

INRS-Institut Armand-Frappier



**Associations entre les indices de défavorisation des écoles
et l'état de santé buccodentaire des élèves au Québec**

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**Associations between School Deprivation Indices and
Oral Health Status among Quebec Schoolchildren**

By

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List of Symbols and Abbreviations

CI	Confidence Interval
COD	Chronic Oral Diseases
DMF-S	Decayed, Missing, Filled Surfaces
DMF-T	Decayed, Missing and Filled Teeth
HDI	Human Development Index
HPS	Health Promoting Schools
MEQ	Quebec Ministry of Education
OR	Odds Ratios
QSOHS	Quebec Schoolchildren Oral Health Survey
SD	Standard Deviation
SEP	Socioeconomic Position
SPSS	Statistical Package for Social Science
UK	United Kingdom
US	United States of America
WHO	World Health Organization

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Summary

The prevalence of chronic oral diseases (COD) has decreased substantially, but they still occur mostly among children in the lower social strata. Schools offer an ideal setting for health promotion programs and opportunities to decrease oral health inequalities.

Objective: To investigate the associations between school deprivation indices and schoolchildren oral health status.

Methods: We conducted an ecological study using a sample of 316 elementary public schools in the province of Quebec, Canada. Data from two sources were linked using school identifiers: (i) Two school deprivation indices (in deciles) obtained from the Ministry of Education, a poverty index and a socioeconomic environment index; (ii) Oral health outcomes from the Quebec Schoolchildren Oral Health Survey 1998-99 aggregated at the school level. These included proportions of children with caries, and reporting oral pain. The relation between school deprivation indices and oral health outcomes was assessed with linear regression for dental caries experience and with logistic regression for oral pain.

Results: The mean DMF-S (mean number of decayed, missing and filled permanent teeth surfaces) by school was 0.73 (SD=0.55); the average proportions of children with caries and reporting oral pain were 25% and 3%, respectively. The poverty index was not associated with oral health outcomes. For the socioeconomic environment index, each unit increase (higher deciles meaning unfavorable) was associated with a 1.3% (95% confidence interval: 0.6-1.9%) increase in the proportion of children with caries. Furthermore, schools in more unfavourable socioeconomic environments, as compared to those in more favourable ones, were twice as likely to have children reporting oral pain.

Conclusion: The school socioeconomic environment index – defined by parental employment and maternal education – was associated with oral health outcomes, and should be studied for its potential usefulness in planning school-based oral health promotion and screening strategies.

Résumé

Les écoles représentent un cadre idéal pour les programmes de promotion de la santé et les opportunités de réduction des inégalités en santé buccodentaire.

Objectif: Examiner l'association entre les indices de défavorisation des écoles et le statut de santé buccodentaire des élèves.

Méthodes: Nous avons mené une étude écologique utilisant un échantillon de 316 écoles primaires publiques dans la province de Québec, au Canada. Des données provenant de deux sources ont été appariées en utilisant des identificateurs scolaires: (i) Deux indices de défavorisation scolaire (en déciles) provenant du Ministère de l'Éducation, du Loisir et du Sport : un indice de faible revenu et un indice de milieu socio-économique; (ii) La prévalence des problèmes de santé buccodentaire provenant de l'Étude 1998-1999 sur la santé buccodentaire des élèves québécois de 5-6 ans et de 7-8 ans, agrégés au niveau de l'école. Ces problèmes incluaient la proportion d'enfants atteints par la carie et la proportion d'enfants rapportant une douleur buccodentaire. La relation entre les indices de défavorisation scolaire et les problèmes de santé buccodentaire a été évaluée au moyen de la régression linéaire pour ce qui est de l'expérience de la carie dentaire et au moyen de la régression logistique pour la douleur buccodentaire.

Résultats: L'indice CAO-F (le nombre moyen de faces cariées, obturées ou extraites) moyen par école était de 0,73 (écart-type = 0,55); les proportions moyennes d'enfants atteints par la carie et rapportant une douleur buccodentaire étaient respectivement de 25% et de 3%. L'indice de faible revenu n'était pas associé aux problèmes de santé buccodentaire. En ce qui concerne l'indice de milieu socio-économique, chaque augmentation d'une unité (des déciles plus élevés indiquant un milieu plus défavorable) était associée à une augmentation de 1,3% (intervalle de confiance à 95%: 0,6-1,9%) dans la proportion d'enfants atteints par la carie. De plus, les écoles situées dans des milieux socio-économiques plus défavorables, comparativement à celles situées dans des milieux socio-économiques plus favorables, étaient deux fois plus susceptibles de comporter des enfants rapportant une douleur buccodentaire.

Conclusion: L'indice de milieu socio-économique scolaire – défini par l'emploi parental et l'éducation maternelle – était associé aux problèmes de santé buccodentaire, et devrait être étudié quant à son utilité potentielle dans la planification de stratégies de promotion et de dépistage en matière de santé buccodentaire en milieu scolaire.

1 Introduction

Over the past 20 years a substantial decrease in the prevalence of chronic oral diseases (COD) has been observed. This reduction has been associated with changing life-styles and living conditions, better oral hygiene practices, effective use of fluoride and preventive programs in schools. However, COD remain a major public health concern throughout most of the world. In addition to their high prevalence in some populations, COD have a major impact on people's quality of life and are expensive to treat.

Evidence from different sources has consistently shown that COD are associated with socioeconomic position (SEP), primarily affecting those in the lower social strata. For example, results from the 1998 Quebec Schoolchildren Oral Health Survey showed that the prevalence of caries free teeth in both primary and permanent dentitions was higher in children from high SEP compared to those from low SEP.

In response to the disease's polarization, researchers started looking for alternative ways to identify those at a high risk of COD. Evidence suggests that ecological study designs, by focusing on groups and communities instead of individual risk factors, can provide reliable indicators to identify groups at high-risk for COD. Among potential target groups, schools are easily accessible and allow reaching an extensive number of children. Thus, they offer an ideal setting to decrease oral health inequalities, since differences in the prevalence of COD may be decreased if oral health promotion interventions are implemented in schools with children at high risk of COD.

A few studies carried out in the UK and Canada showed that school characteristics were associated with COD prevalence, and demonstrated the feasibility and validity of using such indicators as proxy measures for dental treatment needs at the school level.

Although school deprivation indices are routinely produced by the Quebec Ministry of Education (MEQ), little is known about the use of such publicly available indicators to identify children at high risk of COD in the province of Quebec.

The present research project aims to investigate whether publicly available school deprivation indices are associated with the prevalence of COD in Quebec children. In

particular, we hypothesize that unfavorable school socioeconomic indicators will be related to a higher prevalence of COD.

2 Literature Review

The first part of this literature review will cover the anatomy and physiology of the teeth, and the definition of COD with focus on dental caries and oral pain. Then, the descriptive epidemiology of these oral diseases and their impact on people's lives will be presented, followed by a description of the etiology, risk factors and risk indicators of COD.

The second part will discuss public health strategies that have been used to prevent and promote oral health, specifically in schools. Next, ecological studies in which area-based measures were used as indicators of oral health status in different populations will be described. Finally, the school deprivation indices routinely produced by the MEQ will be defined.

2.1 Anatomy and Physiology of the Teeth

In humans, there are two types of dentitions: primary and secondary. The first consists of 20 deciduous or "baby" teeth (8 molars, 4 canines and 8 incisors) for which the first and last eruption occur approximately around 6 - 24 month-old. The later consists of 32 permanent or "adult" teeth (12 molars, 8 premolars, 4 canines and 8 incisors) with the eruption period around 6 - 21 years old (Figure 1.a). However, some children and adolescents may have different eruption time.

All teeth have essentially the same structure: a hard crown, the functional visible part above the gum line, which is attached to 1 or more roots. The roots are unseen portions that support and fasten the teeth in the bones of the jaw. There are four major tissues which make up the teeth. As showed in Figure 1.b external hard layers (enamel, dentin, cement) protect the internal and vital tissue, the dental pulp.

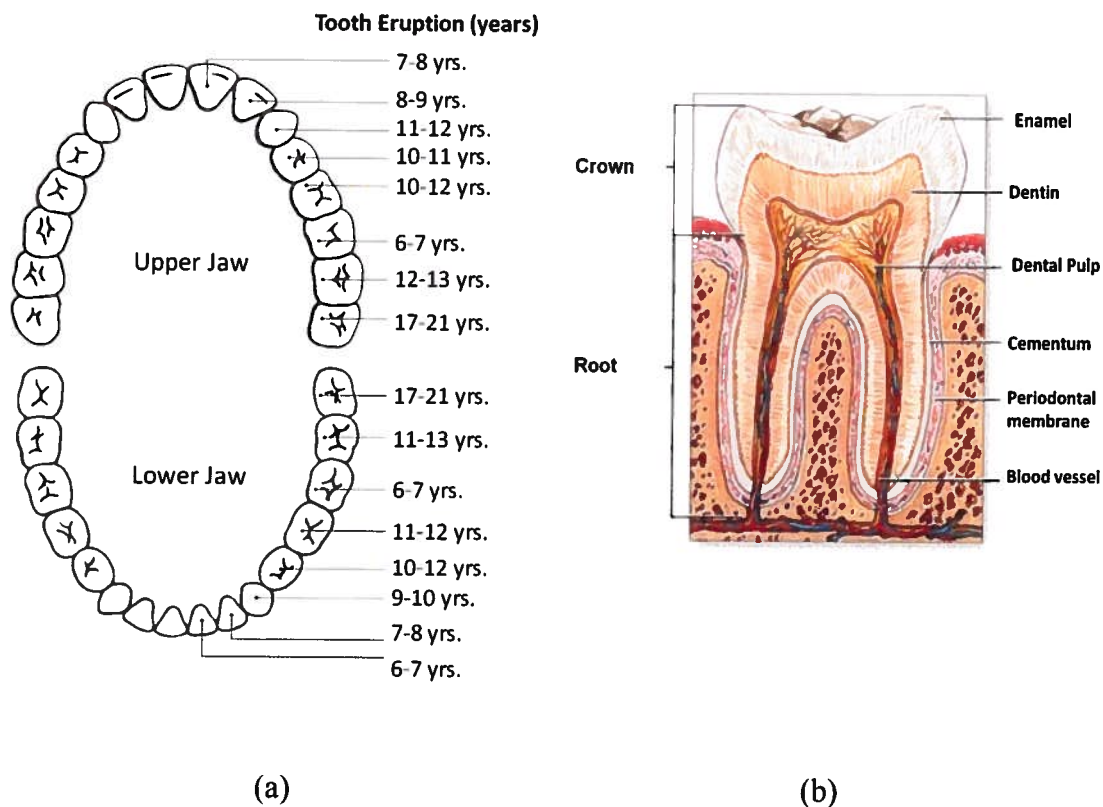


Figure 1. Eruption period of the permanent dentition (a) and the tooth structure (b). Reproduced from (Health Canada 2009).

The most external layer, the tooth enamel, is the hardest and most highly mineralized substance of the human body (99% dry weight and 1% water and organic material). (Fejerskov and Kidd 2003); It consists of tightly packed crystals in the form of prisms called *calcium hydroxyapatite*, $(Ca_{10}(PO_4)_6(OH)_2)$. This mineral is considered to be very sensitive to an acidic environment. In normal conditions, the tooth enamel and oral fluids (saliva and dental plaque fluid) are supersaturated in calcium hydroxyapatite. However, when the pH of the oral fluids that involves the tooth is low ($pH \leq 5$), this acidic environment increases significantly the solubility of calcium hydroxyapatite leading to a decrease in the mineral content (demineralization) of the tooth enamel, which is the first stage in dental caries development. It has been shown that a decrease of one unit in the pH level would result in considerable decrease of the hydroxyapatite solubility by a factor

of 10 g/L (Figure 2), explaining why calcium hydroxyapatite is considered to be so sensitive to an acidic environment (Fejerskov and Kidd 2003).

