys conducted in 1982 and 1995-1996 (48,49). The 1995-96 Nova Scotia Oral Health Survey of Children and Adolescents (NSOHS) provided prevalence estimates for dental caries and compared these to the 1982 survey results (49). The study population consisted of 4765 school

children from grades one (age six to seven), six (age 11-12) and nine (age 14-15) (49). Oral health examinations were conducted by two dentists and information regarding children's demographic characteristics and oral health behaviors was obtained from parental questionnaires (49). In 1995-96, 69.4% of six to seven year olds (dmft=2.4; dmfs= 6.7; DMFS=0.5), 75.6% of 12 year olds (DMFT=1.9-3.4) and 90% of 15 year olds presented with dental caries (i.e. dmft/DMFT score \geq 1) (49). High decay experience, defined as having one or more smooth tooth surfaces with cavitated lesions, was observed in about 20% (95% CI 17.9% - 22.3%) of these children (49). Nonetheless, compared to 1982, the 1995-96 NSOHS survey found a dental caries decline of 37% and 55% in the primary and permanent dentitions, respectively, of grade one school children (49).

Pits and fissures were the most frequently involved tooth surfaces in the permanent dentition, while in primary teeth, smooth surfaces lesions were common (49). In addition, dental decay prevalence was determined to be higher in children of parents with a low educational level, those living in non-fluoridated areas (primary teeth: 71.4%; permanent teeth: 22.3%) and in those who demonstrated poor oral health behavior (49).

In a region-specific study conducted for Truro and Kentville (Nova Scotia) in 1991, the mean decayed, missing and filled tooth surfaces score for grade five and six school children ranged from 1.7 to 4.2, depending on whether non-cavitated lesions were excluded or included in the caries analyses (50). At the time of the study, the community of Kentville was fluoridated at optimum level, while Truro was not fluoridated (50). Although insignificant from a statistical viewpoint, the study found that there was a difference of 17 to 39% (depending on whether analyses included or excluded non-cavitated lesions) in the DMFS values of children living in these two communities (50).

The current prevalence of dental caries in Nova Scotia children is not known. A recent comprehensive province-wide oral health survey, *Evaluation of the Fluoride Mouth Rinse School Eligibility Index and Baseline Information for Oral Health Programs*, involving grade two school children was conducted in 2006-2007 (23). The data from this survey are analyzed in this thesis.

2.3.3 CARIES DISTRIBUTION INTERNATIONALLY

Dental caries is a problem in other parts of the world as well. International studies indicate that there has been a general decline in childhood caries over the past few decades in a majority of the industrialized nations. However, dental decay levels in these regions are still quite high, while the caries experience in most developing countries is relatively low. For instance, the overall disease prevalence was estimated at 70% in 1991 versus 73% in 1996 in five to six year olds and 89.6% in 1991 versus 84.5% in 1996 in 12 year olds in Hungary (51); 42.6% in 1997-1998 (52) versus 39% in 2005-06 (53) in five year olds and 32.7% in 2004-05 in 11 year olds (54) in the UK; 39.5% in six year olds, 48.3% in seven year olds in 2001-2002 (55) and 43.1% in 2004-05 in 12 year olds (56) in Italy; 68.5% in 1983 vs. 52.5% in 1998 in six to seven year olds in Belgium (57); 87.4% in 1995, 82.4% in 1999 and 87.9% in 2000 in six year olds and 90.5% in 1995 vs. 87.9% in 12 year olds in 2000 in Poland (58); 69.2% in 2000 vs. 87.7% in 2003 in six year olds and 80.3% in 2000 vs. 78.9% in 2003 in 12 year olds in Greenland (59); and 47.4% in six year olds and 42.2% in 12 yr olds in 2002 in Australia (60).

Decay experience in primary dentition, indicated by the average dmft score was 3.7 in 1991 vs. 4.5 in 1996 for five to six year olds in Hungary (51); 1.7 in 1997-1998 (52) vs. 1.5 in 2005-2006 (53) for five year olds in UK; 1.57 for six year olds

and 1.79 for seven year olds in 2001-02 in Italy (55); 3.9 in 1983 vs. 2.4 in 1998 in six to seven year olds in Belgium (57); and 3.13 in 1977, 1.90 in 1993 (61) and 2.0 in 2002 for six year olds (60) in Australia. Permanent dentition decay experience (mean DMFT) for the 12 year old age group was 5.0 in 1985, 4.3 in 1991 and 3.8 in 1996 in Hungary (51); 3.1 in 1983, 1.4 in 1993 (62) and 0.7 in 2004-05 (54) in the UK; 1.5 in 2001-2002 (63) and 1.1 in 2004-05 (56) in Italy; 4.2 in 1995 and 3.8 in 2000 in Poland (58); and 0.8 in 2000 (64) and 1.0 in 2002 (60) in Australian children.

In the developing regions, caries prevalence was 55% in 2001-2002 for three to five year olds (65), and 45.8% for 12 year olds and 52.4% for 15 year olds in 1995-1996 in China (66); 4.4% in six year olds and 30% in 12 year olds in 1990-1991 in Nigeria (67); 31% in 12 year olds and 46% in 15 year olds in 1999 in Haiti (68); 36% in six year olds and 22.4% in 12 year olds in 1999-2000 in Ghana (69); and 54.5% in 12 year olds in 2001 in Brazil (70).

The average decayed, missing, or filled primary teeth (dmft) score was 1.0 in six year olds in 1999-2000 in Ghana (69); and 2.57 in three to five year olds in 2001-02 in China (65). Mean DMFT scores were estimated to be 0.7 in 1999 for 12 yr olds in Burkino Faso (Africa) (71); 1.03 in 12 yr olds and 1.4 in 15 yr olds in 1995-1996 in China (66); 0.7% in 12 year olds in 1990-1991 in Nigeria (67); 0.65 for 12 year olds and 1.4 for 15 year olds in 1999 in Haiti (68); 0.4 % in 12 year olds in 1999-2000 in Ghana (69); and 7.0 in 1984, 4.13 in 1995 and 1.53 in 2001 in 12 year olds in Brazil (70).

2.4 RISK FACTORS FOR DENTAL CARIES

Several sociodemographic and lifestyle factors, along with other community- and individual-related determinants predispose to the risk of developing

dental caries and the evidence supporting such relationships is mounting.

Epidemiological research from Canada and around the world has identified high-risk groups prone to the disease. Findings from some of these research studies are discussed below in order to describe the effects of various risk factors on dental caries.

The effect of age and gender on the risk of caries development has been studied. Maserejian et al. analyzed dental caries data collected between 1997 and 2005 from 534 six to ten year old US children as part of the New England Children's Amalgam Trial study (NECAT) (72). Participants were residents of Boston's urban and Maine's rural areas (72). The study found that older age was associated with having a greater number of decayed tooth surfaces in the permanent dentition (p -value= 0.02), but fewer cariously affected teeth (p -value=0.01) and surfaces (p -value=0.03) in the deciduous dentition (72). In Canada, Schroth et al. examined cross-sectional survey data of Manitoba children below the age of six from Winnipeg, Thompson, Roseau River First Nation and a northern First Nations community in 2001-2002 (73). Early childhood tooth decay rates were estimated at 7.1% in children younger than one year old (average $\text{deft} = 0.3 \pm 1.9 \text{ SD}$), 54.7 % in two year olds (mean $\text{deft} = 3.5 \pm 4.2 \text{ SD}$), 78.1 % in three year olds ($\text{deft} = 7.0 \pm 5.2 \text{ SD}$) and 84.2 in five year olds ($\text{deft} = 7.2 \pm 4.9 \text{ SD}$), with prevalence being higher in the older age groups compared to that in younger children ($p < 0.001$) (73). Greater dental decay experience was observed in children aged two or above, as opposed to those younger than two years ($p < 0.05$) (73). The authors suggested that children belonging to older age groups have had their dentition subjected to the detrimental effects of decay-causing agents for an extended amount of time, hence explaining the higher disease occurrence in them (73). Also, increased levels of dental plaque are noticed with

increasing age (74). This plaque, essentially comprising of cariogenic bacteria, is a key factor involved in the causation of tooth decay and influences caries occurrence (74b).

Potential risk factors for dental caries were identified by Casanova-Rosado et al. in a study of 1644 Mexican children in 1997 (75). Study subjects were six to 13 years of age and belonged to the Campeche region. The results of logistic regression analyses revealed that girls were more likely than boys to have dental caries in both primary (OR=1.3, 95% CI=1.00-1.69, p=0.05) and permanent teeth (OR=1.36, 95% CI=1.04-1.78, p=0.027). According to the 2005 Centers for Disease Control and Prevention (CDC) report, 44.5% (SD=1.23) of six to 19 year old American female children suffered from tooth decay in their permanent teeth compared to 39.5% (SD=1.04) of their male counterparts between 1999-2002 (32). However, primary dentition decay prevalence for two to 11 year olds, was relatively lower in girls (38.4% \pm 2.25 SD) compared to boys (43.2% \pm 2.53 SD) (32). Being a female is associated with losing a greater amount of school and work time due to oral disease (20). On the other hand, some research studies have found higher decay levels in the male population as well (35,76). Therefore, there are no clear overall findings relating gender to dental caries susceptibility.

Race, ethnicity and culture are key determinants modifying the dental caries risk in individuals. National data for the U.S. from 1999-2002 indicate elevated dental caries levels in both dentitions of Mexican-American children and teenagers (primary teeth: 54.9% \pm 2.52 SD; permanent teeth: 48.8% \pm 1.84 SD) relative to that found in the Black (43.3% \pm 2.13 SD; 38.8% \pm 1.16 SD) and Caucasian (37.9% \pm 2.33 SD; 39.9% \pm 1.41 SD) two to 19 year old population (32). In Canada, Locker et al.

observed disparities in dental care needs among 13-14 year old residents of North York (Ontario) based on their immigrant status (77). Individuals born outside of Canada were reported to have a greater need for dental restorations (13.6%) and urgent treatment (3.5%), compared to those born within the country (3.5% and 0.5%) (77). The 2007-2009 Canadian Health Measures Survey however, found the prevalence of caries to be lower among foreign-born children (3b). Children, in whom English is not the primary language spoken, exhibited an increased disease burden than those whose mother tongue was English (78). Dental decay prevalence is also particularly high in the First Nations and Inuit populations (6,35,36,40,41). Between 2007 and 2009, dental caries was prevalent in approximately 84% of the Aboriginal Canadian population (3b).

Much evidence exists in the scientific literature linking socioeconomic status (SES) to dental caries. SES measures for children primarily include family income, parental education and parental employment. Leake et al. identified that children from high-income families were at a lower risk of having tooth decay compared to the less affluent children (OR = 0.68; 90% CI = 0.54–0.85; p=0.005) (6). Study participants included 349 Canadian children aged two to six from 13 communities of the Northwest Territories (6). Sixty-nine percent of children from families with annual household income above \$80,000 were free of dental decay in their dentitions, as opposed to 39% and 14% of children in the \$40,000-79,000/year and below-\$40,000/year household respectively (6). The 2007-2009 Canadian Health Measures Survey found that caries prevalence was as high as 55% in children from middle-income groups and about 60% in those from families with an educational attainment level less than a diploma or degree (3b). In Nova Scotia, Ismail et al. found that high parental educational attainment was

linked to reduced severity of dental decay in the teeth of first grade schoolchildren in 1995-96 (79). The decayed, missing and filled primary surface (dmfs) index values were comparatively higher for children of parents with elementary school education only (9.1 ± 1.3 SD) versus children whose parents had a university degree (3.7 ± 0.6 SD) (79). Reports from other parts of the world also demonstrate similar associations between social deprivation and dental caries (32,75,78,80-82). Low SES children have a reduced tendency to be insured for receipt of dental care and hence, have greater unmet oral health care needs (83).

Dietary factors play a major role in dental caries development.

International data collected from 17 countries in 2001 were analyzed by Pine et al., who found that night-time consumption of sugared liquids was significantly associated with an increased probability of having dental caries in children (OR=1.7, $p < 0.001$) (84). A cumulative protective effect against tooth decay (OR=0.6) was linked to healthy dietary habits such as avoidance of sugar in drinks or intake of sweet liquids at nighttime and reduced frequency of having sugared snacks and drinks (84). Other factors such as excessive sugar consumption (85), frequent snacking (86), having soft drinks more often (85) and having juice (87) are also associated with dental caries. Feeding practices such as the use of a baby bottle until a later age (41) and while sleeping (78), along with the presence of sweet liquids in the feeding bottle (41) are particularly hazardous. Vegetables, however, reduce decay occurrence (88) and thus it is beneficial to include them in the daily diet.

Dental decay experience in the deciduous dentition increases the risk of caries in the succeeding permanent dentition. Casanova-Rosado et al. analyzed the effect

of carious primary predecessors on children's permanent teeth (75). Findings of this investigation revealed that the likelihood of having permanent tooth decay significantly increased when the children had cariously affected deciduous teeth (adjusted OR=6.04, 95% CI=4.20-8.69, p= 0.000) (75). Apart from prior decay experience, other patient-related characteristics that enhance the vulnerability to dental caries include presence of increased oral *Streptococcus mutans* bacterial counts (89), structural and hypoplastic defects in enamel (75,89) and high periodontal treatment needs (82).