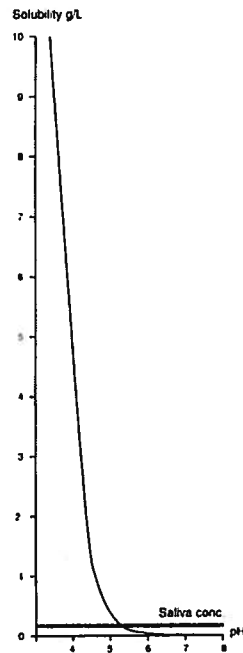


Figure 2. Calcium hydroxyapatite solubility in relation to saliva pH. Adapted from (Fejerskov and Kidd 2003)

The dentin is not as hard as the enamel, but 80% of its dry weight is mineral (calcium *hydroxiapatite*) and 20% is an organic matrix (collagen, phosphoproteins, phospholipids and proteoglycans) and water. It surrounds the dental pulp and is covered by the enamel and cementum on the crown and root, respectively. This layer is composed of several micro tubes, called dentinal tubules, which contain cells (e.g., odontoblasts) and fluids making this tissue more permeable and more sensitive to stimuli than the enamel.

The cementum is also composed of minerals (45% inorganic and 55 % organic), but it is softer than the dentin and the enamel. It covers the dentin in the root and provides an attachment for the periodontal ligament which is one of the supporting structures of the tooth. It is formed by the cells called cementoblasts.

Finally, the most internal tissue is the dental pulp. The pulp is a soft and living tissue, located in the central portion of the tooth (crown and roots). It consists of nerve endings,

blood vessels, fibers and cells (e.g., odontoblasts, fibroblasts). The pulp is called coronal or radicular pulp, depending on whether it is located in the crown or in the root of the tooth. The primary function of this tissue is to form dentin (by odontoblasts cells) and to provide nutrients to the enamel and dentine. In addition, the presence of nerve tissue allows the dental pulp to be sensitive to temperature stimulus or mechanical insult (e.g., severe dental caries/trauma).

2.2 *Chronic Oral Diseases*

COD are diseases with a long duration and with a generally slow progression that may result in irreversible destruction of hard and/or soft tissues in the mouth (Fejerskov and Kidd 2003). The most common COD are dental caries and periodontal disease. The next subsections will review the literature pertinent to the main outcomes of interest in this study: dental caries and oral pain (which often results from dental caries).

2.2.1 *Dental Caries*

Dental caries, although preventable, are the most common COD in several countries across the world (Petersen 2003). Dental caries, also known as tooth decay, are etiologically complex diseases in which several factors (e.g., microbial, genetic, immunological, behavioural, and environmental) are at play in determining the occurrence and severity of clinical diseases. It is an infectious and transmissible disease, which usually develops over a significantly long period of time (Figure 3). Biological factors such as bacterial flora, host defense system, consumption of cariogenic food (Seow 1998) and social factors (e.g., low SEP) are associated with dental caries development.

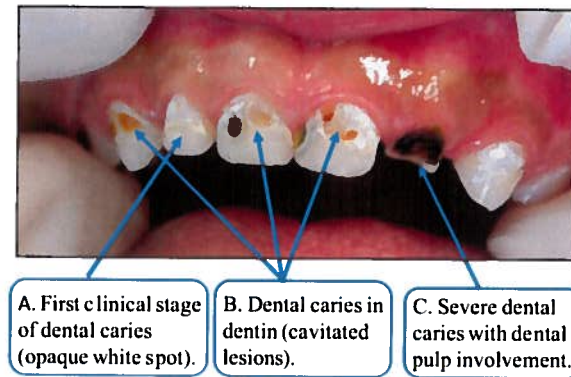


Figure 3. Different stages of dental caries in a 4-year-old child. Reproduced with permission (Losso, Tavares et al. 2009).

The signs and symptoms of dental caries may vary depending on the stage of the disease. In the first stage, there is an initial decalcification of the tooth enamel which results in opaque white spots which are usually asymptomatic. However, if the tooth is left untreated, the decalcification may progress leading to the destruction of a large part of the tooth structure (dentin level). This stage of the disease is usually associated with dental pain.

2.2.1.1 Measurements of Dental Caries

Dental caries are assessed by clinical examination which is usually performed in a dentist chair with a mouth plane mirror, air drying, artificial light and sometimes radiographies to aid in the diagnosis of dental caries among the interproximal faces (between teeth). However, when a population survey is carried out, a team of well trained health professionals collect the data in the field (e.g., schools), using mouth plane mirror and light (natural or artificially). Since the 1930's, researchers have used the DMF index to record dental caries data in epidemiologic surveys. Developed by Klein and Palmer (Klein, Palmer et al. 1938), the DMF index quantifies dental caries prevalence by calculating the number of: decayed (D), missing (M) and filled (F) teeth (DMF-T) or surfaces (DMF-S). The index uses upper and lower case letter to signify permanent (DMF) and deciduous dentitions (dmf), respectively. This score describes the caries prevalence for each individual, providing an estimation of how much the dentition has been affected by dental caries until the time of examination. In addition to using a simple

methodology, the DMF has the advantage of being a well established worldwide measure of dental caries experience. Thus, its use allows comparing results from different populations across the globe. One of the main disadvantages of the index is that it does not consider the number of teeth at risk of disease. In other words, the index does not have a denominator (e.g., number of (D), (M) and (F) teeth or surfaces divided by the total number of teeth in the mouth) which may result in an overestimation of the risk of dental caries. Also, the use of the DMF index can be problematic when computing surfaces (DMF-S). For example, by assigning five surfaces to extracted/missing teeth may overestimate the true caries experience, since the caries lesion which led to extraction may have occurred only in one or 2 surfaces. On the other hand, considering all the tooth surfaces compromised by the disease, provides better information on the severity of disease (e.g., small or large cavity) which will also provide more information for planning the type of dental treatment needed (e.g., filling, tooth extraction and etc.). Another problem which may affect the prevalence of dental caries in a population is the definition of the disease. For example, usually most population studies include only clinical cavitation (cavitated lesion) in their definition of dental caries. Thus, lesions at the enamel level (opaque white spot) are not included in their defined dental caries (diagnostic criteria). The main reason for the exclusion of this early lesions is the difficulty to properly diagnose them without an appropriate setting (e.g., light and tooth surface dried). However, this difference in the diagnostic criteria may result in differences in disease prevalence, since an underestimation in dental caries prevalence would result when early lesions are not considered in the diagnostic criteria. In the present study, the outcome (dental caries experience) was measured using the DMF-S index in which early lesions of tooth decay were included.

Form a public health perspective, the DMF-T or the DMF-S index is usually used by public health departments in order to investigate the disease distribution in the population, and to plan prevention strategies. The prevalence and trends of the disease in the population (e.g., low, medium or high prevalence and decreasing, stable or increasing trends) can be measured by the DMF level in different periods of time, and the effect of different prevention strategies can be analyzed (Fejerskov and Kidd 2003).

2.2.2 Oral Pain

Oral pain refers to pain within the mouth and is a common symptom of dental caries, but it may be also related to other oral health problems, notably severe periodontal disease, tooth fracture or an exposed tooth root. In the present study, only oral pain due to dental caries (toothache / presence of abscess) among children was examined. The intensity of toothache can range from chronic and mild to acute and intense pain. This variation is usually related to the severity of the disease. For example, the closer to the pulp the caries lesion is located, the worse the pain gets, especially when physical or thermal stimulus occurs, such as chewing or ingesting cold or hot foods and liquids. Oral pain is usually less frequent when patients take preventive measures for dental caries such as a healthy diet (low sugar intake), appropriate oral hygiene (tooth brushing and use of dental floss) and regular oral exams (the frequency will depend on the risk level of the patient for dental caries). These preventive measures are directly associated with a decreased risk for COD. However, there are several reasons why this approach may not be used by all. Factors such as the lack of information, distance to a dental office, or financial problems may lead the patient to temporarily relieve the pain with analgesics or anti-inflammatory drugs instead of seeking dental treatment.

2.2.2.1 Measurements of Oral Pain

The main goals of measuring oral pain are to determine its prevalence, to identify the impact on individuals' quality of life, and to analyze the severity of the disease. The majority of the studies assess the prevalence of oral pain related to toothache and use a set of structured questions relating to the presence or not of toothache in the previous weeks or month. One of the main disadvantages of this kind of data is the fact that it uses retrospective data which may lead to an overestimation or underestimation of the occurrence of the outcome due to misclassification (Ratnayake and Ekanayake 2005). For example, Shepherd et al. used the following questions: "*Have you ever suffered from toothache?*", "*Have you had toothache in the last 4 weeks?*" (Shepherd, Nadanovsky et al. 1999). Differently, in the present study, the data on toothache was assessed by clinical examination (presence/absence of infection) and structured questions regarding presence/absence of toothache one week before the clinical examination (e.g., "*Have you*

had toothache during the last week? ”) (Brodeur, Olivier et al. 2001). In the present study, the reference period for toothache was the previous week. The closer time possibly decreased the likelihood of underestimation of the prevalence oral pain due to forgotten events as compared to a reference period of one month. However, this period also being shorter, 1 instead of 4 weeks, the reported prevalence may not be comparable with all previous studies. The focus on oral pain in the previous week would have the advantage of capturing current acute oral pain.

2.3 Chronic Oral Diseases Epidemiology

2.3.1 Prevalence of Dental Caries

Historically, the highest prevalence of dental caries among European and North American children and adolescents were reported in the first half of the 1900's. In the middle of the 20th century, preventive measures to reduce the incidence of dental caries in the population were implemented, especially when it was found that the constant presence of fluoride in the oral cavity was significantly associated with decreased caries occurrence among children (Fejerskov and Kidd 2003). In this context, a substantial decrease in the prevalence of COD was observed in most industrialized countries over the past few decades (Petersen 2003; Marthaler 2004). In Canada, results from the most recent surveys showed a significant reduction (27%) in dental caries among the permanent teeth in 7-8 year-old children (Brodeur, Olivier et al. 2001). Similar results have been reported among 12 year-old American children (WHO 2000). The average DMF-T index decreased from 2.6 to 1.2 during the period of 1980 to 2004 (WHO 2000). The reasons for this change include an improvement in socioeconomic conditions and health behaviours, as well as the widespread use of fluoride, especially in the toothpaste (Watt and Sheiham 1999; Sheiham 2000).

However, despite an overall improvement in oral health status in several countries, dental caries remain a public health problem. They represent the most prevalent oral disease affecting 60 to 90% of schoolchildren in most industrialized countries (Petersen 2003). The US Center for Disease Control and Prevention reported that more than half of the American children between 12 and 15 years of age were affected by dental caries (CDC

2008). Similarly, approximately 26% of 8 year-olds have permanent teeth affected by dental caries, according to the most recent oral health survey in Quebec (Brodeur, Olivier et al. 2001). This is cause for concern, since 8 year-olds would have had their permanent teeth for only 2 years, as they erupt around six years of age.

2.3.2 Prevalence of Oral Pain

The prevalence of oral pain related to toothache has been reported only in a limited number of studies using representative samples. In Canada, a study performed in the Northern region of Ontario suggested that between 5 and 8% of 8-9 year old children reported toothache in the four weeks prior to interview (Graham L. Woodward 1996). In the UK, Shepherd et al. observed that among 586 children, 8% reported toothache in the previous four weeks. In addition, almost half of the 8 year-old children had ever suffered from toothache, and among those, 18% reported crying caused by toothache (Shepherd, Nadanovsky et al. 1999).

2.3.3 Consequences of COD

COD have been considered as a major public health problem around the world. They are prevalent in most countries, have an important impact on people's quality of life, and are expensive to treat. Studies describe that COD may result in oral pain, discomfort, tooth loss, and dysfunctionality for eating and speaking, among other problems. Shepherd et al. reported that schoolchildren presented difficulty eating, sleeping problems and missing school days due to oral pain (Shepherd, Nadanovsky et al. 1999). Studies have also reported an association between children's general and oral health problems and poor school performance results (Nicolau, Marcenes, Hardy et al. 2003; Stephanie, William et al. 2008). Furthermore, the economic burden of COD on the individuals and the public health system is also a concern. High cost of preventive and restorative dental treatment implies that for most individuals, dental treatment is often delayed.