Specific parental and family-related factors predispose to caries risk in children. Younger age of parents, whether or not they reside together, higher parental decay experience and their poor oral-health related behavior are all associated with childhood caries experience (40,90). Furthermore, higher decay levels are observed in children of mothers with no remaining natural teeth compared to those of dentulous mothers (91). Composition of the family also plays a crucial role. Presence of several family members per household or living with a single parent puts a child at a particularly increased risk for tooth decay (40,83).

Protective effect of fluorides and dental sealants is supported by evidence. Ismail et al. identified adequate water fluoridation as an important predictor of reduced dental decay burden in Nova Scotia children (49). Living in fluoridated regions was associated with having caries-free primary and permanent teeth (49). The Canadian Task Force on Preventive Health Care found substantial evidence pertaining to the preventive influence of specific factors on dental decay (92) and suggested that measures such as water fluoridation, daily use of fluoride-containing toothpaste, regular intake of fluoride supplements by persons residing in inadequately fluoridated regions and dental sealants

(92) be used for reducing caries levels. Fluoride mouth rinse use and professional topical fluoride application are recommended for those with active carious lesions (92). The American Dental Association Council on Scientific Affairs has also recommended placing dental sealants to arrest further progression of existing dental decay, and to prevent the development of any new carious lesions (93). The results of the recent Canadian Health Measures Survey showed that approximately 32% of the six to 11 year olds had dental sealants, with a mean of 2.88 sealed teeth. Among the 12-19 year old age group, about 51% had dental sealants, with a mean of 3.51 sealed teeth (3b).

2.4.1 GEOGRAPHIC (URBAN/RURAL) LOCATION AND DENTAL CARIES

Epidemiological studies from many developed nations report higher caries prevalence in rural residents (7,55,58,76,88,90,94,95), while data from several less developed countries indicate increased urban decay levels (66,96-99). Moreover, variations may be noticed even within any given nation. For instance, two separate studies from the United States found contradictory results on the effects of urban/rural status. Cross-sectional data for three to five year old Maryland children in 2000 examined by Vargas et al. identified preschoolers from urban areas as having relatively lower caries rates compared to their rural counterparts (7). The study population consisted of children enrolled in the Head Start program (a national initiative that provides comprehensive services including health care, at numerous settings, to children from socioeconomically deprived backgrounds) (7). Dental caries rates were estimated at 48% in urban preschoolers as opposed to 64% in children from rural Head Start locations (7). On the other hand, Maserejian et al. assessed dental decay prevalence in 534 six to ten year old urban and rural US children for the period from 1997 to 2005 (72) and found

significantly higher decay experience and severity in children from urban areas (72).

There were 3.9 decayed teeth and 7.4 affected surfaces in the primary dentition of rural children, compared to 4.5 decayed teeth and 8.5 decayed surfaces in the primary dentition of urban children (unadjusted p-value: teeth = 0.001; surfaces=0.006; adj. p-value: teeth=0.002, surfaces= = 0.02) (72). Likewise, the risk of having decay in the permanent dentition was also greater among urban children, who presented with comparatively increased involvement of their permanent teeth (OR = 2.8; 95% CI =1.1- 6.8; p =0.03) and surfaces (OR = 3.0; 95% CI =1.4-6.5, p=0.004) (72).

Inequalities in caries experience due to urban/rural location are not limited to children alone, but are also evident among adults. In Canada, Brodeur et al. analyzed caries data for Quebec residents belonging to the 35 to 44 year old age group in 1994-95 (100). According to study findings, the overall caries severity (DMFS) decreased with an increase in urbanization (rural:69.8%; urban:65%; metropolitan:61%; p<0.001) (100). There were a lesser number of filled tooth surfaces, along with greater number of missing teeth due to dental caries among rural residents, compared to that in the more urban populations (100).

Individuals living in rural areas also tend to have decreased access to dental care services, which may further accentuate existing treatment needs. Liu et al. found that the likelihood of having no dental insurance increased by almost 30% for rural children and adolescents (adj.OR=1.27; 95%CI=1.2-1.4; p=<.0001), compared to those living in urban areas (83). Fewer dental visits and higher unmet oral health needs are also common in rural inhabitants (101). Besides, disparities are also evident in the oral health behaviors based on the area of residence, with urban children brushing their teeth more

frequently than rural children (58,102, 103). In addition, urban children also possess an increased level of oral health-related knowledge, which in turn, is related to lower caries levels (58,104).

Despite the increasing global significance placed on the role of geographical location as a contributor to caries risk, there have been no studies that have specifically explored urban/rural disparities in dental decay experience, prevalence and severity among school-aged children in Nova Scotia.

2.4.2 DENTAL HEALTH CARE UTILIZATION AND DENTAL CARIES

Reduced access to and utilization of dental care services is associated with increased caries prevalence in the general population. According to the 2007-2009 Canadian Health Measures Survey, a majority of the population (74.5%) was reported to have visited an oral health professional on an annual basis. Among those with a dental visit within the previous year, approximately 94% had visited a dentist for either regular or preventive dental treatment. Seventeen percent avoided seeing an oral health professional and 16% refrained from having the recommended dental treatment performed in the past year due to the associated costs (3b).

The 1995-96 Nova Scotia Oral health Survey of Children and Adolescents found a link between dental visits and tooth decay in the province (49). According to survey findings, children who had been to a dentist at least once per year were more likely to have no caries in their primary and permanent dentitions, when compared to those whose dental visits were not as regular (49).

Similar findings have been reported in the Canadian adult population as well. In a study of over 2,000 35 to 44 year old individuals from Quebec, Brodeur et al.

found that having seen a dental health professional in the past year made persons less vulnerable to dental decay (100). The average number of decayed tooth surfaces was significantly lower in such individuals than in those who had not visited the dentist in the previous year (3.3 versus 1.1; $p < 0.001$) (100). In addition, these persons presented with greater number of filled tooth surfaces and lesser missing teeth and surfaces ($p < 0.001$) (100). The likelihood of having high decay levels (> 4 carious tooth surfaces) increased by almost four-fold (adj. OR=3.6; 95% CI=2.66-4.94) in those who did not use dental care in the preceding year and by 60% (adj. OR= 1.6; 95% CI=1.12-2.22) in those who lacked dental insurance (100).

Apart from dental visit frequency and regularity, several other characteristics of dental care utilization are also important. Lower caries experience and severity is related to first time visitation to a dental office for a routine check-up (49,79), and having seen an oral health professional in the past year for preventive reasons (85). The caries burden is greater in those children who are relatively older at their first visit to the dental office (40,49). Use of dental care also seems to impact oral health care practices in children (58). Furthermore, dental health professionals are an important source of oral health-related knowledge, which, is in turn linked to reduced childhood caries levels (104). Attending a dentist's office the first time for preventive care before the age of one, positively influences successive preventive visits, while decreasing the probability of seeking emergency and restorative treatment in the future (105). Whether individuals access dental care on a regular basis and the rate of such utilization is influenced by numerous factors. These include, but are not limited to, younger to middle

age of persons, female gender, married status, having dental insurance, deteriorated dental health condition, higher educational status and high family income (106).

There is no information regarding the current dental caries prevalence, experience and severity by dental visit frequency and recency among school-aged children in Nova Scotia.

2.4.3 ORAL HYGIENE PRACTICES AND DENTAL CARIES

Poor oral hygiene, depicted in the presence and levels of dental plaque in the oral cavity, is associated with the occurrence of tooth decay (73,74,75,85,107). Dental plaque, comprising of cariogenic microorganisms, is an essential factor in caries causation (74b). The role of routine oral health care practices such as tooth brushing and flossing is highly significant as these help in the mechanical removal of dental plaque, thereby preventing the process of caries initiation. The 2007-2009 Canadian Health Measures Survey found that approximately 73% of the Canadian population brushed twice per day and 28.3% flossed at least five times per week. Flossing frequently was less prevalent among children (11.6%) when compared to adults (40.6%) (3b).

According to the 1995-96 Nova Scotia Oral Health Survey of Children and Adolescents (NSOHS), those who brushed their teeth at least once per day had increased odds of having non-carious primary and permanent dentitions (49). Similarly, regular flossing of teeth was associated with having no childhood tooth decay (49).

In an epidemiological assessment of caries data from 17 nations, Pine et al. found that the odds of being affected by dental decay were greater in children who did not start brushing until after age two (OR=1.6, $p<0.001$) (84). Presence of certain oral health care habits such as brushing two times per day, starting tooth brushing prior to the

age of one and adult supervision of brushing, collectively demonstrated a protective effect against childhood tooth decay (OR=0.5) (84).

Children, in whom regular tooth brushing is a norm, also tend to show a decreased prevalence of other negative oral health-related behaviors such as increased consumption of sweets and sugar in the daily diet (102). Determinants of habitual tooth brushing behavior among children include urban residential status, having dental insurance, belonging to an affluent background, positive maternal oral health-care habits, mother's self-efficacy with regard to dental health and her awareness of the child's oral hygiene (108).

For Nova Scotia, disparities in the current childhood caries experience, prevalence and severity by routine oral hygiene practices' frequency are not known.

2.5 STUDY RATIONALE AND IMPLICATIONS

Although dental caries is a significant public health problem, there is no information on the current prevalence of this disease in Nova Scotia children. It has been over a decade since estimates of dental caries in children have been updated for the province. Furthermore, there is only limited existing research pertaining to the influence of rural/urban location and specific preventive oral health-related lifestyle and behavioral factors such as regular dental care services utilization and oral health care practices, on dental decay experience and severity among Canadian school-aged children. Using data from the 2006 "*Evaluation of the Fluoride Mouth rinse School Eligibility Index and Baseline Information for Oral health Programs*" (FMSEI) province-wide survey (23), the proposed research study aimed to investigate the current prevalence of dental caries in seven to eight year old Nova Scotia children and to identify disparities in decay

prevalence, experience and severity by geographic (urban/rural) location, dental care utilization and oral hygiene practices.

The information derived from this study will provide a basis for future comparisons of dental caries prevalence, experience and severity for the seven to eight year old population in the province. Identification of subgroups of children who are at increased risk for developing the disease will not only help in careful allocation of limited available resources, but will also reduce the overall oral health-related financial burden in the province. In addition, the results of this investigation are intended to help foster future oral health initiatives such as planning and development of community-based oral health programs and policies, targeted towards preventing and reducing dental decay, decreasing inequalities in oral health, and promoting children's overall health and well-being.

CHAPTER THREE: OBJECTIVES

This study of seven to eight year old Nova Scotia children aimed to:

1. Determine dental caries prevalence, experience and severity, and
2. Investigate disparities in dental decay prevalence, experience and severity by
 - (a) geographic (urban/rural) location,
 - (b) dental health care utilization, and
 - (c) oral hygiene practices.

CHAPTER FOUR: METHODOLOGY

4.1 DATA SOURCE AND STUDY POPULATION

For the purpose of this research, the data were derived from the 2006 *Evaluation of the Fluoride Mouth rinse School Eligibility Index and Baseline Information for Oral health Programs (FMSEI)* survey (23). It is a recent provincial survey, conducted as a joint effort by the Nova Scotia Department of Health, Nova Scotia Health Promotion, Dalhousie University and Nova Scotia District Health Authorities (23). The survey objectives were primarily to assess a novel socioeconomic indicator-based index to be potentially employed for identifying and establishing the eligibility of schools for inclusion in a fluoride mouth rinse program, and secondarily, to gather comprehensive data regarding the oral health status of seven to eight year old Nova Scotia children (23). The surveillance was conducted between 2006 and 2007, and collected information on 1,247 grade two elementary school children in the province (23). The seven to eight year old population was chosen since children in this age group not only possess the permanent anterior and first molar teeth that are used in the estimation of permanent tooth decay indices (DMFT and DMFS), but also have minimal possibility of having gained from other prior school-based fluoride mouth rinse programs (23).

The original FMSEI survey had a study sample representative of the entire provincial grade two school population in Nova Scotia (23). The survey employed a multistage stratified random sampling design, with both schools and children as the ultimate sampling units (23). The study sample was derived from a sampling frame, which was comprised of 10,052 children attending the grade two classes, from 321 primary schools throughout the entire province (23). First, all elementary schools in each

of the nine District Health Authorities (DHA) were stratified based on four new socioeconomic index categories, with ranks ranging from -6 to +6 (+4 to +6, 0 to +3, -3 to -1, -6 to -4) (23). Then, they were further stratified according to urban/rural status and English/French language of instruction (23). This resulted in a total of 16 strata of schools for each of the nine DHA's. A random selection of one school was made per stratum (23). All schools with a minimum of ten grade two children were included in the survey (23). Prior parental consent was sought through consent forms, which were signed and returned to the study team (23). All elementary school children in grade two, having parental consent, were included in the survey (23). However, students having behavioral issues or those having parental consent, but unwilling to undergo a clinical examination, were excluded from the study (23). Overall, 115 schools were included in the original study. Questionnaires were completed for 1302 students and 1247 students underwent oral health examinations (23b). A total of 1202 grade two students had both the parental questionnaire completed and the clinical oral health examination done (23b). All of these eligible participants would be included in this study.