In the Bulletin of The World Health Organization (2005), it has been shown that dental caries is the fourth most expensive disease to treat in both industrialized and developing countries (Petersen, Bourgeois et al. 2005). The amount devoted to oral health by the

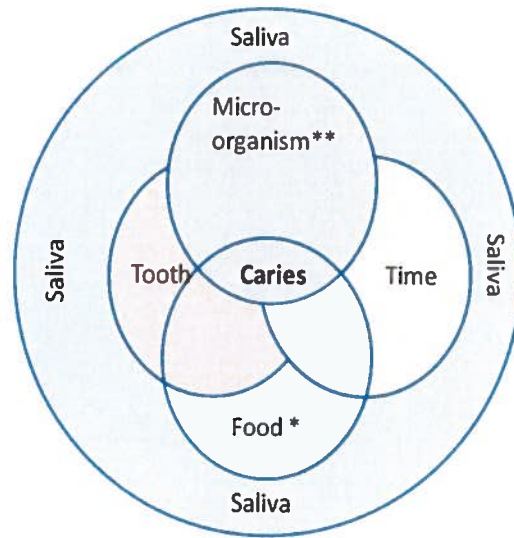
public government is around 5-10% of the health care budget in most developed countries (Taubman and Nash 2006; WHO 2007). In Quebec, dental care accounts for approximately 10% of the annual public health care cost, spent only for some subgroups of the population such as children less than ten years of age and welfare recipients (Institut National de Santé Publique du Québec 2008). For individuals, the financial cost of dental treatment has been reported as one of the barriers to seeking dental care. In the US, oral health care accounted for around US\$ 75 billion in 2004 (Taubman and Nash 2006) partly explaining why a survey evaluating health inequalities in five countries (Australia, Canada, New Zealand, UK and US) showed that 20 to 50% of individuals with income below the national median did not seek dental care despite needing it, due to financial cost (Blendon, Schoen et al. 2002).

2.4 COD Etiology

2.4.1 Dental Caries Etiology

According to Keyes (Keyes 1968), the process of caries development is dependent on three sets of factors: host factors (teeth and saliva), environmental factors (oral biofilm), and substrate factors (e.g., diet). Newbrun introduced time as a fourth factor (Figure 4) (Newbrun 1982).

Figure 5 depicts in a graphical form the process of caries development. A high frequency of ingestion of fermentable carbohydrates (e.g., sucrose), a cariogenic microflora (*Streptococcus mutans* and *lactobacilli*) and a susceptible host (e.g., hypocalcification of the enamel, low saliva flow) are the necessary factors for dental caries development (Newbrun 1982).



*Fermentable carbohydrate
 **Especially *Streptococcus mutans*

Figure 4. Factors involved in dental caries etiology. Adapted from Keyes diagram (1962) and Newbrun (1989) (Newbrun 1989).

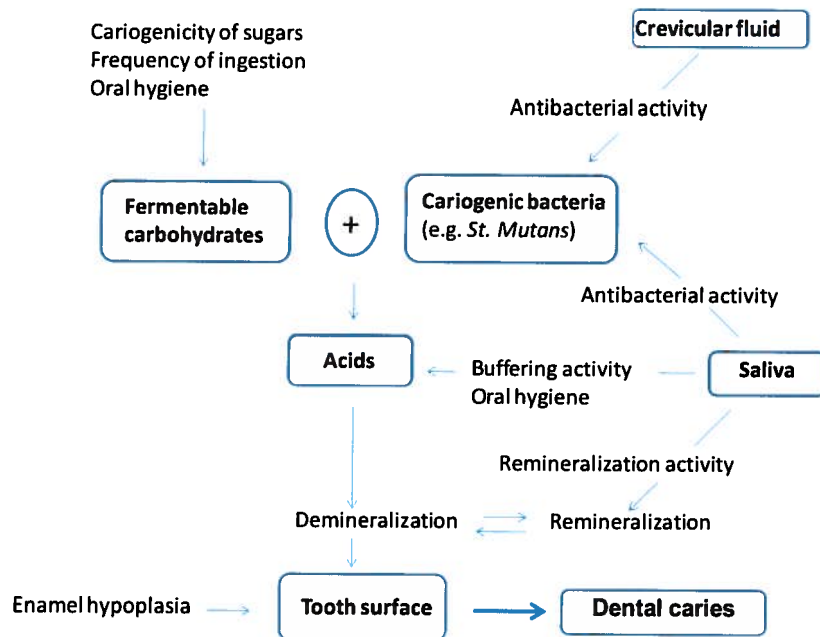


Figure 5. Dental caries progress. Adapted from (Seow 1998).

2.4.1.1 Microbiological factors

Several lines of evidence have suggested that streptococci mutans (SM), a group of phenotypically similar bacteria, is the principal microbiological component involved in dental caries development in humans (Gibbons and Houte 1975; Loesche, Rowan et al. 1975).

This group of acid tolerant bacteria is able to rapidly metabolize carbohydrate to acid. A high frequency of carbohydrate ingestion is directly associated with dental demineralization, since it increases the colonization of the SM and constantly generates a high concentration of acids that will substantially decrease the saliva's pH ($\text{pH} < 5$). The low pH in the saliva is the ideal milieu for SM to grow and metabolize. The low Ph makes this bacteria more competitive since most other bacterial species associated with enamel health are sensitive to acidic conditions (Bradshaw and Marsh 1998).

2.4.1.2 Diet and Fluoride

The presence of a pH less than 5, at which the solubility of the mineral calcium hydroxyapatite increases drastically, over a long duration and repeated over time causes the demineralization of the tooth enamel (Van Houte 1994). This may result in an early lesion of the tooth surface, referred to as a white spot. In this context, a diet low in cariogenic sugars (sucrose, glucose and fructose), daily oral hygiene with fluoride toothpaste are important measures to prevent dental caries. The mechanical removal of the oral biofilm (dental plaque) will decrease at least partially the growth of the biofilm and the presence of topical fluoride will prevent lesion development and progression. The basic action of fluoride occurs after tooth eruption and its topical action stabilizes the hydroxyapatite matrix on internal and external surfaces. A low consumption of fermentable carbohydrates, especially sucrose, will decrease the adherence of the *mutans* bacteria on the tooth surface and the production of organic acids which will decrease the pH of the saliva.

2.4.1.3 Saliva

The saliva is one of the most important systems of defense against dental caries (Seow 1998). Individuals with low saliva flow (e.g., use of drugs to reduce high blood pressure) are considered to be at high risk of dental caries. The saliva has the capacity to buffer acids, that is, it neutralizes the acid produced by the bacteria present in the oral biofilm (dental plaque). In addition, it helps to clean the oral cavity, and to interfere with the bacterial adhesion on the tooth surface. For example, the presence of a carbonic acid-bicarbonate buffer system, proteins and phosphate in the saliva results in the neutralization of acids from bacterial fermentation of carbohydrates and other food sources. In addition, studies have suggested that the presence of immunoglobulins in the saliva, may interfere with the bacterial adherence on the tooth surface increasing the protection of the tooth against the cariogenic bacteria (Seow 1998).

2.4.1.4 Enamel defects

Enamel defects such as hypocalcification of the enamel (hypoplasia) which may be associated with malnutrition, may result in irregularities in the tooth surface leading to an increase risk of tooth decay. The enamel with less calcium is less resistant to dental caries as irregularities in the tooth surface would be favorable to colonization by bacteria (Seow 1998).

In summary, caries development is a dynamic and reversible process involving several factors which play a role at different stages of the disease process. An imbalance among the factors involved in this process (e.g., absence of fluoride, diet rich in carbohydrate and low saliva flow) leads to a demineralization of the enamel (loss of calcium hydroxyapatite) which is clinically represented by an opaque white spot on the tooth surface. This first stage of dental caries can progress from the enamel to the dentin and finally the dental pulp, causing major damage to the tooth in the form of small, medium and large cavities that may lead to an inflammation of the pulp.

Treatment for tooth decay depends on the stage of the disease. During the early stage, local administration of fluoride, a good plaque removal through oral hygiene and a diet

low in carbohydrates may be sufficient. However, in cases where there is a cavity lesion, a filling will be necessary. Depending on the size of the cavity, radical procedures (e.g., root canal treatment, tooth extraction) may be warranted.

2.5 Individual Risk Factors for COD

A risk factor is any individual characteristic or attribute such as individual's behaviour, lifestyle, inborn characteristics or environmental exposures that increases the chances of occurrence of an outcome (e.g., smoking is a risk factor for oral cancer as a low saliva flow is a risk factor for dental caries). According to Beck "*Risk factors are part of the causal chain or expose the host to the causal chain. Once disease occurs, removal of a risk factor may not result in a cure*" (Beck JD 1998). However, once the risk factors are identified, strategies to decrease such exposures or to make some intervention are important in order to reduce the incidence of a disease or condition in the population.

Caries susceptibility has been associated with biological and genetic factors (Van Houte 1994; Shuler 2001). These factors as described previously include salivary characteristics such as buffering capacity, structure of dental enamel, and immunological response. The saliva also has the potential to deliver calcium, phosphate, and fluoride to the tooth surface, thus preventing the demineralization of the tooth enamel. All those aspects are protective against dental caries development and vary within each individual (Stephan 1944). A systematic review of dental decay susceptibility and genetics supported the evidence of a relationship between genetic factors and an increase in dental caries risk. For example, studies in monozygotic twins have shown the relationship between some genetic polymorphisms and an increase in dental caries incidence. The authors explain that the variation in some proteins may have an influence on caries development through an effect on some risk factors for dental caries, such as: salivary characteristics, tooth development period, or morphology. However none of the studies were able to describe specific genes associated with those risk factors (Shuler 2001).

Similarly to general health, biological and genetic factors cannot fully explain variations in oral health. Other factors such as nutritional habits (low consumption of fermentable

carbohydrate), oral hygiene (biofilm removal, presence of fluoride in the tooth paste), and regular oral exams are associated with low levels of dental caries.

2.6 Individual Risk Indicators for COD

As opposed to risk factors, risk indicators are “possible” risk factors that increase the chance of disease development but for which the relationship has not been shown to be necessarily causal (e.g., low SEP). This term is correctly used for factors identified in cross-sectional studies in which the temporal sequence of the factors clearly preceding the disease was not observed (Beck JD 1998). However, it is also possible to identify risk indicators associated with etiological factors in longitudinal studies (e.g., SEP).

A relationship between SEP indicators and oral health outcomes has been observed in cross-sectional studies. Data from the last Quebec Schoolchildren Oral Health Survey (QSOHS) showed that dental caries was associated with indicators of SEP, i.e., adolescents from low income families, those whose parents had low levels of education and whose parents were unemployed, had more dental diseases (Brodeur, Olivier et al. 2001). The prevalence of untreated decay in American children between 6-8 years of age was more than twice in those at lower SEP, which supports the evidence of strong social gradient in oral health (CDC 2005).

The associations between SEP indicators and health outcomes (e.g., morbidity and mortality) have been observed since the seventeenth century. The Black report, a landmark work in the field of health inequalities, clearly demonstrated a strong social gradient in general health with higher mortality and morbidity in less privileged groups (Black, Townsend et al. 1982). In COD, socioeconomic inequalities have also been reported in both developing and developed countries (Watt and Sheiham 1999; Nicolau, Marcenes, Bartley et al. 2003; Thomson, Poulton et al. 2004; Antunes, Peres et al. 2006; Sanders, Spencer et al. 2006).

SEP along the life course has been reported as a risk indicator for COD. A Brazilian study showed that adolescents whose families were in low SEP along their life course had a higher prevalence of dental caries and periodontal disease when compared to those whose

families remained in high SEP along their life course (Nicolau, Marcenes, Bartley et al. 2003; Nicolau, Marcenes and Sheiham 2003). Similarly, results from the Dunedin birth cohort in New Zealand showed that individuals in low SEP across the life course presented more dental caries experience and less dental treatment than those who remained in high SEP throughout their life course (Thomson, Poulton et al. 2004).

2.7 Group Level Indicators of COD

Group level indicators are variables that measure factors or outcomes at the population or group level (e.g., schools, neighbourhoods) rather than individuals. The unit is the group and each group indicator has one value (e.g., mean poverty index of school 1, mean poverty index of school 2, etc.). This value may be obtained through aggregation of the data at individual level or directly at the group level.

In oral health, variables at the group level have been used to investigate, among other topics, geographic inequalities in dental caries. For example, a multilevel study on determinants of tooth decay demonstrated that the likelihood of a higher DMF-T score was higher in those cities without tap water fluoridation. Similarly, towns with lower score on the human development index (HDI) – which measures the average achievements of human development in three basic dimensions: life expectancy, literacy and standard of living (Antunes, Peres et al. 2006) had higher DMF-T scores. Also, an ecological study that used school classes as a unit of analysis found that classrooms in which the students' parents had low levels of education presented more dental caries compared to classrooms in which the students' parents had high education levels (Amstutz and Rozier 1995).

Other contextual composite measures of SEP have been associated with COD. The Jarman index, which is a composite measure of material deprivation (Locker 2000) has been used to demonstrate inequalities in COD. Areas with high levels of deprivation had a high prevalence of COD compared to less deprived areas (Muirhead and Marcenes 2004). Indeed, oral health inequalities are ubiquitous: less affluent people have worse oral health and this evidence is consistent across individual and group levels of analysis, through the life course and across generations (Locker 2000; Brodeur, Olivier et al. 2001;

Nicolau, Marcenés, Bartley et al. 2003; Bedos, Brodeur et al. 2005; Bernabé, Sheiham et al. 2009).

Finally, risk factors and indicators have been widely explored in order to understand the factors that are related to the development of COD and to identify groups of individuals at higher risk. However, strategies to identify groups of individuals at high risk of COD and not risk factors remain a challenge in oral health research. From a public health point of view, area-based measures offer an excellent alternative to identify groups at risk of COD (Locker 2000), and to plan public health strategies and policies specifically for those groups.

2.8 Strategies and Interventions to Prevent COD

Strong efforts have been devoted to the reduction of oral diseases in industrialized and non industrialized countries (Petersen 2003). Several approaches to prevent and control non-communicable diseases such as COD have been considered over the years; and such approaches could be seen at two different levels: individual and population levels. While the individual approach focuses on individual risk factors and lifestyle (e.g., the high-risk strategy), the population approach aims to understand the social, physical and environmental determinants of the diseases. Its strategies are tailored to improve the health of the populations (e.g., the direct population approach).

Dental health education, which has been widely used as part of schools dental programs, is an example of an individual approach. The premise of this approach is to provide knowledge to change behaviours and attitudes which will lead to adoption of healthy lifestyle (e.g., low sugar consumption, better oral hygiene, etc.). However, due to the narrow scope in understanding the determinants of diseases, the effectiveness of this strategy has been questioned. Indeed, results from a systematic review suggested that health policies focusing on dental health education have failed to reduce dental caries occurrence and only had a temporary effect on dental plaque accumulation (Kay and Locker 1996).

Another example of a preventive approach which focuses on the individual is the *high risk strategy*. This approach proposes the identification of subjects at high risk of diseases (e.g., schoolchildren at higher risk for COD) to provide treatment and preventive measures. Examples of dental programs using this strategy include: the use of topical fluoride (gel or tablets), sealant applications and oral health education (e.g., oral hygiene and dietary counseling). Dental sealants, a plastic material used to seal the occlusal surface of teeth at high risk, have been widely used to prevent dental caries in individuals at higher risk for COD. However, studies have shown that this strategy, applied mainly in industrialized countries, is costly and inefficient in reducing dental caries risk at the population level (Hannu Hausen 2000).

The direct population approach is a preventive approach which focuses on a group of people or a population. Water fluoridation is an example of such an approach. The effect of water fluoridation on the dental tissues was discovered in the 1940's and provided the basis for the use of fluoride to prevent dental caries (Fejerskov and Kidd 2003). The water fluoridation has been shown as a very effective strategy. According to a systematic review performed by McDonagh et al., the presence of fluoride in drinking water reduces by 15% the prevalence of dental caries (McDonagh, Whiting et al. 2000). Also, it has been shown as a cost-effective population strategy to prevent COD, especially where the prevalence is high. In Brazil, fluoridated tap water in the whole country was approved by law in 1974 and nowadays more than 50% of the population is exposed to water fluoridation. A study looking for differences in COD prevalence among different cities with and without water fluoridation in Brazil found that individuals living in cities with water fluoridation presented a lower prevalence of dental caries when compared to those living in cities without water fluoridation. For example, in urban areas, 40% of 12-year-old children were caries free (without caries) in cities with water fluoridation against 24% where fluoridated water was not offered. An important result of this research was that SEP levels were associated with fluoride exposure, where high SEP were more exposed to fluoridated water than those in low SEP (Peres, Antunes et al. 2006). Forty-two percent of the Canadian population and seven percent of the Quebec population are exposed to fluoridated water, respectively. The major argument against the use of water fluoridation in Canada concerns the adverse effects of fluoridated water, such as the dental fluorosis (a

cosmetic condition) and cancer. However, results from the systematic review discussed above suggest that water fluoridation, when the optimal level of fluoride was respected (7 to 1.2 ppm), has no adverse effects. It should be noted that the authors concluded that the quality of research in this field remains poor (McDonagh, Whiting et al. 2000).

Nevertheless, as COD are multifactorial diseases, the use of fluoride has its limits. To achieve better results in promoting oral health through a healthy population, some other strategies need to be considered: (i) the use of directed population approach, which aims to provide oral health care (preventive and curative) to population groups at high risk of COD (Muirhead and Marcenes 2004); and (ii) the common risk factor approach, which aims to reduce risk factors that are common to both general and oral health, by integrating oral health into the general health (Sheiham and Watt 2000). Schools have been shown as an important setting to apply such strategies, since changes in the social and physical environment of the schools (e.g., healthy school meals and safe places for physical activity) would promote long term healthy behaviours and lifestyles.

2.8.1 Oral Health Promotion in Schools

Schools have been seen as an important setting to promote health, since actions to promote a better environment can be done at the group level, with easy access and follow-up. Indeed, Health Promoting Schools (HPS) is one of the examples of health promotion strategies proposed by the World Health Organization (WHO).

In 1991, the WHO published a report suggesting that schools which promote healthy behaviours, well-being and individual skills are important settings that will improve children's health (WHO 1991). Physical, cultural and social environments where children live and are educated have a large influence on the children's health. In 1998, the WHO launched the HPS strategy based on the assumption that "a school constantly strengthening its capacity as a healthy setting for living, learning and working" (WHO 1998). Empirical evidence supports this strategy. A Brazilian study reported that children's oral health status was better in schools with HPS (e.g., schools with food and smoking policies, as well as dedicated space for physical activity) when compared to those which did not have HPS (Moyses, Moyses et al. 2003). Similar findings were

reported in a Thai study. Children attending schools which had better physical and social school environments presented less traumatic dental injury when compared to children attending schools with worse physical and social school environments (Malikaew, Watt et al. 2003).

2.9 Ecological Studies and COD

The ecological study design has been widely applied in public health, since such studies are fast and cost efficient as compared to studies at the individual level. This epidemiological approach commonly uses already existing data (secondary analysis), and takes into consideration differences in groups (e.g., schools, neighbourhoods) rather than individuals. It allows answering hypotheses at the group level when secondary data are reliable and measures, analyses and interpretation are made at the aggregate level. However, findings from ecological studies needs be carefully interpreted, since associations reported among groups does not necessarily exist among individuals. The extrapolation of the findings from ecological studies to the individual level leads to a potential error called the “ecological fallacy”(Morgenstern 1998; Porta 2008).

Evidence suggests that ecological designs provide reliable indicators to identify those at high-risk for COD (Crowley, O'Brien et al. 2003; Muirhead and Marcenes 2004; Muirhead and Locker 2006). They offer a way to move beyond the traditional public health strategy of identifying high-risk individuals that, although widely used, has important limitations in the context of COD, such as high cost and the low sensitivity and specificity of screening and diagnostic tests for COD (Batchelor and Sheiham 2006).

In the UK, an ecological study performed by Crowley et al. showed a significant association between school league tables (a rank table of the schools based on their performance) and children’s dental treatment needs. The study suggested that school league tables which is readily available, inexpensive, could be used a potential indicator of dental treatment needs (Crowley, O'Brien et al. 2003).

Similar results were observed by (Muirhead and Marcenes 2004). School with worse performance results, free meal programs, and those located in areas with high levels of

deprivation had higher prevalence of dental caries. It was argued that free school meals could be considered as a measure of material deprivation as families may not have money to support the cost of school meals. Likewise, a Canadian study evaluated the feasibility and predictive ability of using school characteristics such as performance results (e.g., English, math, and literacy tests) as proxy measures for school dental treatment need. The authors concluded that using such indicators available from the Ontario education system was indeed feasible and that they could be used as proxy measures for school dental treatment needs (Muirhead and Locker 2006).

In addition, a Brazilian study assessed whether there were differences in the population's access to public water fluoridation. Using data from an epidemiological survey among 246 municipalities the authors reported that larger populations and more socioeconomically advantaged areas had better access to public water fluoridation (Gabardo, Da Silva et al. 2008).

In summary, increasing evidence suggest that publicly available data may be used as a potential indicator of COD risk. However, to date little is known about the use of these indicators to identify children at high risk of COD in the province of Quebec.

2.10 School Deprivation Indices produced by the Quebec Ministry of Education

The school deprivation indices, the socioeconomic environment index and the poverty index, are produced yearly by the MEQ and are publicly available on the MEQ website (Ministère de l'Éducation du Loisir et du Sport 2009). In order to obtain those area measurements of school deprivation, the province of Quebec is divided by the MEQ in 1445 territorial units. This categorization is based on social, economic and familial characteristics and with this information, the MEQ classifies the public schools in underprivileged or not. The main goal of this classification is to allocate resources. The classification is done through continuous indices (0-100) and decile ranks (1-10) according to the distribution over the entire province of Quebec. Thus, each school is classified according to the decile rank to which they belong, the most underprivileged schools represented by a decile rank value of 10.

For the present study the deprivation indices were obtained for the academic year 2000-2001, and were based on the 1996 census data. According to the MEQ, such indices vary little from year to year. Each of the indices is defined in the following sections.

2.10.1 The Socioeconomic Environment Index

The socioeconomic environment index is a composite score considering the proportion of maternal under-schooling (a weight of 2/3 of the index) and the proportion of unemployed parents (a weight of 1/3 of the index) in each school territorial unit. This index, called “Indice du milieu socio-économique” or IMSE by the MEQ, is available as a proportion (1 to 100) and as a decile rank (1 to 10). A higher proportion or rank relates to a more unfavourable school socioeconomic environment. For example, a school with a IMSE rank of 10 indicates that the combined proportions of maternal under-schooling and of unemployed parents in this specific school territory unit are in the highest decile of the distribution in Quebec, indicating an unfavourable socioeconomic environment. (Ministère de l'Éducation du Loisir et du Sport 2005).

Maternal under-schooling

The proportion of under-schooled mothers is estimated as the number of mothers (women who have children aged 0-18 years) who have completed less than high school (without a high school diploma), divided by the total number of mothers in the school territorial unit. Mathematically, it is calculated as follows:

$$\text{Maternal under - schooling (MUS)} = \frac{A}{(A + B + C + D + E + F)}$$

Where:

- A: Number of mothers whose education level corresponds to the primary or secondary level without diploma for the secondary;
- B: Number of mothers who received the diploma or certificate for the secondary level;

- C: Number of mothers whose education level corresponds to college without certificate or diploma;
- D: Number of mothers whose education level corresponds to college with certificate or diploma;
- E: Number of mothers whose education level corresponds to university without bachelor's or graduate diploma;
- F: Number of mothers whose education level corresponds to university with bachelor's or graduate diploma.

Parental unemployment

Parental inactivity on the job market constitutes the second component of the IMSE index. It consists in the proportion of families in which there are no parents employed and either one or none of the parents actually looking for work. It is calculated as follows:

$$\text{Parental unemployment (PU)} = \frac{(Y + Z)}{(X + Y + Z)}$$

Where:

- X: Number of families with at least one parent employed;
- Y: Number of families with none of the parents employed and at least one of the parents looking for work;
- Z: Number of families with inactive parent(s).