The survey procedure included clinical oral health examinations as well as retrospective questionnaires completed by the parents (23). The intra-oral clinical assessments were carried out using validated criteria laid out by Dr. Patricia Main (Faculty, University of Toronto) based on the World Health Organization indications (23). The survey components have been tested and used in various Ontario surveys (23). Sixteen trained dental hygienists, forming eight groups of one examiner and one recorder per group performed the clinical oral health examinations (23). The hygienists were employed in the public health system of Nova Scotia by the District Health Authorities,

and were familiar with the seven to eight year old age level and accustomed to examining this age group (23). These dental hygienists underwent a two-day calibration session (23). The parental questionnaires provided information on the children's dental care utilization, oral hygiene practices, oral pain experience, school time lost due to oral health problems, and parental perception of and satisfaction with their child's oral health status (23).

Sampling weights were used to adjust for the sampling strategy and to account for the non-response of survey participants (23).

4.2 PRIMARY OUTCOME VARIABLES

The outcome variables included in the statistical analyses in this study included prevalence of any dental caries, deft (decayed, extracted/missing, or filled primary teeth) index, DMFT (decayed, missing, or filled permanent teeth) index, defts (decayed, extracted/missing, or filled primary teeth surfaces) index, and DMFS (decayed, missing, or filled permanent teeth surfaces) index, as well as dichotomous versions (any vs. none) of these variables.

4.2.1 DENTAL CARIES PREVALENCE

The original FMSEI dataset contains information on the tooth status (whether decayed, extracted, filled, or missing, etc) for each of the primary and permanent teeth present in every participant who was examined (23). Proportion of children with any dental caries experience provided the overall caries prevalence rate for the given population. Similarly, the proportion of children with any caries experience in the primary and permanent teeth separately provided the caries prevalence rate for each of these two dentitions.

4.2.2 DENTAL CARIES EXPERIENCE (TEETH)

Dental caries experience was assessed using the the deft (also referred to as dmft) and DMFT indices for the primary and permanent dentitions respectively. Any given tooth that is both filled and carious is regarded as a decayed tooth (109). The DMFT index usually takes into account all teeth except the permanent third molars (109). However, the more recent WHO methodology has included these teeth as well in the DMFT analysis (109). The deft score ranges from zero to 20, while the DMFT values range from zero to an upper limit of 28 (when third molars are excluded) or 32 (109).

The master dataset contains information regarding the decayed, missing and filled teeth for each of the survey participants (23). For the purpose of this study, in order to determine the dental caries experience in the primary and permanent dentitions of the study population, the deft and DMFT dental index scores were estimated from the original dataset.

4.2.3 DENTAL CARIES SEVERITY (TEETH SURFACES)

The severity of dental decay was assessed using the defs and DMFS indices for the primary and permanent dentitions respectively. The defs (also referred to as dmfs) index indicates decayed, extracted/missing (due to caries) or filled primary teeth surfaces, whereas the DMFS represents the decayed, missing or filled permanent surfaces (109). Any given tooth surface that is both filled and carious, is regarded as a decayed surface (109). The defs values range from zero to 88, while the DMFS score ranges from zero to 128 (excluding third molar surfaces) (109).

The master dataset contains information about the decayed, missing and filled surfaces for each of the primary and permanent teeth present for every survey

participant who was examined (23). For the purpose of this study, in order to determine the dental caries severity, the defs and DMFS dental indices' scores will be estimated from the original dataset.

4.2.4 ASSESSMENT OF ANY CARIES PREVALENCE

In order to determine the effects of key independent variables on caries in the primary dentition, the deft scores were dichotomized into $deft \geq 1$ and $deft = 0$, to indicate presence of any decay and no decay respectively. Similarly, for the permanent teeth, the DMFT values were dichotomized into $DMFT \geq 1$ and $DMFT = 0$, to represent any versus no decay.

For the purpose of this study, in order to find out the number of study participants that would be required to support the data analysis, we performed power calculations (110). The power calculations indicated that, assuming equal numbers of children in the “exposure” groups of interest (e.g., roughly equal numbers of children who did or did not have dental visit in the past year), and assuming a two sided test with alpha of 0.05, the available sample size would yield 90% power to detect an odds ratio of about 1.5, or a difference between about 23-24% prevalence of caries among children without a recent dental visit vs. 15% prevalence of caries among children who had a recent dental visit.

4.3 PRIMARY INDEPENDENT VARIABLES

The master dataset contains questions from the clinical assessment forms and parental questionnaires, which helped in identifying the specific independent and potential confounding variables of interest (23). The key independent variables of focus

in the analyses include geographic (urban/rural) location, dental health care utilization and oral hygiene practices.

4.3.1 GEOGRAPHIC (URBAN/RURAL) LOCATION

In order to identify urban and rural areas, the FMSEI survey utilized the Statistics Canada guideline (used in the 2001 Census), according to which ‘Urban’ is indicated as any region having a minimum population of 1,000, with at least 400 residents per sq. km (23). For the purpose of analyses, rural and urban location was based on the dataset question ‘Urban/Rural’, which indicated the area in which each school was located. The response measured for this question was dichotomous and was recorded as a numerical code assigned for each of the two regions as follows: Urban=1; Rural=2 (23). This explanatory variable was included as is in the analyses.

4.3.2 DENTAL HEALTH CARE UTILIZATION

In this study, the utilization of dental care services was assessed according to both the frequency and recency of visitation to an oral health care professional.

4.3.2.1 DENTAL VISIT FREQUENCY

‘Dental visit frequency’ was based on the dataset question “How often do you usually take your child to see a dentist or dental hygienist?” (23). The response measured for this question included: 1= more than once a year for check-ups or treatment; 2= about once a year for check-ups or treatment; 3= less than once a year for check-ups or treatment; 4= only for emergency care; 5= never (23).

In the analyses, in order to determine whether the frequency of dental visits was once per year vs. less or more often, the above response categories were collapsed into three categories: dental visit frequency of less than once per year (includes

response elements 3, 4 and 5), once per year (includes response element 2), and dental visit frequency of more than once per year (includes response element 1).

4.3.2.2 DENTAL VISIT RECENCY

‘Dental visit recency’ was based on the question “When was the last time that your child saw a dentist or dental hygienist?” (23). The response measured for this question included: 1= Less than 1 year ago; 2= 1 year to less than 2 years ago; 3= 2 years to less than 3 years ago; 4= 3 years to less than 4 years ago; 5= 4 years to less than 5 years ago; 6= 5 years to less than 6 years ago; 7= Never (23).

In the analyses, in order to determine whether there has been a dental visit in the previous year vs. less recently, the above response elements were collapsed into three categories: dental visit within the past year (includes response element 1), dental visit between one to less than two years ago (includes response element 2) and dental visit two or more years ago (includes response elements 3, 4, 5, 6 and 7).

4.3.3 ORAL HYGIENE PRACTICES

Oral hygiene practices were explored according to both the frequency of tooth brushing and flossing.

4.3.3.1 TOOTH BRUSHING FREQUENCY

‘Tooth brushing frequency’ was based on the dataset question “How often does your child usually brush his/her teeth?” (23). The response measured for this question was: 1 =__times per day; 2 =__ times per week; 3 =__times per month; 4 =__times per year; 5 = Never (23).

For the purpose of the analyses, the above response categories were first converted to ‘times per day’ and then collapsed into: brushing frequency of less than once per day, once per day and brushing more than once per day.

4.3.3.2 FLOSSING FREQUENCY

‘Flossing frequency’ was based on the question “How often do you usually floss your child’s teeth?” (23). The response measured for this question was: 1 = __ times per day; 2 = __ times per week; 3 = __ times per month; 4 = __ times per year; 5 = Never (23).

For the purpose of the analyses, the above response categories were first converted to ‘times per day’ and then collapsed into: flossing frequency of at least once per day and flossing less often.

4.4 SOCIODEMOGRAPHIC AND CLINICAL VARIABLES

Sociodemographic variables included for purposes of describing the characteristics of the study population included gender of the child, geographic location (urban/rural), socioeconomic class, country of birth (born in Canada vs. foreign-born), primary language of instruction at school, Shared Service Area (SSA) and District Health Authority (DHA). Oral health-related variables (in addition to the primary independent variables discussed in section 4.3) used to describe the clinical characteristics of the study population included dental fluorosis, dental sealants, pain in the mouth in the past year, whether there was missed school-time due to oral health problems. The FMSEI survey did not have information regarding water fluoridation of home tap water, as the question relating to this was to be answered by the surveyed children and it might have been possible that many children would have not known for sure whether there was fluoride in

their home tap water, thereby making the response to this question unreliable and invalid (23). Therefore, it was not included in the original FMSEI survey data (23) and hence was not available for inclusion in this study. The sociodemographic and clinical variables are presented in greater detail below.

Gender:

The question ‘Sex’ yielded the variable ‘gender’. FMSEI survey personnel were instructed to record if the child was male or female (23). Codes were designated as follows: Male=1; Female=2 (23). This variable was included as is in the analyses.

Geographic (Rural/Urban) Location

As noted earlier, for the analyses in this study, rural and urban location were derived from the data set question ‘Urban/Rural’ (23), which indicated the area in which each school was located. Numerical codes were assigned for the two regions as follows: Urban=1; Rural=2 (23). This explanatory variable was included as is in the analyses.

Socioeconomic Class:

The master dataset included 4 new socioeconomic index categories, with ranks ranging from -6 to +6 (+4 to +6, 0 to +3, -3 to -1, -6 to -4) (23). For the analyses in this study, the above categories were described as low (rank= -6 to -4), lower middle (rank= -3 to -1), upper middle (rank =0 to +3), and high (rank=+4 to +6) SES groups.

Country of birth:

The question ‘‘Born in Canada’ (23) provided the ‘Country of birth’ variable. The response elements included: No (Born outside Canada) = 0; Yes (Born inside Canada) = 1; Don’t know = 2; Missing value = 9 (23).

Primary language of instruction at school:

This variable was derived from the original dataset question 'English/French' (23). The survey personnel recorded if the school is English or French. Numerical codes were designated as follows: English=1; French=2 (23).

Shared Service Area (SSA):

This variable was derived from the question 'Shared Service Area' in the dataset (23). The four shared service areas in the province were coded as random numbers ranging from one to four in the original dataset to protect confidentiality of participants (23).

District Health Authority (DHA):

This variable was derived from the question 'DHA' in the dataset (23). The nine DHA's in the province were coded as random numbers ranging from one to nine in the original dataset to protect confidentiality of participants (23).

Fluorosis:

The question 'Fluorosis' (23) provided information on the variable 'Fluorosis'. The survey personnel in the FMSEI were instructed to examine the four upper anterior permanent teeth and record the highest score for the detected fluorosis lesions (23). Response values included:

0 = none; no fluorosis;

1 = Parchment white color on less than 1/3 of the enamel surface of 2 or 4 contralateral teeth;

2 = Parchment white color on 1/3 but less than 2/3 of the enamel surface of 2 or 4 contralateral teeth;

3 = Parchment white color on 2/3 or more of the enamel surface of 2 or 4 contralateral teeth;

4 = Staining or pitting of 2 or 4 contralateral teeth in conjunction with scores of 1, 2, or 3;

8 = Teeth unerupted, cannot score (23).

Pain in the mouth in the past year:

The variable ‘Pain in the mouth in the past year’ was based on the question “In the past year, has your child had any mouth pain that lasts?” (23). Response options included: 1= Often; 2= Sometimes; 3= Rarely; 4= Never (23).

In the analyses, the above response elements were collapsed into two categories: Pain present (includes response element 1 and 2) and pain absent (includes response elements 3 and 4).

School-time lost due to oral health problems:

The question “If you answered often or sometimes to question 3, has your child taken time off school because of this pain or other dental problems?” (23) provided the variable ‘School-time lost due to oral health problems’. Response elements included: 1 = Yes; 2 = No (23). This original question was based on the response to question three in the parental questionnaire regarding presence of any mouth pain (23). This variable was used as is in the analyses.

4.5 DATA ANALYSIS

Data were analyzed using SAS version 9.1 (SAS Institute Inc., Cary.N.C.) statistical software.

The proposed study involved analysis of aggregate-level (de-identified) data from the FMSEI dataset and aimed to address each of the study objectives as described in the following section.

The FMSEI data belong to Nova Scotia Health and Wellness. Nova Scotia Health and Wellness carried out a formal review of this proposed research and made a decision to grant permission for access to aggregate-level data. Based on the objectives and detailed analytic plans indicated in my thesis, Nova Scotia Health and Wellness personnel agreed to conduct descriptive analyses and provide the results. The aggregate-level results of data analyses provided prevented identification of study participants. This approach helped to ensure confidentiality of the data. Where the 95% confidence intervals were not available in the results provided, these were calculated for the percentages for each of the key variables in the bivariate analyses, using estimates provided by Nova Scotia Health and Wellness. To compare proportions of dental caries between groups, the odds ratios and 95% Wald's confidence limits were estimated for the bivariate analyses.