Combining the two parts of this index, the socioeconomic environment index becomes:

$$\text{IMSE} = \frac{2}{3} \text{MUS} + \frac{1}{3} \text{PU}$$

2.10.2 The Poverty Index Based on Low-Income Cut-Offs

Since 1999, the poverty index, called the “Seuil de faible revenu” or SFR has been used by the MEQ to allocate resources and for research purpose. It is based on the low-income cut-offs (LICO) established by Statistics Canada (Statistics Canada 2006). It is defined as the income thresholds in which families spend a larger amount of the family income (70% or more) on basic needs (e.g., food, housing, and clothing) when comparing to the average family. This index takes into account community density of the area of residence and the number of individuals in the family (Ministère de l'Éducation du Loisir et du Sport 2005).

The SFR index is available as a proportion (1 to 100) and as a decile rank (1 to 10), just like the IMSE. A higher proportion or rank relates to a higher level of “poverty” in the school territorial unit. For example, a school with a SFR rank of 10 indicates that the proportion of low-income families in this specific school territory unit is in the highest decile of the distribution in Quebec (Ministère de l'Éducation du Loisir et du Sport 2005).

More specifically, within each school territory unit, the poverty index corresponds to the proportion of families living around or under the low income cut-off divided by the number of families in the school territory unit. The poverty index is calculated as follows:

$$\text{SFR} = \frac{[(B \times 20\%) + C]}{(A + B + C)}$$

Where:

- A: Number of families whose income is equal or higher than 1.33 times the low income cut-off;
- B: Number of families whose income is between the low-income cut-off and a threshold of 1.33 times the low-income cut-off;
- C: Number of families under the low-income cut-off.

Although not an exact measure of poverty, the SFR estimates the proportion of families whose income can be considered low.

The variables describing the school deprivation indices are indices calculated annually by the MEQ and are described as: the socioeconomic environment index and the poverty index based on low-income cut-offs. Both indices are used to classify the public schools in underprivileged school or not and to allocate resources based on that information. In this study the variables are used as decile rank, in which a value of 10 represents the most underprivileged schools.

3 Rationale and Objectives

Despite a substantial decline in dental caries observed in several countries in recent decades and an effort to decrease inequalities in oral health, oral health care programs still require improvement. Dental caries have an important impact on people's lives and remain common in low socioeconomic level groups and in young children. Since there are limited resources to provide oral health care to the population, a strategy focusing on high risk groups seems optimal. However, before this can be achieved, possible predictors of high risk groups at the population level need to be investigated.

Few studies have addressed a possible association between school deprivation indices routinely produced by Education Ministries and COD, so that evidence in the field remains limited. Moreover, little is known about the use of publicly available indicators to identify children at high risk of COD in the province of Quebec. In this context, this present study aimed to address current gaps in the literature, using existing data as a fast and inexpensive way to address those gaps.

The main objective of this project was to identify school-level indicators of populations of 7-8-year-old children at high risk of COD. Publicly available school deprivation indices produced by the MEQ in 2001 (based on the 1996 census data) were examined as indicators of oral health status among 316 elementary public schools in the province of Quebec.

The specific aims were to estimate the associations between two school deprivation indices, the school socioeconomic environment index and the school poverty index, and oral health outcomes. The outcomes of interest were the proportion of children with dental caries and the proportion of children reporting oral pain, both provided by the Quebec Schoolchildren Oral Survey 1998-99. We hypothesized that unfavourable school socioeconomic environment would be associated with an increased prevalence of COD.

Our results may provide an empirical basis for policy makers to set efficient and cost-effective public health intervention towards COD prevention and should ultimately contribute to decrease oral health inequalities.

4 Manuscript

4.1 *Résumé en Français*

Les écoles représentent un cadre idéal pour les programmes de promotion de la santé et les opportunités de réduction des inégalités en santé buccodentaire.

Objectif: Examiner l'association entre les indices de défavorisation des écoles et le statut de santé buccodentaire des élèves.

Méthodes: Nous avons mené une étude écologique utilisant un échantillon de 316 écoles primaires publiques dans la province de Québec, au Canada. Des données provenant de deux sources ont été appariées en utilisant des identificateurs scolaires: (i) Deux indices de défavorisation scolaire (en déciles) provenant du Ministère de l'Éducation, du Loisir et du Sport : un indice de faible revenu et un indice de milieu socio-économique; (ii) La prévalence des problèmes de santé buccodentaire provenant de l'Étude 1998-1999 sur la santé buccodentaire des élèves québécois de 5-6 ans et de 7-8 ans, agrégés au niveau de l'école. Ces problèmes incluaient la proportion d'enfants atteints par la carie et la proportion d'enfants rapportant une douleur buccodentaire. La relation entre les indices de défavorisation scolaire et les problèmes de santé buccodentaire a été évaluée au moyen de la régression linéaire pour ce qui est de l'expérience de la carie dentaire et au moyen de la régression logistique pour la douleur buccodentaire.

Résultats: L'indice CAO-F (le nombre moyen de faces cariées, obturées ou extraites) moyen par école était de 0,73 (écart-type = 0,55); les proportions moyennes d'enfants atteints par la carie et rapportant une douleur buccodentaire étaient respectivement de 25% et de 3%. L'indice de faible revenu n'était pas associé aux problèmes de santé buccodentaire. En ce qui concerne l'indice de milieu socio-économique, chaque augmentation d'une unité (des déciles plus élevés indiquant un milieu plus défavorable) était associée à une augmentation de 1,3% (intervalle de confiance à 95%: 0,6-1,9%) dans la proportion d'enfants atteints par la carie. De plus, les écoles situées dans des milieux socio-économiques plus défavorables, comparativement à celles situées dans des milieux

socio-économiques plus favorables, étaient deux fois plus susceptibles de comporter des enfants rapportant une douleur buccodentaire.

Conclusion: L'indice de milieu socio-économique scolaire – défini par l'emploi parental et l'éducation maternelle – était associé aux problèmes de santé buccodentaire, et devrait être étudié quant à son utilité potentielle dans la planification de stratégies de promotion et de dépistage en matière de santé buccodentaire en milieu scolaire.

ASSOCIATIONS BETWEEN SCHOOL DEPRIVATION INDICES AND ORAL HEALTH STATUS

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Abstract

Schools offer an ideal setting for health promotion programs and opportunities to decrease oral health inequalities.

Objective: To investigate whether school deprivation indices were associated with schoolchildren oral health status.

Methods: This ecological study used a sample of 316 elementary public schools in the province of Quebec, Canada. Data from two sources were linked using school identifiers: (i) Two school deprivation indices (in deciles) from the Ministry of Education, a poverty index and a socioeconomic environment index; (ii) Oral health outcomes from the Quebec Schoolchildren Oral Health Survey 1998-99 aggregated at the school level. These included proportions of children with dental caries and reporting oral pain. The relation between school deprivation indices and oral health outcomes was assessed with linear regression for dental caries experience and with logistic regression for oral pain.

Results: The mean DMF-S (mean number of decayed, missing and filled permanent teeth surfaces) by school was 0.73 (SD=0.55); the average proportions of children with dental caries and reporting oral pain were 25% and 3%, respectively. The poverty index was not associated with oral health outcomes. For the socioeconomic environment index, each unit increase (higher deciles meaning unfavorable) was associated with a 1.3% (95% confidence interval: 0.6-1.9%) increase in the proportion of children with caries. Furthermore, schools in more unfavourable socioeconomic environments, as compared to more favourable ones, were twice as likely to have children reporting oral pain.

Conclusion: The school socioeconomic environment index was associated with oral health outcomes, and should be studied for its potential usefulness in planning school-based oral health promotion and screening strategies.

Introduction

Over the past few decades a substantial decrease in the prevalence of chronic oral diseases (COD) has been observed in most industrialized countries (1, 2). However, COD remain a major public health concern throughout most of the world. Dental caries, the most prevalent COD, affects 60 to 90% of the population (2) and is among the four most expensive diseases to treat (3). Furthermore, COD have a major impact on overall health, well-being, and constitute a public health burden (4, 5).

Evidence has consistently shown that health outcomes, including COD, are associated with individual socioeconomic position (SEP) (6, 7), primarily affecting those in the lower social strata (8-11). In several populations, the prevalence of dental caries in primary and permanent dentitions was higher in school-age children from low SEP compared to those in high SEP (7, 11-13). Moreover, SEP at different periods of life course affects COD (7, 10).

This polarization of COD prompted the use of ecological study designs to allow identification of groups and communities at risk, instead of individuals. Such studies have been used to reliably identify groups at high-risk for COD (14-16). They offer a way to move beyond the traditional public health strategy of identifying high-risk individuals which, although widely used, has important limitations in the context of COD. COD are etiologically complex diseases in which several factors (e.g., microbial, genetic, immunological, behavioral, and environmental) are at play in determining the occurrence and severity of clinical diseases. Screening and diagnostic tests for COD based on a single risk indicator are therefore unlikely to accurately discriminate between those at high and low risk, that is, they have low sensitivity and specificity (17, 18). In addition, screening does not naturally lead to dental care attendance and receiving the appropriate treatment (18).

Directed population strategy, in which oral health care is provided to groups (e.g., schools, neighbourhoods) at high risk of COD, has been proposed as a more efficient way to promote oral health (19). Among potential target groups, schools are easily accessible and allow reaching an extensive number of children. Thus, they offer an ideal setting for health promotion programs and opportunities to decrease health inequalities, as recognized by the Commission on Social Determinants of Health launched by the World Health Organization (20).

Studies have shown that school indicators could be used as a risk indicator of COD. Characteristics of the school environment such as performance results (e.g., English, math, and literacy tests), free meal programs and socioeconomic environment were associated with COD (14). Similarly, a Canadian study using indicators available from the Ontario province's education system (e.g., school performance), has established the feasibility and validity of using such indicators as proxy measures for dental treatment needs at the school level (15).

Nevertheless, evidence remains limited and the usefulness of publicly available indicators for the identification of children at high risk of COD needs to be assessed in different populations. The purpose of this study was to investigate whether publicly available indicators of school socioeconomic environment could be used as predictors of oral health status in schoolchildren, in the province of Quebec, Canada.

Materials and Methods

This ecological study used 316 elementary public schools as the units of observation. School deprivation indices were obtained from publicly available datasets produced yearly by the Quebec Ministry of Education. Oral health data for 7-8 year-old schoolchildren were obtained from the 1998-1999 Quebec Children Oral Health Survey (QCOHS)(11), and were aggregated at the school level. These datasets were matched using school name, address, postal code, and the Ministry of Education's unique school identifier (Appendix 1).

School Deprivation Indices

The Ministry of Education has categorized the entire province of Quebec into 1445 territorial units, in which the population is relatively homogeneous in terms of social, economic and familial characteristics. These territorial units are used to produce area-based measures of deprivation level for each public school in the province (21). Two school deprivation indices are produced yearly by the Ministry of Education: the socioeconomic environment index and the poverty index, estimated using census data.

The socioeconomic environment index is based on maternal under-schooling (with a weight of two-thirds of the index) and parental unemployment (one-third of the index) in each school's territorial unit. The proportion of under-schooled mothers is defined as the number of mothers

(women with children aged 0 to 18 years) who do not earn a high-school diploma divided by the number of mothers in the school's territorial unit. Similarly, the proportion of unemployed parents is calculated by dividing the number of families in which none of the parents work by the total number of families in the school's territorial unit (22).

The poverty index uses the low income cut-off established by Statistics Canada, which is the level of income at which families spend 70% or more of their income on basic needs (food, housing, clothes) (23). The low income cut-off varies according to the demographic density in the area of residence and the number of individuals in the family. The poverty index represents the proportion of families living around or under the low income cut-off, within each school's territorial unit.

The deprivation indices for public schools in Quebec are produced for resources allocation and research purposes. The continuous indices are divided in deciles, and schools are classified according to the decile rank to which they belong. A decile rank value of 10 is given to the most underprivileged schools. The school deprivation indices are publicly available on the Quebec Ministry of Education website (24). This project used the deprivation indices for the academic year 2000-2001 produced using the 1996 census data.

Oral Health Data

The Quebec Schoolchildren Oral Health Survey (QSOHS) was conducted in 1998-99 among 5-6 and 7-8 year-old children (11). The aim of this cross-sectional study, co-directed by University of Montreal and the Public Health Department of Montreal-Centre, was to draw a portrait of the oral health status of kindergarten and grade 2 schoolchildren in the province of Quebec. This study has been described elsewhere (11). Briefly, using stratified random sampling by region, area of residence and socioeconomic level of the area of residence, a representative sample of children in kindergarten and grade 2 was drawn per school. The study sample included 2,901 kindergarten and 5,526 grade 2 schoolchildren with a participation rate of 85%. A questionnaire administered by a dental hygienist was completed by the children regarding their health related behaviours (diet and oral hygiene) while the parents received by mail a questionnaire on their socioeconomic status (e.g., educational level, annual family income, etc.). In addition, children were clinically examined at school by research teams composed of a public health dentist and a

dental hygienist. The dental professionals completed extensive training and a calibration session before the data collection phase. Children's oral health status (caries experience) was assessed using the American Dental Association type 3 dental exams. In addition, oral pain was assessed by asking children about any dental symptoms in the week prior to the interview and by clinical examination in order to include any dental infection. For the present study, only data from grade 2 schoolchildren were used. The oral health data were aggregated at the school level which included mean DMF-S (mean number of decayed, missing and filled permanent teeth surfaces per school), proportion of children with dental caries experience, and proportion of children reporting oral pain.

Water Fluoridation Data

Data on water fluoridation was provided by the Quebec Ministry of Health and Social Services for all the municipalities that have participated in the drinking water fluoridation program. Each school was considered as being in a municipality with or without water fluoridation based on its location.

Statistical Analysis

The school deprivation indices, oral health and water fluoridation data were matched and analysed using the Statistical Package for Social Science (SPSS) version 15.0. Following descriptive statistics, correlations between school deprivation indices (ordinal variables with values ranging from 1 to 10 for the socioeconomic environment and poverty indices) and school-level oral health indicators (proportion of children with dental caries and proportion of children reporting oral pain) were examined using Spearman rank correlation coefficients.

Associations between each school deprivation index and oral health outcomes were assessed using linear regression. The linearity assumption was verified by inspecting the distribution of residuals (25), which were normally distributed for dental caries, but not for oral pain. As a result, linear regression analysis was performed for dental caries, whereas logistic regression analysis was carried out for oral pain.

In the linear regression analysis, the independent variables school deprivation indices (socioeconomic environment and poverty indices) were included in the model as ordinal

variables in deciles, and the dependent variable proportion of dental caries as a continuous variable. Univariate models were done first, then both school deprivation indices were mutually adjusted for one another. To verify whether these associations differed according to the presence or absence of water fluoridation in the municipality, the water fluoridation variable and an interaction term were added in the models.

In order to address our research question about school deprivation indices and oral pain, logistic regression analyses were performed with the socioeconomic environment and poverty indices categorized in tertiles (favourable, intermediate, unfavourable) and the proportion of children reporting oral pain as a dichotomous dependent variable (no oral pain reported vs. some children reporting oral pain). For the deprivation indices, the specific values categorized into each tertile were as follows: socioeconomic environment index [1-5= favourable, 6-8= intermediate, 9-10= unfavourable] and poverty index [1-4= favourable, 5-7= intermediate, 8-10= unfavourable]. The presence of effect modification by water fluoridation status was verified by adding this variable and an interaction term in the models.

Results

School deprivation indices were available for all the elementary public schools of Quebec. Oral health data aggregated at the school level was obtained for 319 schools. However, three schools were excluded from the final sample due to missing information on variables (e.g., school address and postal code) that were essential to match the data files. Thus, the final sample was 316 schools including 4,903 schoolchildren. School-level characteristics of the study sample are shown in Table 1.

Frequency distributions for the school deprivation indices and the oral health outcomes are presented in Table 2. Both school deprivation indices were approximately normally distributed (provided in Appendix 2), and ranged from 1 to 10. The mean school socioeconomic environment index was 6.3 (SD 2.7), while the mean poverty index was 5.6 (SD 2.7). As for oral health, the school-level mean DMF-S was 0.7 (SD 0.5); the filled and missing components were 0.6, (SD=0.5) and close to zero, respectively. The average proportion of children with caries experience and reporting oral pain were 25% and 3.4% respectively. In most schools (67%), no

children reported oral pain, but the upper quartile had 5.3% or more children who reported oral pain with a maximum value of 44%.

Figures 1 and 2 display the distributions of the oral health outcomes by levels of the socioeconomic environment and poverty indices. While there is not a clear pattern between the poverty index and COD, a tendency is observed between socioeconomic environment index and COD. School socioeconomic environment index was significantly correlated with both caries experience (r Spearman=0.22, $p<0.001$) and oral pain (r Spearman=0.15, $p<0.001$). No statistically significant associations were found between the school poverty index and the oral health outcomes (caries experience: r Spearman=0.06, $p=0.25$; and oral pain: r Spearman=0.07, $p=0.20$).

The results of simple and multiple linear regression analysis (Table 3) demonstrated that the school socioeconomic environment index was associated with dental caries experience, while the poverty index was not. Since the correlation between the socioeconomic environment and poverty indices was strong (r Spearman=0.57, $p<0.001$) the indices were also modeled while adjusted for one another. Mutual adjustment of the two indices only slightly increased the association with the socioeconomic environment index, for which a one unit increase (higher values meaning more unfavourable environment) lead to a 1.3% (95% confidence interval: 0.6-1.9%) increase in dental caries experience. Thus, comparing the most unfavourable school socioeconomic environment to the most favourable one (an index of 10 vs. an index of 1), the increase of 9 units in the index leads to a predicted average increase of 11.7% ($9 \times 1.3\%$) in dental caries experience. When effect modification by water fluoridation was verified, this association did not differ according to presence or absence of water fluoridation in the municipality where each school was located. Therefore, the water fluoridation variable and interaction terms were not entered in the models. This model explained 5% of the dental caries variation.

Odds ratios and 95% CI from logistic regression models conducted to assess the associations between the school deprivation indices and the report of oral pain showed that schools in the most unfavourable socioeconomic environments (deciles 9-10), were twice as likely to have children reporting oral pain (OR=2.08; 95% CI=1.06-4.08) when compared to more favourable

school environment (deciles 1-2). No association was found between the poverty index and the proportion of children reporting oral pain (Table 4). Similarly to linear regression models for dental caries, no effect modification by water fluoridation was present and final logistic regression models did not include water fluoridation.

Discussion

Using publicly available school indicators, we have found evidence of a positive association between the school socioeconomic environment index and oral health outcomes. Our results demonstrate that the prevalence of dental caries experience is almost 12% higher in the most unfavourable school environment compared to those in the most favourable environment. Furthermore, in schools with a more unfavourable socioeconomic environment, we observed a higher percentage of children reporting oral pain. Conversely, no association was found between the school poverty index and either caries experience or oral pain.

These findings provide some support for the argument that the socioeconomic environment index may be used as a risk indicator of oral health outcomes in Quebec school children. Indeed, ecological studies performed in other populations have reported similar results. Muirhead and Locker reported that the use of readily available school performance results (e.g., Math, English results) was a feasible strategy to identify schools with high dental treatment needs in Ontario, Canada (15). In the United Kingdom, school-provided free meals, Jarman index (a composite index used to measure material deprivation), and academic achievement were associated with dental caries experience and dental care needs (14, 16).

While our results report a statistically significant association between school socioeconomic environment index and oral health outcomes, no associations were found with the school poverty index. One possible explanation for these contrasting findings might be related to the fact that all Quebec children under the age of 10 have free access to dental care. Thus, the school poverty index, based solely on family income in the school area, may not capture the oral health needs of the school population. In fact, our results show that the “filled teeth surfaces” component of the DMF-S index represented approximately 83% of the whole index, suggesting high utilization of dental care resources.

Another possible explanation for these findings relates to the underlying definition of each of these deprivation indices. Although they were both created to summarize the school socioeconomic environment, they probably reflect different dimensions. For example, the core variables used in the computation of the socioeconomic environment index are maternal level of education and parental employment status. These variables, more specifically mother level of education which comprises 2/3 of the index, may be particularly important in the low economic sectors of the populations. In such groups, women's education levels have been consistently associated with health (26). Formal education leads to collecting and better understanding information, learning new concepts, and discovering how to access information. This, therefore, may increase cognitive resources, which in turn, will have major impact on health, (27). Children attending schools with a high percentage of educated mothers may have more educational resources which influence, for example, healthy choices and behaviours (28). Income, in contrast, translates into financial power to buy resources, nutrition, housing and access to health care (29). However, education can modify the effect of income, since highly educated parents may spend more money on healthy food and health care behaviours.

The socioeconomic environment index explained only 5% of the variation in dental caries experience in linear regression analyses. This may be related to the fact this index did not measure all aspects that can influence oral health, such as characteristics at the individual level. It is widely reported that population health is determined by a combination of individual (e.g., genetic background, gender, culture, ethnicity) and environmental factors (e.g., support networks, social and physical environment) that act together in influencing population health (30). The two indicators in our study were available at the school level, and their interest rested on the fact that they are produced yearly by the Ministry of Education. However, there is no doubt that other group-level (neighbourhood, family, social network) and individual variables could have contributed to explain differences in dental caries experience. As an example of group-level factor, water fluoridation status might have been expected to influence the observed associations, but no such effect modification was observed. In the interest of finding publicly available indicators that can be used to predict dental care needs, other school and group-level variables that could complement the socioeconomic environment index should be explored.

From a methodological point of view, this study has some limitations, and thus results need to be interpreted carefully. Firstly, this is an ecological study in which information was at the school level, and thus inference cannot be extrapolated to the individual level. As our study aimed to identify indicators of COD at the school level for prevention and intervention purposes, the ecological design was the most appropriate one. In addition, it cannot be assumed that these findings can be generalized to other populations, since school indicators, patterns of oral health needs, and oral health programs certainly vary in different settings.

Secondly, we acknowledge that the data that we used were collected for purposes other than ours. The deprivation indices are calculated using census data for all public schools in Quebec. Both are reliable indicators used by the Ministry of Education to allocate resources among the school boards based on the characteristics of each school's student population. Nonetheless, it is likely that school indicators designed specifically to identify schools at high-risk for COD would have encompassed additional information. The oral health data from the QCOHS were carefully collected using the clinical examination type 3, according to the American Dental Association (11). On one hand, the variable oral pain was based on subjective report from the children, and its etiology was not explored (e.g., dental caries, trauma, eruption of permanent teeth). On the other hand, the DMF-S is the most widely used indicator for dental caries experience in oral epidemiology studies. Despite some debates (31, 32), it remains recommended by the World Health Organization (33).

Thirdly, the original sample size was calculated for the Quebec Schoolchildren Oral Health Survey. In the study sample, there were large variations in the number of grade 2 children contributing to the aggregate values at the school level (range: 2-36). As a result, the aggregated values can be more or less misclassified depending on the school specific response rates and representativeness of the participating schoolchildren. This could have led to an underestimation or overestimation of the prevalence of oral health outcomes. In addition, it is possible that children who did not participate in the study (absence or refusal) had more or less dental caries than those who participated, which could also result in over- or underestimation of the prevalence of dental caries.

To our knowledge, this is the first study investigating associations between publicly available school deprivation indices and oral health status among Quebec schoolchildren. Moreover, this work contributes to a better understanding of the relation between school-based socioeconomic level and oral health. Finally, these findings suggest that ecological studies can be useful to identify groups at risk of COD and may provide an empirical basis for efficient and cost-effective public health interventions towards COD prevention, ultimately leading to reduced oral health inequalities.

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Table1. School-level characteristics of the study sample – 4,903 grade 2 schoolchildren – among 316 schools in Quebec, 1998-99.

	Mean (SD)	Range	Quartiles		
			25th	50th	75th
Number of students per school	15.5 (7.2)	2-36	9.0	16.0	20.0
Proportion of girls per school	49.6 (15.9)	11-100	39.3	50.0	58.0
Proportion of children with yearly family income less than 30,000 CAN \$	35.1 (23.2)	0 - 100	18.7	33.3	50.0
Proportion of children whose parents' highest level of education was high school	40.9 (21.3)	0-100	25.0	41.2	55.5
Proportion of children with at least one parent on welfare	11.0 (15.2)	0-100	0.0	6.2	16.5
Proportion of children who speak a language other than English or French at home	4.2 (13.2)	0-100	0.0	0.0	0.0

Figure 1. Frequency distribution of oral health outcomes by the socioeconomic environment index.