Objective 1:

(a) Assessment of Dental caries prevalence:

Descriptive statistics yielded overall proportions of children with any caries experience (i.e. combined deft + DMFT > 0), as well as proportion with caries in the permanent dentition (DMFT>0) and proportion with caries experience in the primary teeth (deft>0). These were estimated as follows:

(i) Dental Caries Prevalence (Weighted prevalence to represent population) =

$$\frac{\sum_h \sum_{mh} (\text{student having a combined deft + DMFT score} > 0 * w_h)}{\sum_h \sum_{mh} w_h}$$

where the stratum weight is defined as $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum (1, ... 115)}$

$m_h = \text{number of children examined in the stratum}$

(ii) Caries Prevalence in Primary dentition (Weighted prevalence to represent population)

$$= \frac{\sum_h \sum_{m_h} (\text{student having a deft score} > 0 \times w_h)}{\sum_h \sum_{m_h} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum (1, ... 115)}$

$m_h = \text{number of children with primary teeth examined in the stratum}$

(iii) Caries Prevalence in Permanent dentition (Weighted prevalence to represent

population) =
$$\frac{\sum_h \sum_{m_h} (\text{student having a DEFT score} > 0 \times w_h)}{\sum_h \sum_{m_h} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum (1, ... 115 schools)}$

$m_h = \text{number of children with permanent teeth examined in the stratum}$

Prevalence estimates are reported as percentages and reflect survey weights.

(b) Assessment of Dental caries experience:

First, the deft (decayed, extracted/missing, or filled primary teeth) and DMFT (decayed, missing, or filled permanent teeth) indices for each individual were

calculated by counting the number of decayed teeth (d or D), extracted/missing teeth (e or M) and filled teeth (f or F) separately and then adding together all of these components (i.e. D+M+F= DMFS for permanent dentition; d+e+f=deft for primary dentition).

Finally, to estimate the descriptive statistics for the entire study population, the average deft and DMFT scores for the primary and permanent dentitions respectively, were calculated. These were estimated as follows:

(i) Average dental caries experience in the primary dentition (Weighted estimate to

$$\text{represent population}) = \frac{\sum_h \sum_{mh} (\text{deft score for each child} \times w_h)}{\sum_h \sum_{mh} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum } (1, \dots, 115)$

$mh = \text{number of children with primary teeth examined in the stratum}$

(ii) Average dental caries experience in the permanent dentition (Weighted estimate to

$$\text{represent population}) = \frac{\sum_h \sum_{mh} (\text{DEFT score for each child} \times w_h)}{\sum_h \sum_{mh} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum } (1, \dots, 115)$

$mh = \text{number of children with permanent teeth examined in the stratum}$

The results are presented in the form of means and standard error (weighted estimates).

(c) Assessment of Dental caries severity:

The defs (decayed, extracted/missing, filled primary teeth surfaces) and DMFS (decayed, missing, filled permanent teeth surfaces) indices for each survey

participant were first calculated by counting the number of decayed surfaces (ds or DS), extracted/missing surfaces (es or MS) and filled surfaces (fs or FS) separately and then adding together these components (i.e. DS+MS+FS= DMFS for permanent dentition; ds+es+fs =dmfs for primary dentition).

Then, to estimate the descriptive statistics for the entire grade two population, the average defs and DMFS scores for primary and permanent dentitions respectively, were calculated. These were estimated as follows:

(i) Average dental caries severity in the primary dentition (Weighted estimate to represent population) =
$$\frac{\sum_h \sum_{mh} (\text{defs score for each child} \times w_h)}{\sum_h \sum_{mh} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum } (1, \dots, 115)$

$mh = \text{number of children with primary teeth examined in the stratum}$

(ii) Average dental caries severity in the permanent dentition (Weighted estimate to represent population) =
$$\frac{\sum_h \sum_{mh} (\text{DMFS score for each child} \times w_h)}{\sum_h \sum_{mh} \times w_h}$$

where stratum weight $w_h = \frac{\text{number of grade 2 children in the stratum}}{\text{number of children examined in the stratum}}$

$h = \text{the stratum } (1, \dots, 115)$

$mh = \text{number of children with permanent teeth examined in the stratum}$

The results are reported as means and standard error (weighted estimates).

Objectives 2a, 2b, 2c:

Exploratory bivariate analyses were carried out to examine the relationship between urban/rural status and dental caries distribution. Using estimates

provided by Nova Scotia Health and Wellness, we then calculated the 95% confidence intervals for those percentages for each of the key independent variables in the bivariate analyses, where the 95% confidence intervals were not available in the results provided. Odds ratios (crude OR) and 95% Wald's confidence intervals are reported for the categorical variables of interest. Means, standard error and 95% confidence intervals for the means are reported for the continuous variables of interest. The results of all analyses reflect survey weights.

4.6 ETHICS APPROVAL AND DATA CONFIDENTIALITY

This research study received ethics approval from the Dalhousie University Health Sciences Human Research Ethics Board. Permission was also obtained from Nova Scotia Health and Wellness in order to access the FMSEI database. Nova Scotia Health and Wellness has carried out a formal review of this proposed research and made a decision to grant permission for access to aggregate-level data. Based on the objectives and detailed analytic plans indicated in my thesis, Nova Scotia Health and Wellness personnel agreed to conduct descriptive analyses and provide the results. This approach helped to ensure confidentiality of the data. The aggregate-level results of data analyses provided will not allow identification of study participants.

Aggregate-level (de-identified) results from analyses are securely stored in the Dalhousie Department of Community Health and Epidemiology. In accordance with the Dalhousie University policy, all electronic results of the data analyses are maintained in a SAS database on a secure, password-protected computer in the Department of Community Health and Epidemiology. Any paper copies of the results of data analyses are maintained in a secure, locked filing cabinet. It is in a locked private office, on a floor

that is locked after hours. Only the master's thesis committee members and the master's student responsible for this study may have access to these.

According to Dalhousie University policy, the results of data analyses will be kept for five years after the publication of the thesis, after which they will be securely destroyed.

CHAPTER FIVE: RESULTS

5.1 SOCIODEMOGRAPHIC CHARACTERISTICS OF STUDY SAMPLE

Table 5.1 provides an overview of the sociodemographic features of the study population. The age of children in this study ranged between seven to eight years. All children (n=1247) were enrolled in grade two of schools. Among these children, 49% (n=614) were male and 51% (n=633) were female. Forty-two percent (n=528) resided in urban areas, while 58% (n=719) lived in rural localities. Thirty percent (n=410) were from low socioeconomic background, while 51% (n=683) were from the lower middle, ten percent (n=131) from the higher middle and nine percent (n=123) were from high socioeconomic backgrounds.

Approximately 99% (n=1224) of children comprising the study population were born in Canada. Eighty-nine percent (n=1105) were enrolled in schools where English was the primary language of instruction, while 11% (n=142) were enrolled in schools where French was the primary language of instruction.

5.2 CLINICAL CHARACTERISTICS OF STUDY SAMPLE

Table 5.2 summarizes the clinical characteristics of the study population. A majority (57%; n=745) of children were reported to have had a dental visit more than once a year, while 38% (n=489) had visited a dentist or dental hygienist only once per year and three percent (n=39) visited less than once per year. Only one percent (n=12) saw a dentist for emergency care and about one-percent (n=12) had never been to an oral health professional previously.

The majority (88%; n=1137) of children had a dental visit within the previous year and 12% (n=139) had been to dentist more than a year ago.

About 73% (n=946) reported brushing their teeth more than once a day, while 23% (n=304) brushed once per day and only four percent (n=52) brushed less than once a day. Only 11% (n=149) flossed one or more times a day.

Eleven percent (n=137) of children were reported to have suffered from pain in the mouth in the previous year. Eight percent (n=47) were reported to have had lost time from school due to oral health-related problems.

Eight percent (n=99) of children exhibited signs of fluorosis. Thirty-six percent (n=444) had pit and fissure sealants in their teeth.

Table 5.1 Sociodemographic characteristics of study sample

Characteristics	Unweighted N	Unweighted %
Gender		
Male	614	49.24
Female	633	50.76
Geographic location		
Urban	528	42.34
Rural	719	57.66
Socioeconomic class		
Low	410	30.44
Lower middle	683	50.71
Upper middle	131	9.73
High	123	9.13
Country of Birth		
Canada	1224	98.63
Other	17	1.37
Primary language of instruction at school		
English	1105	88.61
French	142	11.39
Shared Service Area		
1	503	37.34
2	326	24.20
3	275	20.42
4	243	18.04
District Health Authority		
1	139	10.32
2	180	13.36
3	184	13.66
4	163	12.10
5	80	5.94
6	83	6.16
7	120	8.91
8	155	11.51
9	243	18.04

Table 5.2 Clinical characteristics of study sample/population

Characteristics	Unweighted N	Uweighted %	Weighted N	Weighted %
Fluorosis				
Present	99	8.15	1091.30	12.18
Absent	1115	91.85	7869.89	87.82
Sealants				
Present	444	35.61	3397.29	37.15
Absent	803	64.39	5746.70	62.85
Dental visit frequency				
> 1 times per year	745	57.44	5401.19	59.40
1 time per year	489	37.70	3317.43	36.48
< 1 times per year	39	3.01	245.60	2.70
For emergency care only	12	0.93	59.19	0.65
Never	12	0.93	70.23	0.77
Dental visit recency				
< 1 year ago	1137	87.80	8230.10	90.37
1 to < 2 years ago	107	8.26	592.49	6.51
2 to < 3 years ago	19	1.47	85.51	0.94
3 to < 4 years ago	8	0.62	57.38	0.63
4 to < 5 years ago	3	0.23	12.30	0.14
≥ 5 years ago	2	0.15	4.74	0.05
Never	19	1.47	124.91	1.37
Brushing frequency				
< 1 times per day	52	3.99	265.97	2.91
1 time per day	304	23.35	1828.15	19.99
> 1 times per day	946	72.66	7049.87	77.10
Flossing frequency				
< 1 times per day	1152	88.55	8187.96	89.62
≥ 1 times per day	149	11.45	948.53	10.38
Pain in the mouth in past year				
Present = often or sometimes	137	10.55	877.01	9.62
Absent = rarely or never	1162	89.45	8240.79	90.38
School time lost due to oral health problems				
Yes	47	7.83	383.71	9.39
No	553	92.17	3700.95	90.61

5.3 DENTAL CARIES PREVALENCE

Table 5.3 reports dental caries prevalence estimates for the primary, permanent and overall dentitions of the grade two school population in Nova Scotia.

The weighted overall prevalence rate of any dental caries experience (deft+DMFT > 0) among the seven to eight year olds was 57.3% (N=5242; 95% CI: 51.35 - 63.29). Forty-three percent (N=3902; 95% CI: 36.70 - 48.64) were found to be caries-free (deft+DMFT = 0) in their overall dentition. As children in the seven to eight year old age group typically tend to have most of their primary teeth and only a few erupted permanent teeth, caries in the primary dentition contributed predominantly to the overall caries prevalence estimates in this population. This may also explain the generally lower dental caries estimates in the permanent dentition compared to those observed in the primary dentition in this study.

The weighted prevalence of primary dentition caries experience (deft>0) was 55.3% (weighted N=5061; 95% CI: 49.42 - 61.27). Approximately 45% (weighted N=4083; 95% CI: 38.72 - 50.57) were found to be caries-free in the primary dentition (deft=0).

The weighted prevalence rate of permanent dentition caries experience (DMFT>0) was 14.2% (weighted N=1299; 95% CI: 11.23 - 17.19). Eighty-six percent (weighted N=7844; 95% CI: 82.80 - 88.76) were caries-free in their permanent dentition (DMFT=0).

5.4 DENTAL CARIES EXPERIENCE

Table 5.4 provides an overview of the dental caries experience for the seven to eight year old population in Nova Scotia.

The weighted mean deft (decayed, extracted or filled primary teeth) score was 2.58 ± 0.08 SE (95% CI: 2.41- 2.75). The weighted average DMFT (decayed, missing, or filled permanent teeth) score was estimated to be 0.26 ± 0.02 SE (95% CI: 0.22- 0.30).

5.5 DENTAL CARIES SEVERITY

Table 5.5 outlines the dental caries severity among the grade two school population in Nova Scotia.

The weighted average defs (decayed, extracted or filled primary teeth surfaces) score was 6.86 ± 0.28 SE (95% CI: 6.31- 7.42). The weighted mean DMFS (decayed, missing, or filled permanent teeth surfaces) score was found to be 0.47 ± 0.04 SE (95% CI: 0.39-0.56).

Table 5.3 Dental caries prevalence in seven to eight year old Nova Scotia children in 2006-07

	Unweighted N	Weighted N	Weighted %	95% Confidence Interval (weighted)
Overall Dentition				
No caries (deft + DMFT = 0)	442	3902.07	42.67	36.70 - 48.64
Any caries (deft + DMFT >0)	805	5241.92	57.32	51.35 - 63.29
Primary Dentition				
No caries (deft = 0)	460	4083.03	44.65	38.72 - 50.57
Any caries (deft > 0)	787	5060.96	55.34	49.42 - 61.27
Permanent Dentition				
No caries (DMFT = 0)	1050	7844.08	85.78	82.80 - 88.76
Any caries (DMFT > 0)	197	1299.91	14.22	11.23 - 17.19

Table 5.4 Dental caries experience in seven to eight year old Nova Scotia children in 2006-07

	Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
Primary Dentition (dft)	2.58	0.08	2.41 - 2.75
Permanent dentition (DMFT)	0.26	0.02	0.22 - 0.30

Table 5.5 Dental caries severity in seven to eight year old Nova Scotia children in 2006-07

	Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
Primary Dentition (defs)	6.86	0.28	6.31 - 7.42
Permanent dentition (DMFS)	0.47	0.04	0.39 - 0.56

5.6 DENTAL CARIES PREVALENCE BY GEOGRAPHIC LOCATION

Tables 5.6A, 5.6B and 5.6C provide estimates of dental caries prevalence by geographic (urban/rural) location.