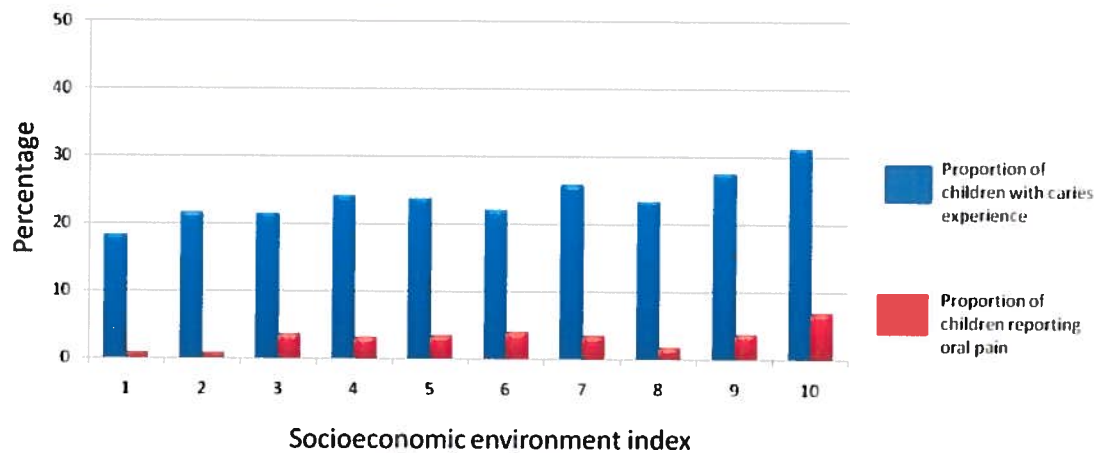


Figure 2. Frequency distribution of oral health outcomes by the poverty index.

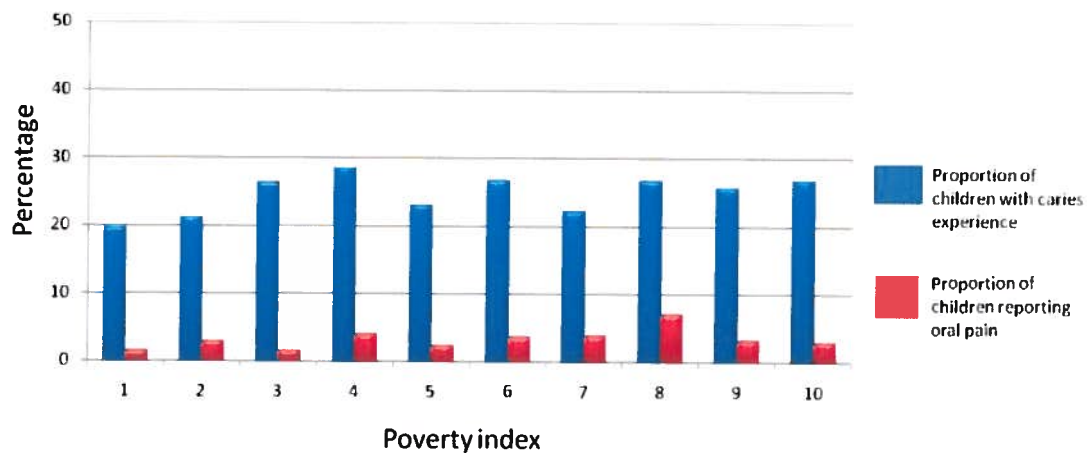


Table 2. Descriptive statistics for independent – school deprivation indices – and dependent variables – proportion of children with caries experience and reporting oral pain – among 316 schools in Quebec, 1998-99.

	Mean (SD)	Range	Quartiles		
			25th	50th	75th
School socioeconomic environment index (deciles)	6.3 (2.7)	1 - 10	4.0	7.0	9.0
School poverty index (deciles)	5.6 (2.7)	1 - 10	3.0	6.0	8.0
Proportion of children with caries experience (%)	24.7 (14.1)	0.0 - 80.0	14.3	25.0	33.3
Proportion of children reporting oral pain (%)	3.4 (6.4)	0.0 - 44.0	0.0	0.0	5.3

Table 3. Unadjusted and mutually adjusted differences in proportion of children with dental caries experience per unit of school deprivation indices among 316 schools in Quebec, 1998-99.

		Unadjusted	Mutually adjusted*	
		β (95% CI)	β (95% CI)	R^2
Socioeconomic index	environment	1.08 (0.52, 1.63)	1.26 (0.58, 1.94)	0.05
Poverty index		0.42 (-0.16, 0.99)	-0.32 (-1.01, 0.37)	

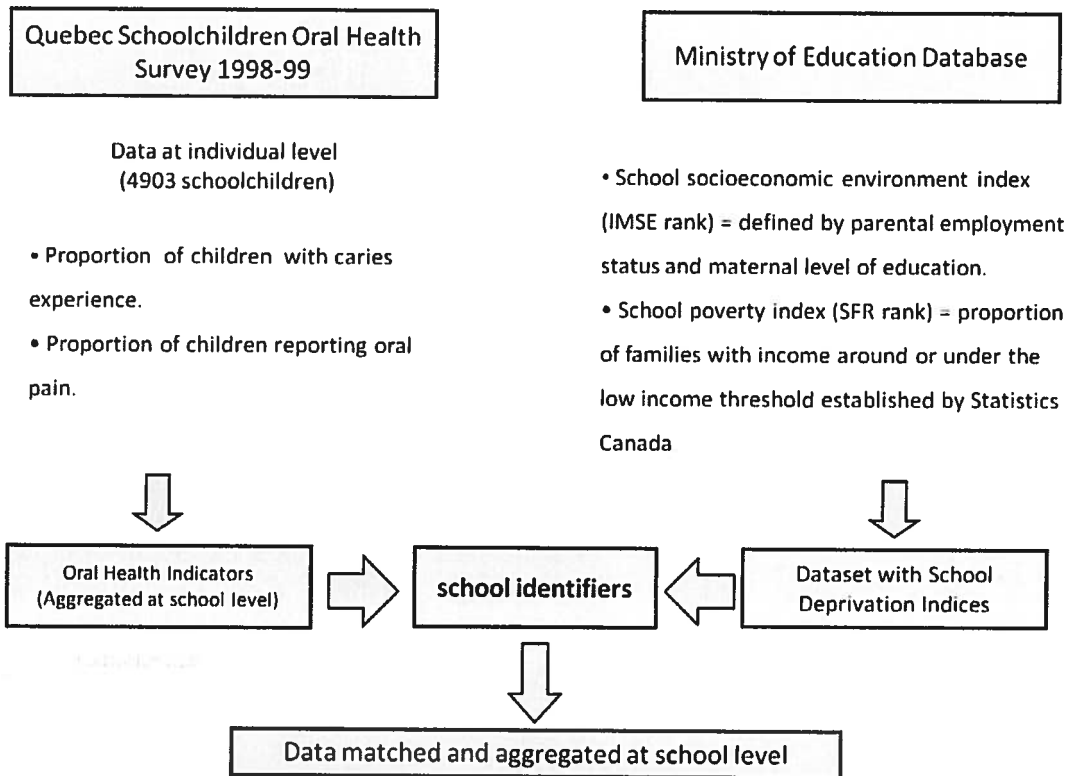
* Linear regression model including variables for socioeconomic environment index and poverty index.

Table 4. Odds ratios for the associations between school deprivation indices and reporting of oral pain (yes/no) among 316 schools in Quebec, 1998-99.

	Unadjusted OR (95% CI)	Mutually adjusted OR (95% CI)*
	For reporting of oral pain	For reporting of oral pain
Socioeconomic environment index		
Favourable (1-5)	1.00	1.00
Intermediate (6-8)	1.49 (0.84, 2.64)	1.55 (0.85, 2.84)
Unfavourable (9-10)	1.96 (1.08, 3.56)	2.08 (1.06, 4.08)
Poverty index		
Favourable (1-4)	1.00	1.00
Intermediate (5-7)	1.16 (0.66, 2.03)	0.95 (0.52, 1.72)
Unfavourable (8-10)	1.24 (0.69, 2.20)	0.88 (0.45, 1.70)

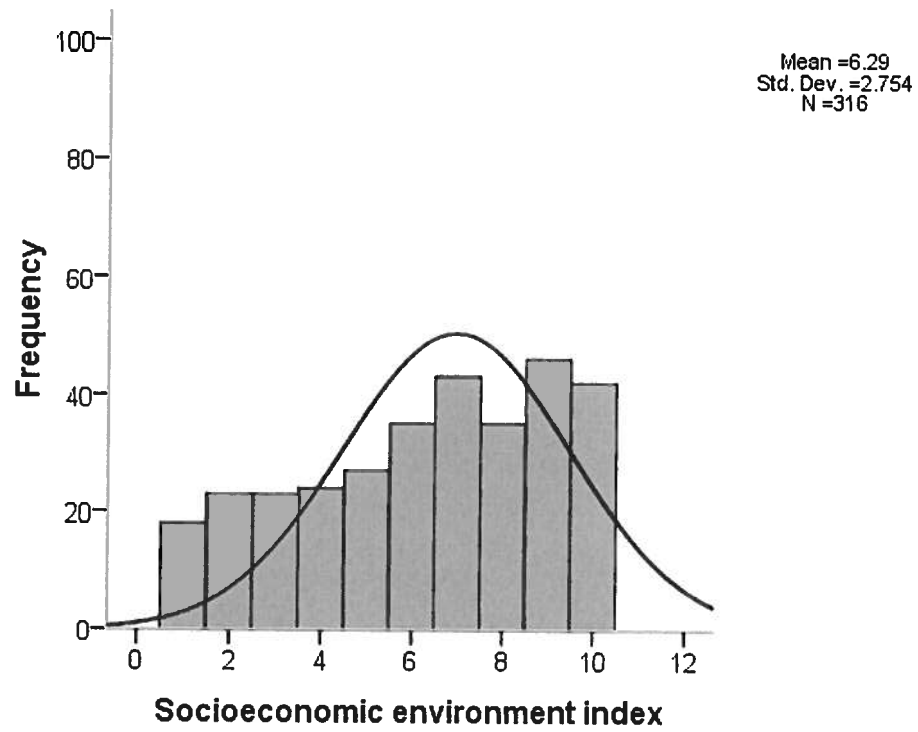
* Logistic regression model including variables for socioeconomic environment index and poverty index.

Appendix 1

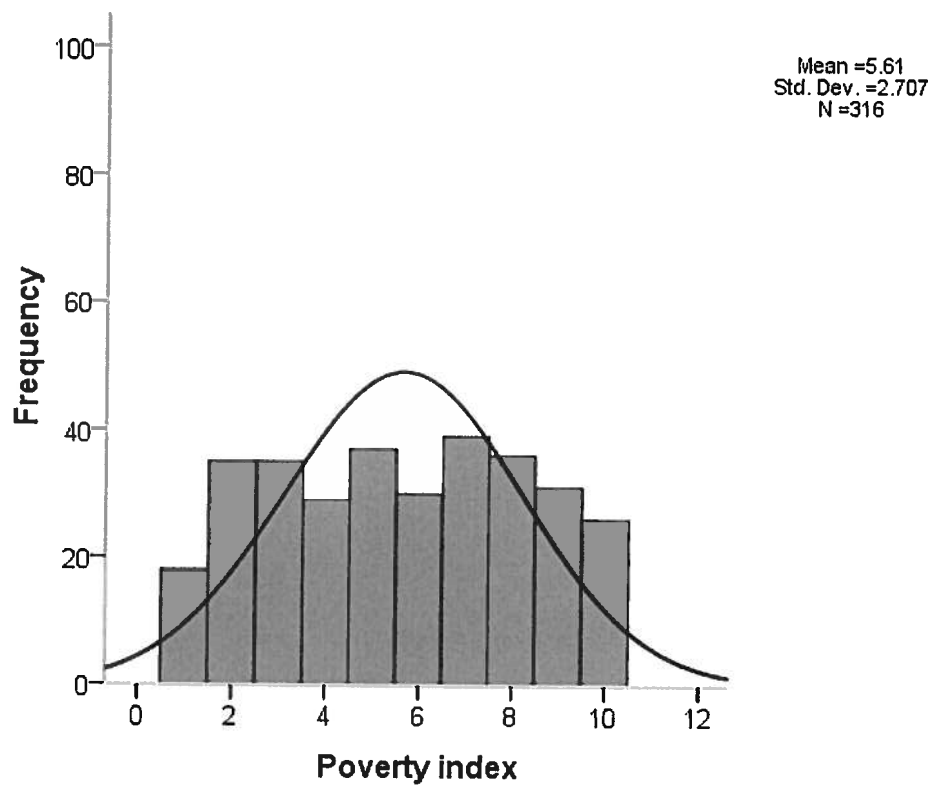


Flowchart describing the files matching from both sources: Quebec Oral health Survey and Ministry of Education.