The overall weighted prevalence rate of dental caries (deft+DMFT > 0) was 63.2% (95% CI: 59.22 - 67.13) among rural children compared to 54.3% (95% CI: 43.03 – 65.57) among children residing in urban areas.

Thirty-seven percent (95% CI: 32.86 – 40.77) of rural children were caries-free in both their primary and permanent dentitions (deft+DMFT = 0) versus 45.7% (95% CI: 34.42 – 56.96) of caries-free urban children.

When compared to urban children, the odds of having any dental caries in the overall dentition increased by over 40% in rural children (OR=1.44; 95% CI: 0.91-2.27). This result, however, was not statistically significant.

Likewise, while the primary dentition caries prevalence (deft>0) increased by 40% if children resided in rural versus urban areas, it was not significantly different between the two groups (OR: 1.40; 95% CI: 0.91-2.14). Thirty-nine percent (95% CI: 34.12 – 44.27) of rural children had caries-free primary dentition (deft=0) versus 47.5% (95% CI: 37.45 – 57.47) of urban children.

Approximately 15% (95% CI: 11.88 – 18.43) of children residing in rural areas had experienced permanent dentition caries (DMFT>0) compared to 13.7% (95% CI: 6.08 - 21.37) of urban children. 84.8% (95% CI: 81.56 – 88.11) of rural children were found to be caries-free in their permanent dentition caries (DMFT=0) compared to 86.3% (95% CI: 78.62 – 93.91) of their urban counterparts. The odds of having permanent

dentition caries were not significantly different in rural children when compared to those residing in urban localities (OR: 1.12; 95% CI: 0.58-2.14).

5.7 DENTAL CARIES EXPERIENCE BY GEOGRAPHIC LOCATION

Table 5.7 provides an overview of dental caries experience by geographic location. The weighted mean deft (decayed, extracted or filled primary teeth) score was 2.82 ± 0.11 SE (95% CI: 2.60 - 3.05) among rural children compared to 2.46 ± 0.13 SE (95% CI: 2.19 - 2.72) for urban children. The weighted average DMFT (decayed, missing, or filled permanent teeth) scores were also found to be similar in children residing in rural (0.25 ± 0.02 SE; 95% CI: 0.20 – 0.31) and urban areas (0.26 ± 0.03 SE; 95% CI: 0.20 – 0.33).

5.8 DENTAL CARIES SEVERITY BY GEOGRAPHIC LOCATION

Table 5.5 outlines the dental caries severity by geographic location. No statistically significant differences were observed in the weighted average defs (decayed, extracted or filled tooth surfaces) scores for the primary dentition between rural (7.79 ± 0.39 SE; 95% CI: 7.02 – 8.57) and urban children (6.38 ± 0.41 SE; 95% CI: 5.56 – 7.21).

Similar findings were observed with respect to the weighted mean DMFS (decayed, missing, filled permanent tooth surfaces) scores among rural (0.44 ± 0.05 SE; 95% CI: 0.34 – 0.55) and urban children (0.49 ± 0.06 SE; 95% CI: 0.35 – 0.62).

Table 5.6A Dental caries prevalence (Overall) by geographic (urban/rural) location

		Unweighted Frequency N	Weighted Frequency N	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	Urban	186	2756.26	45.69	34.42 – 56.96
2	Rural	256	1145.82	36.82	32.86 – 40.77
	Any Caries				
1	Urban	342	3275.74	54.31	43.03 – 65.57
2	Rural	463	1966.18	63.18	59.22 - 67.13

Odds Ratio (2 vs. 1): 1.44; 95% CI: 0.91-2.27

Table 5.6B Dental caries prevalence (Primary Dentition) by geographic (urban/rural) location

		Unweighted Frequency N	Weighted Frequency N	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	Urban	194	2863.11	47.47	37.45 – 57.47
2	Rural	266	1219.93	39.20	34.12 – 44.27
	Any Caries				
1	Urban	334	3168.89	52.53	42.52 – 62.54
2	Rural	453	1892.07	60.80	55.72 – 65.87

Odds Ratio (2 vs. 1): 1.40; 95% CI: 0.91-2.14

Table 5.6C Dental caries prevalence (Permanent Dentition) by geographic (urban/rural) location

		Unweighted Frequency N	Weighted Frequency N	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	Urban	435	5203.87	86.27	78.62 – 93.91
2	Rural	615	2640.22	84.84	81.56 – 88.11
	Any Caries				
1	Urban	93	828.133	13.73	6.08 - 21.37
2	Rural	104	471.782	15.16	11.88 – 18.43

Odds Ratio (2 vs. 1): 1.12; 95% CI: 0.58-2.14

Table 5.7 Dental caries experience by geographic (urban/rural) location

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (deft)			
1	Urban	2.46	0.13	2.19 - 2.72
2	Rural	2.82	0.11	2.60 - 3.05
	Permanent dentition (DMFT)			
1	Urban	0.26	0.03	0.20 - 0.33
2	Rural	0.25	0.02	0.20 - 0.31

Table 5.8 Dental caries severity by geographic (urban/rural) location

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (defs)			
1	Urban	6.38	0.41	5.56 - 7.21
2	Rural	7.79	0.39	7.02 - 8.57
	Permanent dentition (DMFS)			
1	Urban	0.49	0.06	0.35 - 0.62
2	Rural	0.44	0.05	0.34 - 0.55

5.9 DENTAL CARIES PREVALENCE BY DENTAL HEALTH CARE UTILIZATION

5.9.1 DENTAL CARIES PREVALENCE BY DENTAL VISIT FREQUENCY

Tables 5.9A, 5.9B and 5.9C provide an overview of dental caries prevalence by dental visit frequency.

The overall weighted prevalence of any dental caries ($\text{deft} + \text{DMFT} > 0$) was 80.2% (95% CI: 69.79 – 90.74) among children who visited a dentist less than once per year and 56% (95% CI: 41.79 – 70.30) among those who had a dental visit more than once per year, compared to 59.1% (95% CI: 55.96 – 62.22) among children who saw a dentist once per year.

Among those who had a dental visit less than once a year, 19.7% (95% CI: 9.25 – 30.20) were caries-free in their overall dentition ($\text{deft} + \text{DMFT} = 0$) versus 40.9% (95% CI: 37.77 – 44.03) caries-free children among those who had visited once per year, and 43.9% (95% CI: 29.69 – 58.20) caries-free children among those who had visited more than once a year.

In comparison with those children who had a dental visit once per year, the odds of having any dental caries in the overall dentition increased almost three times in those who visited the dentist less frequently (OR: 2.81; 95% CI: 1.48-5.35), while there was no statistically significant difference observed in those who visited more than once per year (OR: 0.88; 95% CI: 0.49-1.56).

The weighted prevalence of primary dentition caries experience ($\text{deft} > 0$) was 77.6% (95% CI: 66.42 – 88.71) among children who visited a dentist less than once a year and 53.2% (95% CI: 40.30 – 66.04) among those who had a dental visit more than

once a year, compared to 58.7% (95% CI: 55.46 – 61.84) among children who saw a dentist once a year.

Among those with a dental visit frequency of less than once per year, twenty-two percent (95% CI: 11.28 – 33.57) were caries-free in their primary dentition (deft=0) versus 41.3% (95% CI: 38.15 – 44.53) among those who had visited once per year, and 46.8% (95% CI: 33.95 – 59.69) among those who had visited more than once per year.

When compared to those children who had a dental visit once per year, the odds of having primary dentition caries increased by more than twice in those who visited the dentist less frequently (OR: 2.43; 95% CI: 1.30- 4.54), while there was no statistically significant difference in those who visited more than once per year (OR: 0.80; 95% CI: 0.47-1.34).

The weighted prevalence of permanent dentition caries experience (DMFT>0) was 17.4% (95% CI: 8.07 – 26.68) among children who visited a dentist less than once a year and 16.7% (95% CI: 9.60 – 23.78) among those who had a dental visit more than once a year, compared to 9.9% (95% CI: 6.10 – 13.72) among children who saw a dentist once a year.

Eighty-three percent (95% CI: 73.31 – 91.92) of those who had a dental visit less than once a year were caries-free in their permanent dentition (DMFT=0) versus 83.3% (95% CI: 76.21 – 90.39) among those who had visited more than once a year and 90% (95% CI: 86.27 – 93.89) among those who had visited once per year.

When compared to those children who had had a dental visit once per year, the odds of experiencing permanent dentition caries increased by almost two times

in those who had visited more often (OR: 1.82; 95% CI: 1.20 – 2.74). Similarly, the odds of having caries in the permanent dentition increased by about two times in those who visited the dentist less than once per year (OR: 1.91; 95% CI: 0.85 – 4.26), but this finding was not statistically significant.

5.9.2 DENTAL CARIES PREVALENCE BY DENTAL VISIT RECENCY

Tables 5.9D, 5.9E and 5.9F provide an overview of dental caries prevalence by dental visit recency.

The overall weighted prevalence of any dental caries experience (deft+DMFT > 0) was 65% (95% CI: 53.69 – 76.38) among children who visited a dentist between one to less than two years ago and 70.6% (95% CI: 59.07 – 82.11) among those who had a dental visit two or more years ago, compared to 56.8% (95% CI: 47.56 – 66.08) among children who had seen a dentist within the past year.

Forty-three percent (95% CI: 33.91 – 52.43) of those who had a dental visit less than a year ago were caries-free in their overall dentition (deft+DMFT = 0) versus 35% (95% CI: 23.61 – 46.30) caries-free children among those who had visited between one to less than two years ago, and 29.4% (95% CI: 17.88 – 40.92) caries-free children among those who had visited two or more years ago.

The odds of having any dental decay in the overall dentition were 40% higher in those who had a dental visit between one to less than two years (OR: 1.41; 95% CI: 0.78 – 2.54) and were about 80% higher in those that had a dental visit two or more years ago (OR: 1.82; 95% CI: 0.97 – 3.41), when compared to those children who had seen a dentist within the past year. However, these results were not statistically significant.

In the primary dentition, prevalence of dental caries ($deft>0$) was 65% (95% CI: 53.69 – 76.38) among children who had visited a dentist one to less than two years ago and 67.3% (95% CI: 55.49 – 79.09) among those who had a dental visit two or more years ago, compared to 54.8% (95% CI: 46.50 – 63.02) among children who saw a dentist within the past year.

Forty-five percent (95% CI: 36.97 – 53.49) of those who had a dental visit less than a year ago were caries-free in their primary dentition ($deft=0$) versus 35% (95% CI: 23.6 – 46.30) caries-free children among those who had visited between one to less than two years ago, and 32.7% (95% CI: 20.90 – 44.50) caries-free children among those who had visited two or more years ago.

When compared to those children who had seen a dentist within the past year, the odds of having primary dentition decay increased by about 50% in those had a dental visit between one to less than two years ago, but this was not statistically significant (OR: 1.53; 95% CI: 0.87 – 2.69). Likewise, in those that had a dental visit two or more years ago, the odds increased by about 70%, but this did not show statistical significance (OR: 1.69; 95% CI: 0.94 – 3.06).

In the permanent dentition, prevalence of dental decay ($DEFT>0$) was 6.1% (95% CI: 1.41 – 10.83) among children who visited a dentist one to less than two years ago and 23.2% (95% CI: 13.49 – 32.86) among those who had a dental visit two or more years ago, compared to 14.2% (95% CI: 8.36 – 20.06) among children who saw a dentist within the past year.

Eighty-six percent (95% CI: 79.93 – 91.63) of those who had a dental visit less than a year ago were caries-free in their permanent dentition ($DEFT=0$) versus 93.9%

(95% CI: 89.16 – 98.58) among those who had visited between one to less than two years ago, and 76.8% (95% CI: 67.13 – 86.50) caries-free children among those who had visited two or more years ago.

When compared to those who had seen a dentist within the past year, the odds of having permanent dentition caries decreased significantly (OR: 0.39; 95% CI: 0.15 – 0.98) in those had a dental visit between one to less than two years ago. For those that had a dental visit two or more years ago, while the odds increased by almost 80%, this was not significantly different from those who had been to a dentist less than a year ago (OR: 1.82; 95% CI: 0.93 – 3.53).

Table 5.9A Dental caries prevalence (Overall) by dental visit frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< once a year	16	66.64	19.73	9.25 – 30.20
2	once a year	178	1298.43	40.91	37.77 – 44.03
3	> once a year	230	2297.3	43.95	29.69 – 58.20
Any Caries					
1	< once a year	42	271.08	80.27	69.79 – 90.74
2	once a year	269	1875.73	59.09	55.96 – 62.22
3	> once a year	463	2929.78	56.05	41.79 – 70.30

Odds Ratio (3 vs. 2): 0.88; 95% CI: 0.49-1.56

Odds Ratio (1 vs. 2): 2.81; 95% CI: 1.48-5.35

Table 5.9B Dental caries prevalence (Primary Dentition) by dental visit frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< once a year	17	75.74	22.43	11.28 – 33.57
2	once a year	181	1312.32	41.34	38.15 – 44.53
3	> once a year	243	2447.35	46.82	33.95 – 59.69
Any Caries					
1	< once a year	41	261.98	77.57	66.42 – 88.71
2	once a year	266	1861.84	58.66	55.46 – 61.84
3	> once a year	450	2779.72	53.18	40.30 – 66.04

Odds Ratio (3 vs. 2): 0.80; 95% CI: 0.47-1.34
Odds Ratio (1 vs. 2): 2.43; 95% CI: 1.30- 4.54

Table 5.9C. Dental caries prevalence (Permanent Dentition) by dental visit frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< once a year	51	279.04	82.62	73.31 – 91.92
2	once a year	386	2859.42	90.08	86.27 – 93.89
3	> once a year	573	4354.49	83.31	76.21 – 90.39
Any Caries					
1	< once a year	7	58.69	17.38	8.07 – 26.68
2	once a year	61	314.74	9.92	6.10 – 13.72
3	> once a year	120	872.58	16.69	9.60 – 23.78

Odds Ratio (3 vs. 2): 1.82; 95% CI: 1.20 – 2.74

Odds Ratio (1 vs. 2): 1.91; 95% CI: 0.85 – 4.26

Table 5.9D Dental caries prevalence (Overall) by dental visit recency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	< 1 year ago	376	3433.37	43.17	33.91 – 52.43
2	1 to <2 yrs ago	35	181.69	34.96	23.61 – 46.30
3	≥2 years ago	14	81.12	29.41	17.88 – 40.92
	Any Caries				
1	< 1 year ago	676	4518.95	56.83	47.56 – 66.08
2	1 to <2 yrs ago	62	338.03	65.04	53.69 – 76.38
3	≥2 years ago	33	194.75	70.59	59.07 – 82.11

Odds Ratio (2 vs. 1): 1.41; 95% CI: 0.78 – 2.54

Odds Ratio (3 vs. 1): 1.82; 95% CI: 0.97 – 3.41

Table 5.9E Dental caries prevalence (Primary Dentition) by dental visit recency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	< 1 year ago	392	3597.32	45.24	36.97 – 53.49
2	1 to <2 yrs ago	35	181.69	34.96	23.6 – 46.30
3	≥2 years ago	15	90.22	32.71	20.90 – 44.50
	Any Caries				
1	< 1 year ago	660	4355.01	54.76	46.50 – 63.02
2	1 to <2 yrs ago	62	338.03	65.04	53.69 – 76.38
3	≥2 years ago	32	185.65	67.29	55.49 – 79.09

Odds Ratio (2 vs. 1): 1.53; 95% CI: 0.87 – 2.69

Odds Ratio (3 vs. 1): 1.69; 95% CI: 0.94 – 3.06

Table 5.9F Dental caries prevalence (Permanent Dentition) by dental visit recency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< 1 year ago	885	6821.83	85.78	79.93 – 91.63
2	1 to <2 yrs ago	88	487.89	93.88	89.16 – 98.58
3	≥2 years ago	38	211.94	76.82	67.13 – 86.50
Any Caries					
1	< 1 year ago	167	1130.5	14.22	8.36 – 20.06
2	1 to <2 yrs ago	9	31.82	6.12	1.41 – 10.83
3	≥2 years ago	9	63.93	23.18	13.49 – 32.86

Odds Ratio (2 vs. 1): 0.39; 95% CI: 0.15 – 0.98

Odds Ratio (3 vs. 1): 1.82; 95% CI: 0.93 – 3.53

5.10 DENTAL CARIES EXPERIENCE BY DENTAL HEALTH CARE UTILIZATION

5.10.1 DENTAL CARIES EXPERIENCE BY DENTAL VISIT FREQUENCY

Table 5.10A represents the dental caries experience by dental visit frequency. The weighted mean deft (decayed, extracted or filled primary teeth) score was higher (4.50 ± 0.50 SE; 95% CI: 3.49 – 5.51) among children who visited a dentist less than once a year and slightly lower (2.33 ± 0.10 SE; 95% CI: 2.12 – 2.54) among those who had a dental visit more than once a year, compared to that among children who saw a dentist once a year (2.89 ± 0.15 SE; 95% CI: 2.58 – 3.20). The differences between the groups were statistically significant.

The weighted average DMFT (decayed, missing, or filled permanent teeth) score was estimated to be 0.29 ± 0.10 SE (95% CI: 0.08 – 0.49) among children who visited a dentist less than once a year and 0.30 ± 0.03 SE (95% CI: 0.24 – 0.36) among those who had a dental visit more than once a year, compared to 0.19 ± 0.03 SE (95% CI: 0.13 – 0.25) among children who saw a dentist once a year. No significant differences were observed in the means between the three groups.

5.10.2 DENTAL CARIES EXPERIENCE BY DENTAL VISIT RECENCY

Table 5.10B provides an overview of dental caries experience by dental visit recency. The weighted mean deft score for the primary dentition was higher (3.53 ± 0.37 SE; 95% CI: 2.78 – 4.28) in children who visited a dentist one to less than two years ago and in those who had a dental visit two or more years ago (3.33 ± 0.46 SE; 95% CI: 2.39 – 4.27), compared to that among children who saw a dentist within the past year (2.52 ± 0.09 SE; 95% CI: 2.34 – 2.70). The difference in primary dentition caries experience between the three groups approached statistical significance.

With respect to the weighted average DMFT score for the permanent dentition, no significant differences were observed between the three groups ('one to less than two years ago' group: 0.10 ± 0.04 SE; 95% CI: 0.008 – 0.20 vs. 'two or more years ago' group: 0.34 ± 0.11 SE; 95% CI: 0.12 – 0.56 vs. 'within the past year' group: 0.27 ± 0.02 SE; 95% CI: 0.22 – 0.31).

Table 5.10A Dental caries experience by dental visit frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
Primary Dentition (deft)				
1	< once a year	4.50	0.50	3.49 - 5.51
2	once a year	2.89	0.15	2.58 - 3.20
3	> once a year	2.33	0.10	2.12 - 2.54
Permanent dentition (DMFT)				
1	< once a year	0.29	0.10	0.08 - 0.49
2	once a year	0.19	0.03	0.13 - 0.25
3	> once a year	0.30	0.03	0.24 - 0.36

Table 5.10B Dental caries experience by dental visit recency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (deft)			
1	< 1 year ago	2.52	0.09	2.34 - 2.70
2	1 to <2 yrs ago	3.53	0.37	2.78 - 4.28
3	≥2 years ago	3.33	0.46	2.39 - 4.27
	Permanent dentition (DMFT)			
1	< 1 year ago	0.27	0.02	0.22 - 0.31
2	1 to <2 yrs ago	0.10	0.04	0.008 - 0.20
3	≥2 years ago	0.34	0.11	0.12 - 0.56

5.11 DENTAL CARIES SEVERITY BY DENTAL HEALTH CARE UTILIZATION

5.11.1 DENTAL CARIES SEVERITY BY DENTAL VISIT FREQUENCY

Table 5.11A outlines the dental caries severity by dental visit frequency. The weighted average defs (decayed, extracted or filled primary teeth surfaces) score was greater (11.03 ± 1.51 SE; 95% CI: 8.00 – 14.05) in children who visited a dentist less than once a year and lesser among those who had a dental visit more than once a year (6.02 ± 0.34 SE; 95% CI: 5.35 – 6.69), compared to that observed in children who saw a dentist once a year (8.07 ± 0.52 SE; 95% CI: 7.03 – 9.10). The difference in the means between the three groups was statistically significant.

The weighted average DMFS (decayed, missing, filled permanent teeth surfaces) score was estimated to be higher (0.74 ± 0.23 SE; 95% CI: 0.26 – 1.21) among children who visited a dentist less than once a year and in those who had a dental visit more than once a year (0.56 ± 0.06 SE; 95% CI: 0.43 – 0.68), compared to that observed in children who saw a dentist once a year (0.29 ± 0.05 SE; 95% CI: 0.19 – 0.39). The difference in the means between the three groups was found to be statistically significant.

5.11.2 DENTAL CARIES SEVERITY BY DENTAL VISIT RECENCY

Table 5.11B provides an overview of the dental caries severity by dental visit recency. The weighted mean defs score for the primary dentition was higher (8.84 ± 1.10 SE; 95% CI: 6.65 – 11.02) in children who visited a dentist one to less than two years ago and in those who had a dental visit two or more years ago (7.97 ± 1.39 SE; 95% CI: 5.16 – 10.78), compared to that in children who saw a dentist within the past year (6.77 ± 0.30 SE; 95% CI: 6.17 – 7.37). However, there were no statistically significant differences in caries severity when the three groups were compared.

The weighted average DMFS score for the permanent dentition was estimated to be 0.19 ± 0.09 SE (95% CI: 0.006 – 0.37) in children who visited a dentist one to less than two years ago and 0.86 ± 0.26 SE (95% CI: 0.32 – 1.40) in those who had a dental visit two or more years ago, compared to 0.46 ± 0.04 SE (95% CI: 0.37 – 0.56) among children who saw a dentist within the past year. The difference in caries severity between the three groups was not statistically significant.

Table 5.11A Dental caries severity by dental visit frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
Primary Dentition (defs)				
1	< once a year	11.03	1.51	8.00 - 14.05
2	once a year	8.07	0.52	7.03 - 9.10
3	> once a year	6.02	0.34	5.35 - 6.69
Permanent dentition (DMFS)				
1	< once a year	0.74	0.23	0.26 - 1.21
2	once a year	0.29	0.05	0.19 - 0.39
3	> once a year	0.56	0.06	0.43 - 0.68

Table 5.11B Dental caries severity by dental visit recency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (defs)			
1	< 1 year ago	6.77	0.30	6.17 - 7.37
2	1 to <2 yrs ago	8.84	1.10	6.65 - 11.02
3	≥2 years ago	7.97	1.39	5.16 - 10.78
	Permanent dentition (DMFS)			
1	< 1 year ago	0.46	0.04	0.37 - 0.56
2	1 to <2 yrs ago	0.19	0.09	0.006 - 0.37
3	≥2 years ago	0.86	0.26	0.32 - 1.40

5.12 DENTAL CARIES PREVALENCE BY ORAL HYGIENE PRACTICES

5.12.1 DENTAL CARIES PREVALENCE BY TOOTH BRUSHING FREQUENCY

Tables 5.12A, 5.12B and 5.12C represent the dental caries prevalence by tooth brushing frequency.

The overall weighted prevalence of any dental caries (deft+DMFT > 0) was 69.5% (95% CI: 60.02 – 77.87) among children who brushed their teeth less than once per day and 74.7% (95% CI: 65.34 – 82.26) among those who brushed once a day compared to 53.2% (95% CI: 43.74 – 63.06) among children who brushed more frequently (i.e. more than once per day).

Thirty-one percent (95% CI: 22.13 – 39.98) of those who brushed less than once per day were caries-free in both their overall dentition (deft+DMFT = 0) versus 25.3% (95% CI: 17.74 – 34.66) of those who brushed once per day and 46.7% (95% CI: 36.94 – 56.26) of those who brushed more frequently.

The odds of having caries in the overall dentition increased two-fold (OR: 1.99; 95% CI: 1.50- 2.63) in children who did not brush their teeth daily and increased almost 2.6 times (OR: 2.58; 95% CI: 2.29- 2.91) in those who brushed only once per day, when compared to children who brushed more frequently.

In the primary dentition, weighted prevalence of dental decay experience (deft>0) was 65.6% (95% CI: 55.85 – 74.27) among children who brushed their teeth less than one time per day and 74.5% (95% CI: 67.49 – 81.53) in those who brushed once per day, compared to 50.9% (95% CI: 41.27 – 60.67) in children who brushed more often.

Among those who brushed less than once per day, 34.4% (95% CI: 25.73 – 44.15) were caries-free in their primary dentition (deft=0) versus 25.5% (95% CI: 18.46

– 32.50) of those who brushed once per day, and 49% (95% CI: 39.32 – 58.72) of those who brushed more frequently.

The odds of having primary tooth decay increased by about two times (OR: 1.84; 95% CI: 1.40 - 2.41) in children who did not brush their teeth on a daily basis and increased almost three-fold (OR: 2.80; 95% CI: 2.49 - 3.16) in those who brushed once a day, when compared to children who brushed more often.

In the permanent dentition, the weighted prevalence of dental decay experience (DMFT>0) was 15.8% (95% CI: 9.43 - 23.53) among children who brushed less than once per day and 16.7% (95% CI: 10.66 – 22.50) among those who brushed once per day compared to 13.5% (95% CI: 7.35 – 19.73) among children who brushed more than once per day.

Of those who brushed less than once per day, 84.2% (95% CI: 76.47 – 90.57) were caries-free in their permanent dentition (DMFT=0), versus 83.3% (95% CI: 77.49 – 89.33) among those who brushed once a day, and 86.5% (95% CI: 80.26 – 92.64) among those who brushed more frequently.

When compared to children who brushed more than once per day, the odds of experiencing caries in permanent teeth increased by 20% (OR: 1.20; 95% CI: 0.84 - 1.71) in children who did not brush their teeth every day, although this was not found to be statistically significant. Similarly, the odds increased by 30% (OR: 1.28; 95% CI: 1.11 - 1.48) in those who brushed only once a day, when compared to children who brushed more often. These results did not approach statistical significance either.

5.12.2 DENTAL CARIES PREVALENCE BY FLOSSING FREQUENCY

Tables 5.12D, 5.12E and 5.12F outline the dental caries prevalence by frequency of flossing.

The overall weighted prevalence of any dental caries (deft+DMFT >0) was 56.5% (95% CI: 46.74 – 65.68) among children who flossed their teeth less than one time per day versus 69.3% (95% CI: 59.01 – 79.68) among those who flossed at least once per day.

Thirty-one percent (95% CI: 20.31 – 40.98) of those who flossed at least once per day were caries-free in their overall dentition (deft+DMFT = 0) versus 43.5% (95% CI: 34.31 – 53.25) of those who flossed less frequently.

The odds of having dental decay in the overall dentition were not significantly different in children who flossed less than once a day (OR: 0.56; 95% CI: 0.29 – 1.07) compared to those who flossed one or more times a day.

The weighted prevalence of primary dentition decay experience (deft>0) was 55.4% (95% CI: 45.92 – 64.41) among children who flossed their teeth less than once a day compared to 59.6% (95% CI: 49.50 – 69.89) in children who flossed more often.

Among those who flossed one or more times a day, 40.4% (95% CI: 30.10 – 50.49) were caries-free in their primary dentition (deft=0), versus 44.6% (95% CI: 35.58 – 54.07) among those who flossed less frequently.

There were no significant differences in the prevalence of primary dentition decay between children who flossed less than once a day (OR: 0.83; 95% CI: 0.42 – 1.62) and those who flossed one or more times a day.

The weighted prevalence of permanent dentition decay experience (DMFT>0) was 12.8% (95% CI: 7.39 – 17.84) among children who flossed their teeth less than once per day, compared to 25.82% (95% CI: 15.17 – 36.32) among those who flossed more often.

Of those who flossed at least once a day, 74.2% (95% CI: 63.67 – 84.82) were found to be caries-free in their permanent dentition (DMFT=0), versus 87.2% (95% CI: 82.15 – 92.60) among those who flossed less frequently.

When compared to those who flossed one or more times a day, the odds of experiencing permanent dentition decay were significantly lower in children who flossed less than once a day compared to those who flossed one or more times per day (OR: 0.41; 95% Wald's CI: 0.21 – 0.79).

Table 5.12A Dental caries prevalence (Overall) by tooth brushing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	< 1 times per day	15	72.76	30.54	22.13 – 39.98
2	1 time per day	76	425.05	25.31	17.74 – 34.66
3	> 1 times per day	337	3208.66	46.73	36.94 – 56.26
	Any Caries				
1	< 1 times per day	32	165.49	69.46	60.02 – 77.87
2	1 time per day	202	1254.2	74.69	65.34 – 82.26
3	> 1 times per day	540	3657.11	53.27	43.74 – 63.06

Odds Ratio (1 vs. 3): 1.99; 95% CI: 1.50 - 2.63

Odds Ratio (2 vs. 3): 2.58; 95% CI: 2.29 - 2.91

Table 5.12B Dental caries prevalence (Primary Dentition) by tooth brushing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< 1 times per day	16	81.86	34.36	25.73 – 44.15
2	1 time per day	78	428.92	25.54	18.46 – 32.50
3	> 1 times per day	351	3369	49.07	39.32 – 58.72
Any Caries					
1	< 1 times per day	31	156.39	65.64	55.85 – 74.27
2	1 time per day	200	1250.34	74.46	67.49 – 81.53
3	> 1 times per day	526	3497.03	50.93	41.27 – 60.67

Odds Ratio (1 vs. 3): 1.84; 95% CI: 1.40 - 2.41

Odds Ratio (2 vs. 3): 2.80; 95% CI: 2.49 - 3.16

Table 5.12C Dental caries prevalence (Permanent Dentition) by tooth brushing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< 1 times per day	40	200.56	84.18	76.47 – 90.57
2	1 time per day	233	1398.36	83.27	77.49 – 89.33
3	> 1 times per day	741	5938.35	86.49	80.26 – 92.64
Any Caries					
1	< 1 times per day	7	37.69	15.82	9.43 - 23.53
2	1 time per day	45	280.89	16.73	10.66 – 22.50
3	> 1 times per day	136	927.41	13.51	7.35 – 19.73

Odds Ratio (1 vs. 3): 1.20; 95% CI: 0.84 - 1.71

Odds Ratio (2 vs. 3): 1.28; 95% CI: 1.11 - 1.48

Table 5.12D Dental caries prevalence (Overall) by flossing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	< 1 times per day	393	3436.65	43.52	34.31 – 53.25
2	≥ 1 times per day	35	269.82	30.72	20.31 – 40.98
	Any Caries				
1	< 1 times per day	674	4460.91	56.48	46.74 – 65.68
2	≥ 1 times per day	99	608.39	69.28	59.01 – 79.68

Odds Ratio (1 vs. 2): 0.56; 95% CI: 0.29 – 1.07

Table 5.12E Dental caries prevalence (Primary Dentition) by flossing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
	No Caries				
1	< 1 times per day	405	3524.7	44.63	35.58 – 54.07
2	≥ 1 times per day	40	354.82	40.40	30.10 – 50.49
	Any Caries				
1	< 1 times per day	662	4372.86	55.37	45.92 – 64.41
2	≥ 1 times per day	94	523.40	59.60	49.50 – 69.89

Odds Ratio (1 vs. 2): 0.83; 95% CI: 0.42 – 1.62

Table 5.12F Dental caries prevalence (Permanent Dentition) by flossing frequency

		Unweighted Frequency (n)	Weighted Frequency (N)	Weighted %	95% Confidence Interval (Weighted)
No Caries					
1	< 1 times per day	908	6885.77	87.19	82.15 – 92.60
2	≥ 1 times per day	106	651.50	74.18	63.67 – 84.82
Any Caries					
1	< 1 times per day	159	1011.79	12.81	7.39 – 17.84
2	≥ 1 times per day	28	226.72	25.82	15.17 – 36.32

Odds Ratio (1 vs. 2): 0.41; 95% CI: 0.21 – 0.79

5.13 DENTAL CARIES EXPERIENCE BY ORAL HYGIENE PRACTICES

5.13.1 DENTAL CARIES EXPERIENCE BY TOOTH BRUSHING FREQUENCY

Table 5.13A provides an overview of the dental caries experience by dental visit frequency.

The weighted average deft (decayed, extracted or filled primary teeth) score was greater (3.29 ± 0.47 SE; 95% CI: 2.33 – 4.24) among children who did not brush their teeth at least once a day and among those who brushed only once a day (3.89 ± 0.20 SE; 95% CI: 3.49 – 4.30), compared to that observed in children who brushed more often (2.26 ± 0.09 SE; 95% CI: 2.07 – 2.46). The difference in the means between the three groups was statistically significant.

The weighted mean DMFT (decayed, missing, or filled permanent teeth) score was estimated to be 0.20 ± 0.08 SE (95% CI: 0.03 – 0.37) among children who brushed less than once per day and 0.31 ± 0.04 SE (95% CI: 0.21 – 0.40) among those who brushed once a day, compared to 0.25 ± 0.02 SE (95% CI: 0.20 – 0.30) among children who brushed more frequently. There were no statistically significant differences in permanent dentition caries experience between the three groups.

5.13.2 DENTAL CARIES EXPERIENCE BY FLOSSING FREQUENCY

Table 5.13B represents dental caries experience by flossing frequency. The weighted average deft score for the primary dentition in children who did not floss their teeth daily was similar to that observed among those who flossed at least once per day (2.56 ± 0.09 SE, 95% CI: 2.38 – 2.75 vs. 2.97 ± 0.27 SE, 95% CI: 2.42 – 3.52).

Likewise, the weighted mean DMFT scores for the permanent dentition, were not found to be significantly different in children who did not floss daily versus

those who flossed one or more times a day (0.25 ± 0.02 SE, 95% CI: 0.20 – 0.29 vs. 0.34 ± 0.05 SE, 95% CI: 0.22 – 0.45).

Table 5.13A Dental caries experience by tooth brushing frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (deft):			
1	< 1 times per day	3.29	0.47	2.33 - 4.24
2	1 time per day	3.89	0.20	3.49 - 4.30
3	> 1 times per day	2.26	0.09	2.07 - 2.46
	Permanent dentition (DMFT):			
1	< 1 times per day	0.20	0.08	0.03 - 0.37
2	1 time per day	0.31	0.04	0.21 - 0.40
3	> 1 times per day	0.25	0.02	0.20 - 0.30

Table 5.13B Dental caries experience by flossing frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (deft):			
1	< 1 times per day	2.56	0.09	2.38 - 2.75
2	≥ 1 times per day	2.97	0.27	2.42 - 3.52
	Permanent dentition (DMFT):			
1	< 1 times per day	0.25	0.02	0.20 - 0.29
2	≥ 1 times per day	0.34	0.05	0.22 - 0.45

5.14 DENTAL CARIES SEVERITY BY ORAL HYGIENE PRACTICES

5.14.1 DENTAL CARIES SEVERITY BY TOOTH BRUSHING FREQUENCY

Table 5.14A outlines the dental caries severity by dental visit frequency. The weighted average deft (decayed, extracted or filled primary teeth) score was greater (8.52 ± 1.55 SE; 95% CI: 5.38 – 11.65) among children who did not brush their teeth at least once a day and in those who brushed once a day (11.03 ± 0.72 SE; 95% CI: 9.60 – 12.47), compared to children who brushed more often (5.86 ± 0.30 SE; 95% CI: 5.26 – 6.47). The difference in primary dentition caries severity between the three groups was statistically significant.

The weighted mean DMFT (decayed, missing, or filled permanent teeth) score was estimated to be 0.27 ± 0.10 SE (95% CI: 0.05 – 0.48) among children who brushed less than once per day and 0.59 ± 0.11 SE (95% CI: 0.37 – 0.81) among those who brushed once a day, compared to 0.44 ± 0.04 SE (95% CI: 0.34 – 0.54) among children who brushed more frequently.

5.14.2 DENTAL CARIES SEVERITY BY FLOSSING FREQUENCY

Table 5.14B represents dental caries severity by flossing frequency. The weighted average deft score for the primary dentition was 6.74 ± 0.30 SE (95% CI: 6.15 – 7.34) in children who did not floss daily, compared to 8.58 ± 0.94 SE (95% CI: 6.72 – 10.44) among those who flossed at least once per day. However, this difference between the two groups was not statistically significant.

The weighted mean DMFT score for the permanent dentition was estimated to be 0.44 ± 0.04 SE (95% CI: 0.34 – 0.53) in children who did not floss daily, compared to 0.70 ± 0.13 SE (95% CI: 0.43 – 0.96) among those who flossed one or more

times a day. This difference in the caries severity between the two groups was not statistically significant.

Table 5.14A Dental caries severity by tooth brushing frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
	Primary Dentition (defs):			
1	< 1 times per day	8.52	1.55	5.38 - 11.65
2	1 time per day	11.03	0.72	9.60 - 12.47
3	> 1 times per day	5.86	0.30	5.26- 6.47
	Permanent dentition (DMFS):			
1	< 1 times per day	0.27	0.10	0.05 - 0.48
2	1 time per day	0.59	0.11	0.37 - 0.81
3	> 1 times per day	0.44	0.04	0.34 - 0.54

Table 5.14B Dental caries severity by flossing frequency

		Mean (Weighted)	Standard Error (Weighted)	95% Confidence Interval (Weighted)
Primary Dentition (defs):				
1	< 1 times per day	6.74	0.30	6.15 - 7.34
2	≥ 1 times per day	8.58	0.94	6.72 - 10.44
Permanent dentition (DMFS):				
1	< 1 times per day	0.44	0.04	0.34 - 0.53
2	≥ 1 times per day	0.70	0.13	0.43 - 0.96

CHAPTER SIX: DISCUSSION

The purpose of this study was to report the overall dental caries prevalence, experience and severity among the seven to eight year old child population in Nova Scotia, Canada. This study also aimed to investigate disparities in dental caries in these children by geographic (urban/rural) location, dental health care utilization and oral hygiene practices. This study appears to be the first to report findings on the oral health status of the grade two school population across the province since the 1995-96 Nova Scotia Oral Health Survey of Children and Adolescents (NSOHS) (49). The data for this research study were derived from the 2006 FMSEI (*Evaluation of the Fluoride Mouth Rinse School Eligibility Index and Baseline Information for Oral Health Programs*) provincial survey (23).

The results are presented as weighted estimates to be representative of the entire population. As children in the seven to eight year old age group typically tend to have most of their primary teeth and only a few erupted permanent teeth, caries in the primary dentition contributed predominantly to the overall caries prevalence estimates in this population. This may also explain the generally lower dental caries estimates in the permanent dentition compared to those observed in the primary teeth in this study.

Comparisons will be drawn with the results of the most recent nation-wide 2007-09 Canadian Health Measures Survey (CHMS) (3b), as well as with the last published 1995-96 province-wide Nova Scotia Oral Health Survey of Children and Adolescents (NSOHS) (49). The CHMS reported national estimates of caries prevalence and experience for various age groups including the six to 11 year old cohort (3b). This age group, although slightly broader than that in the current study (seven to eight year

old), was the sole basis for comparison of the results of this study with the most recent national estimates. For similar reasons, the results of this study will be compared with those reported for the six to seven year old age group in the NSOHS (49).

Analyses revealed that over half (57.3%) of the seven to eight year old Nova Scotia population was afflicted by dental caries in their overall dentition. This was almost the same as the overall caries prevalence estimate (56.8%) for the six to 11 year old Canadian population in 2007-09 (3b), and lower than that observed in the six to seven year old Nova Scotia children in 1995-96 (69.4%) (49).

Approximately 55% of children in this study were found to have experienced caries in their primary teeth. This is slightly higher than the national estimate of 48% in 2007-09 (3b). Prevalence of permanent dentition caries was estimated to be lower (14%) in this study when compared to the national estimate (24%) (3b).

Dental caries experience in the primary dentition, represented by the mean deft score was estimated to be 2.58 ± 0.08 SE. This was higher than the Canadian average (mean deft=1.99) for the six to 11 year old population (3b), and almost the same as that observed in the six to seven year old Nova Scotia children in 1995-96 (mean dmft=2.4) (49). In the permanent dentition, the mean DMFT score was slightly lower (0.26 ± 0.02 SE) than the recent national average (mean DMFT=0.49) for six to 11 year olds (3b).

Dental caries severity represented by the mean defs score was 6.86 ± 0.28 SE in this study, which was practically the same (mean dmfs=6.7) as that noticed among the six to seven year olds in the 1995-96 NSOHS (49). The average DMFS score was 0.47 ± 0.04 SE.

Disparities in dental caries were explored by urban versus rural location. Dental caries was prevalent in a majority (63.2%) of the rural children. A little over half (54.3%) of the urban-dwelling seven to eight year olds were diagnosed as having experienced dental caries. No statistically significant differences were found between urban and rural children in dental caries prevalence, experience or severity.

In terms of dental care utilization, a majority (weighted: 90%) of the seven to eight year old child population in this study had visited an oral health professional within the past year, similar to that reported in the six to 11 year old national cohort (74.5%) in the CHMS (3b). When compared to children who had a dental visit once per year, those who visited the dentist less often were almost three times more likely (OR: 2.81; 95% CI: 1.48-5.35) to experience dental caries. This finding is similar to that reported for the six to seven year old children in the province in the 1995-96 NSOHS (49).

Similarly, compared to those children who were reported to have had a dental visit once per year in this study, those who visited less frequently were more than twice as likely (OR: 2.43; 95% CI: 1.30- 4.54) to have experienced caries in their primary dentition. By contrast, in the permanent dentition, those who had a dental visit more than once per year were twice as likely (OR: 1.82; 95% CI: 1.20 – 2.74) to experience dental caries, when compared to those children who had a dental visit once per year. A possible explanation for this might be increased dental health care utilization by children with caries.

Caries experience in the primary teeth (mean deft score) was higher (4.50 \pm 0.50 SE; 95% CI: 3.49 – 5.51) in children with less frequent dental visits (fewer than

once per year), and slightly lower in those who had more frequent dental visits (2.33 ± 0.10 SE; 95% CI: 2.12 – 2.54), when compared to those who saw a dentist once a year (2.89 ± 0.15 SE; 95% CI: 2.58 - 3.20). The differences in the means between the three groups were statistically significant.

Caries severity in the primary dentition (mean defs score) was greater (11.03 ± 1.51 SE; 95% CI: 8.00 – 14.05) in children with less frequent dental visits (fewer than once per year) and lesser among those who had a dental visit more than once a year (6.02 ± 0.34 SE; 95% CI: 5.35 – 6.69), compared to that observed in children who saw a dentist once a year (8.07 ± 0.52 SE; 95% CI: 7.03 – 9.10). The difference in the means between the three groups was statistically significant.

Dental decay severity in the permanent dentition (mean DMFS score) was estimated to be higher (0.74 ± 0.23 SE; 95% CI: 0.26 – 1.21) among children who visited a dentist less than once a year and in those who had a dental visit more than once a year (0.56 ± 0.06 SE; 95% CI: 0.43 – 0.68), compared to that in children who saw a dentist once a year (0.29 ± 0.05 SE; 0.19 – 0.39). The differences between the three groups were statistically significant. The higher caries severity in those with a dental visit more than once per year might possibly be explained, once again, by increased dental health care utilization by children with caries.

With respect to dental visit recency, the prevalence of caries in the overall and the primary dentitions increased with an increase in the number of years since the last dental visit. The prevalence of any dental caries was lower (56.8%) among those children who had seen a dentist within the past year versus in children who visited a dentist

between one to less than two years ago (65%) or those who had a dental visit two or more years ago (70.6%).

When compared to those who had seen a dentist within the past year, the odds of having permanent tooth decay were significantly lower in those had a dental visit between one to less than two years ago (OR: 0.39; 95% CI: 0.15 – 0.98). However, since there was insufficient study power to detect differences between the various exposure groups of interest by dental visit recency, no confidence can be placed in the validity of the results related to dental visit recency.

Disparities in dental caries were explored by oral hygiene practices in terms of both tooth brushing and flossing frequencies.

A majority (weighted: 77%) of children in this study brushed at least twice a day, similar to that reported for the six to 11 year old national cohort (73%) in the CHMS (3b).

The results pertaining to prevalence of flossing could not be compared with those reported by the CHMS, due to differences in the manner in which the responses to the questions in the questionnaires regarding flossing were collected and analyzed for data presentation in the two studies. However, it was noted that only 10% (weighted) of children in this study flossed one or more times a day. The 2007-2009 Canadian Health Measures Survey found that approximately 28% of the Canadian population flossed at least five times per week and that flossing frequently was less prevalent among children (11.6%) when compared to that among adults (40.6%) (3b).

Overall dental caries prevalence was greater in children who brushed their teeth less than once per day (70%) and in those who brushed only once a day (75%),

versus those who brushed more frequently (53.2%). Compared to children who brushed more than once per day, those who brushed less than once per day were twice as likely (OR: 1.99; 95% CI: 1.50- 2.63) and those who brushed only once per day were over two times (OR: 2.58; 95% CI: 2.29- 2.91) more likely to experience any dental decay. This finding is similar to that reported for six to seven year olds in the 1995-96 NSOHS (49).

Likewise, the prevalence of primary dentition caries was 65.6% among children who brushed their teeth less than once per day versus 74.5% among those who brushed once per day and 50.9% in children who brushed more often. As opposed to children who brushed their teeth more than once per day, those who did not brush daily were twice as likely (OR: 1.84; 95% CI: 1.40 - 2.41) to have had experienced caries in their primary dentition and those who brushed only once a day were thrice as likely (OR: 2.80; 95% CI: 2.49 - 3.16) to have primary tooth decay.

Dental caries experience represented by the mean deft score was greater in children who did not brush their teeth at least once a day (3.29 ± 0.47 SE; 95% CI: 2.33 – 4.24) and in those who brushed only once a day (3.89 ± 0.20 SE; 95% CI: 3.49 – 4.30), when comparison to children who brushed more often (2.26 ± 0.09 SE; 95% CI: 2.07 – 2.46). The difference in the mean deft scores between the three groups was statistically significant.

Dental caries severity in primary teeth, represented by the mean defs score, was also greater in children who did not brush their teeth daily (8.52 ± 1.55 SE; 95% CI: 5.38 – 11.65) and in those who brushed only once a day (11.03 ± 0.72 SE; 95% CI: 9.60 – 12.47), than in children who brushed more often (5.86 ± 0.30 SE; 95% CI:

5.26 – 6.47). These differences in the primary dentition caries severity between the three groups were statistically significant.

When compared to those who flossed one or more times a day, the odds of experiencing permanent dentition decay were lower in children who flossed less than once a day (OR: 0.41; 95% CI: 0.21 – 0.79). However, since there was insufficient study power to detect differences between the various exposure groups of interest by flossing frequency, no confidence can be placed in the validity of the results related to flossing.

6.1 STUDY STRENGTHS

In Nova Scotia, this is the first province-wide study in more than a decade to report findings on the oral health status of school-aged children and to examine the relationship between dental caries and sociodemographic and lifestyle factors. Since the study estimates reflect survey weights, the findings are representative of the entire population of seven to eight year old children.

The last province-wide study, the 1995-96 NSOHS, examined oral health status for different age groups (ages 6-7, 11-12 and 14-15) (49). Participants in the current study belonged to the seven to eight year old age group and therefore the information provided in this study serves as an important basis for any future comparisons of this age group. The results of this study have implications for informing community-based oral health programs and health policy planning.

One of the major strengths of the current study is the high quality of the original FMSEI survey. The FMSEI survey used standardized methodology for intra-oral clinical assessments by employing validated criteria laid out by Dr. Patricia Main (Faculty, University of Toronto) who is an expert in surveys and survey methodology,

and were based on the World Health Organization indications (23). The survey components were tested and used in various Ontario surveys based on their established testing and use in Ontario (23). The dental hygienists, who performed the clinical oral health examinations, underwent a two-day calibration session at Dalhousie University (23). For the purposes of the survey, standard portable dental lights and chairs along with standard WHO probe and mouth mirror were utilized (23b). Additionally, sampling weights were used to adjust for the sampling strategy and to account for the non-response of survey participants (23).

6.2 STUDY LIMITATIONS

Like any other research study, this study also has its limitations. Inherent to the original FMSEI study is the potential for recall bias due to use of parental questionnaires that requested responses to retrospective questions (23). Furthermore, although the study sample size provided adequate power to detect differences in dental caries prevalence between the various exposure groups of interest for geographic location, dental visit frequency and tooth brushing frequency, there was insufficient power to detect differences between the various exposure groups for dental visit recency and flossing frequency.

Another limitation was the inability to access individual-level FMSEI data related to confidentiality concerns.

6.3 CONCLUSIONS

The present study demonstrated that over half (57.3%) of the seven to eight year old Nova Scotia population was afflicted by dental caries in the overall dentition. Primary dentition caries prevalence was 55%, with a mean deft score of $2.58 \pm$

0.08 SE. Prevalence of permanent dentition decay was 14%, with a mean DMFT score of 0.26 ± 0.02 SE.

The findings for the overall dentition were found to be the same as that reported for the six to 11 year old Canadian population in 2007-09 (3b), but lower than that observed for six to seven year old Nova Scotia children in 1995-96 (49).

Primary dentition caries prevalence was slightly higher than the 2007-09 national average for six to 11 year olds. Primary dentition caries experience was almost the same as that reported for six to seven year olds in the 1995-96 NSOHS (49).

Permanent dentition decay prevalence and experience were slightly lower than that reported for the Canadian six to 11 year old population in 2007-09 (3b).

Primary dentition caries severity, represented by the mean defs score, was 6.86 ± 0.28 SE, which was practically the same as that noticed among the six to seven year olds in the 1995-96 NSOHS (49). The average DMFS score was 0.47 ± 0.04 SE.

This study found that geographic (urban/rural) location did not have a major influence on dental caries among the seven to eight year old Nova Scotia population.

The majority of the seven to eight year olds in this study had visited an oral health professional within the past year, similar to that reported in the six to 11 year old national cohort in the CHMS (3b).

The study also demonstrated a significant relationship between dental caries and the frequency of dental visits. When compared to children who had a dental visit once per year, those who visited the dentist less often were almost three times more likely to experience caries in their overall dentition. This finding is consistent with that

reported for the six to seven year old children in the 1995-96 NSOHS (49). Severity of dental caries in both the primary and permanent teeth was also significantly higher among children who visited the dentist less than once per year.

A majority of children in this study brushed at least twice per day, similar to that reported in the six to 11 year old national cohort in the CHMS (3b).

Only 10% of children in this study flossed one or more times a day. The results pertaining to prevalence of flossing could not be compared with those reported by the CHMS, due to differences in the manner in which the responses to the questions in the questionnaires regarding flossing were collected and analyzed for data presentation in the two studies.

This study found a strong relationship between childhood dental caries and frequency of brushing. As a general rule, those who brushed at least twice per day had decreased caries rates compared to those who did not. This finding is consistent with that reported in the scientific literature on child populations (49,84,102).

Since the results of this study reflect weighted estimates, the findings may be generalized to the entire population.

Recommendations for future research, policy and program planning are as follows:

- 1) Further research is needed to examine the association of various other influencing factors with dental caries in school-aged Nova Scotia children. This remains vital to understanding disparities in oral health of the population at large.

- 2) Use of hierarchical modeling should be considered in examining such associations, since the results for children within the same school would be correlated.
- 3) In planning and implementation of community-based oral health programs and initiatives for children, it is important to appreciate that improvement in oral health status of children would contribute to improvements in their overall health.
- 4) Finally, efforts should be directed towards implementing effective health promotion measures such as use of pit and fissure sealants and topical fluoride application in susceptible and high-risk children as preventive interventions. Furthermore, oral health education should reinforce the recommended frequency of brushing twice per day using fluoridated toothpaste, as well as preventive and regular dental visits.

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