Appendix 2



Histogram of the school socioeconomic environment index in decile ranks



Histogram of the school poverty index in decile ranks

5 Discussion

Using publicly available school deprivation indices, this study allowed for the observation of a positive association between the school socioeconomic environment index and oral health outcomes (dental caries experience and oral pain). The prevalence of dental caries experience was almost 12% higher in the most unfavourable school environment compared to the most favourable one. Furthermore, in schools with a more unfavourable socioeconomic environment, a higher percentage of children reporting oral pain was observed. Conversely, no associations were found between the school poverty index and oral health outcomes.

The fact that results of the present study showed a statistically significant association between school socioeconomic environment index and oral health outcomes, but not with the school poverty index may be related to the definition of the indices themselves. Also of note is the context in which this study was set as all Quebec children under the age of 10 have free access to dental care. The school poverty index is based solely on family income in the school area, and thus it is possible that it would not reflect the oral health need of the school population, given the free access to dental care in the age group studied. On the other hand, the socioeconomic environment index is based on maternal level of education (2/3 of the index) and parental employment status. It is conceivable that it was associated with oral health outcomes because it reflects the effect of education on health. Formal education leads to collecting and better understanding information, learning new concepts, and discovering how to access information (Lynch and Kaplan 2000). In contrast, income on which the school poverty index is based, translates into financial power to buy resources, nutrition, housing and access to health care (Winkleby, Jatulis et al. 1992). However, education can modify the effect of income, since highly educated parents may spend more money on healthy food and health care behaviours. At the school level, however, there was no effect modification between the socioeconomic environment and the poverty indices in relation to oral health outcomes.

Furthermore, it was observed that only 5% of the variation in dental caries experience was explained by the socioeconomic index when a linear regression analysis was carried out. One of the possible explanations is the fact that this indicator did not take into account several factors that may be associated with oral health outcomes. As described by the WHO, many factors in combination can contribute to overall general health, such as: gender, genetic background, education, individual behaviours, as well as social and physical environment (WHO 2009). Along the same lines, the World Oral Report 2003 describes how oral health is related to the same determinants of health, as poor socioeconomic condition is commonly related to a diet high in sugar and low in fruits and vegetables. Additionally, poor living conditions is often related to limited access to fluoridate water among others factors (WHO 2003). For this study, the objective was to specifically determine if school deprivation indices routinely produced by the MEQ for allocation of resources and for research purposes could be used to identify subgroups (i.e., schools) of children at higher risk of COD. Should we have decided to take a more comprehensive and substantive approach, we may have aimed to understand all the factors involved in COD aetiology. Although this is a different and pertinent research question, we would undoubtedly have been able to explain a greater proportion of the difference in COD prevalence between schools. In that sense, if we had studied individual, familial, and neighbourhood characteristics in addition to the school deprivation indices, we could have found a more comprehensive set of characteristics that could have explained the differences in COD between schools. Although highly interesting, this would answer a completely different research question, relating to the etiology of COD.

5.1 Strengths

This study is, to our knowledge, the first in Quebec to use publicly available school deprivation indices for the identification of populations of schoolchildren at higher risk of COD. This study used reliable indicators from the MEQ and from the most recent Quebec Schoolchildren Oral Health Survey. It demonstrated the feasibility and usefulness of public information easily available on the MEQ governmental web page as a timely and cost effective way to perform public health research. First, we would like to highlight the

feasibility, since both data sets were readily available for research and were easy to match to each other using school addresses and unique identifiers. Secondly, this study brings forth the idea of integrating publicly available data from different government departments (Public Health Department and MEQ) even if they were created for other purposes such as to allocate resources in schools (e.g., school deprivation indices) or to measure the prevalence of COD (e.g., Quebec Oral Health Survey). Lastly, this study shows how evidence from research may be utilized by the public health system, in which the results from this type of study may lead to new tools for planning strategies in public health prevention and intervention in groups at higher risk for COD. This can easily be done in a quick and cost effective manner, improving the practice of public oral health professionals. This type of research is a direct application of knowledge transfer activities where symbiotic ties between schools and academic researchers can be established.

5.2 *Limitations*

This ecological study was designed to assess the relationship between school deprivation indices and children's oral health status at the school level. One of the well known limitations of this design is that it does not allow for the interpretation of associations at an individual level. Such misinterpretation of group level results at the individual level is referred to as the ecological fallacy. However, as the aim of the study was to identify indicators of COD at the school level, the ecological design was the most appropriate design to use. According to Schwartz, the correlations resulting from ecological studies are not substitutes for those that would be observed at individual level, but this design is important in the public health perspective since it allows assessing the effect of group level variables on population health. Thus, ecological studies provide essential information to understand group level characteristics of the disease and to complement the individual level studies (Schwartz 1994).

The number of children per school is an important issue that needs to be considered. For the oral health data, the original sample size was calculated for the Quebec Schoolchildren Oral Health Survey. There were large variations in the number of grade 2 children contributing to the aggregate values at the school level, ranging between 2 and 36 children per school among the 316 schools included in this ecological analysis. Thus,

the aggregated values could be more or less misclassified depending on the school specific response rates and representativeness of the participating schoolchildren. If participants were not representative of the grade 2 student population in some schools, that is, if children who were absent or declined to participate had a higher or lower prevalence of COD than those who participated, the prevalence of oral health outcomes could have been underestimated or overestimated by the study sample.

The small number of explanatory variables included in the study is another limitation. Assessing a greater number of publicly available school-level indicators could have allowed us to identify better and/or more indicators of Quebec schoolchildren at high risk of COD. The study was originally designed to also include school performance results, delays in graduation, information on school meals, and attendance of special integration classes as potential explanatory variables. None of these variables could be included in the current study, for the reasons presented below.

School performance results are compiled by the MEQ, only at the high school level. These documents report the proportion of students who successfully wrote the Quebec Ministry exams among all the students who took the exams, by school. These school-level statistics are available for all exams grouped together, for French exams in French schools, and for English exams in English schools (Ministère de l'Éducation du Loisir et du Sport 2004). Although they theoretically could have been of interest as potential indicators of COD risk, these statistics could not be used in the current study because the study population was grade 2 students (7-8 year-olds) and the school performance results related to high school students (adolescents).

Delays in graduation were of interest as another potential indicator for COD. For each school, statistics are produced documenting the age of schoolchildren when they graduate from the first (grades 1-3) to the second (grades 4-5) and third (grades 5-6) cycles of elementary school. These statistics allow determining the proportion of children who graduate with some delay as compared to the “normal” progression. Unfortunately, these indicators were not available for the academic year of interest, and are still considered as unreliable and non-robust because they were introduced fairly recently (2001-2002). Similar statistics are available to document delay for graduating from elementary to high

school which is described as the proportion of children who graduate to high school at the age of 12 years or less. Due to the fact that this variable was not available for all the 316 schools (n=286) it was not included in this study.

Information on meals provided by the schools has been the main focus of previous studies, and was found to be a good indicator of dental care needs (Muirhead and Marcenes 2004). For the current study, this information was not available, since the schools and school-boards do not have to communicate this information to the MEQ. Therefore, collecting this information for all the 316 schools would be against the aim of using readily accessible indicators already produced by the MEQ.

Lastly, the proportion of students per school who had been in “special integration classes” for immigrants, calculated as the proportion of students at the elementary level that were attending or have been attended a special class (classes d’accueil), was available. However, it could not be used because in the vast majority of schools in the study sample, the proportion of students attending special integration classes was extremely low. Therefore, there was not enough variation to perform statistical tests.

5.3 Public health strategies to prevent COD

Two public health strategies to prevent and improve oral health are the high risk strategy and the population level strategy. The latter includes the directed population strategy and its conceptual framework is based on the common risk factor approach.

The high risk strategy is traditionally focused on the disease. It aims to identify individuals or groups at “high risk” of developing certain diseases in order to provide prevention and treatment. As an example of such strategy, the school-based dental program is one of the most important public health interventions in many countries in which dental sealants are applied to those individuals classified at high risk for dental caries. The identification of the individuals at “high risk” or “lower risk” for future dental caries is performed by a clinical examination (screening) and then based on the level of dental caries experience (e.g., high DMF-S). The assumption is that new lesions of dental caries would occur more commonly among those in the “high risk” group, so that only

those schoolchildren considered at “high risk” would receive preventive interventions (e.g., topical fluoride, dental sealants) and dental treatment (e.g., filling). As a result, it would be expected that dental caries incidence would be reduced. The other part of the group, classified as “low risk”, would not receive this intervention. However, it has been argued that this strategy would not be effective in decreasing future dental caries, since there are two important factors that need to be taken into account (Batchelor and Sheiham 2006). Firstly, there is evidence that the incidence of dental caries is actually higher in the individuals at “low risk” than those at “high risk”. For example, a study looking for new dental caries among 7 year-old children over a 4-year period, receiving preventive care, showed that children classified as “low risk” were those who accounted for the largest amount of new lesions (more than 90%) (Batchelor and Sheiham 2006). Secondly, as a multifactorial disease, dental caries could not be predicted based on the DMF as a single risk indicator. Therefore, it has been shown that the “high risk” strategy has minimal impact on dental care attendance and on receiving the appropriate treatment (Milsom et al., 2006), whereas a strategy in which identification of groups or populations rather than individuals would have a better impact on dental caries incidence (Batchelor and Sheiham 2006).

The population level strategy focuses on improving the health status of the population or sub-population rather than individuals. Given that most chronic diseases are preventable and have common risk factors, Geoffrey Rose suggested that the distribution of risk exposure in a population is shaped by contextual conditions (e.g., access to fresh fruits and vegetables, policies on free-smoking in public places, etc.) (Rose 1993). The tap water fluoridation is an example of such a strategy used to reduce COD at the population level. This strategy is implemented by applying the principles of the common risk approach which proposes that health interventions should tackle risk factors common to both general and oral health (e.g., healthy schools meals would reduce obesity and diabetes as well as dental caries) (Sheiham and Watt 2000). Once a population or sub-population at risk is identified, the directed population approach may be used. It aims to provide preventive and curative oral health care to those groups in the population who are at high risk, such as schools or specific age groups. The identification of schools in which children are at high risk for COD, with the use of public indicator as those studied here, is

the first step towards the implementation of the directed population approach for oral health.

5.4 *Future Research*

As a follow-up to this study, further research will be needed in order to confirm these findings and determine whether they can be applied to public health planning policies.

Studies similar to ours including more explanatory variables at the school-level could be conducted in the Quebec population. School performance results are available for high schools (e.g., results for French, English, and mathematics exams) and could be assessed if oral health data was available for that age group. In addition, some indicators such as the proportions of students graduating with delay to the second cycle of elementary school (grades 3-4) and to high school are available for more recent academic years as discussed above.

Furthermore, as a complex disease that is determined by multiple factors at different levels (individual and group level), dental caries etiology needs to be better understood. A multilevel analysis could be performed to identify risk factors for COD at the group level (e.g., neighbourhood characteristics) and at the individual level (e.g., family income, family structure). Thus, the relationship between these factors and COD could be investigated to understand all factors involved in COD etiology at the same time rather than looking at them as singular risks (e.g., only diet). The identification of such factors would allow us to explore interventions and strategies to decrease those risks in a more broad and cost-effective way. For example, a longitudinal study in which there is an identification of risk factors for COD in the individual's family as well as in his/her social environment measured at two or three points in time would result in better understanding of the disease development. It would also lead to a broader knowledge of the risk factors to which the individuals are exposed and could give clues for more effective prevention.

Finally, the results from this study could be used to implement health promotion strategies and preventive programs to reduce COD in schools at high risk for these diseases (e.g., Quebec schools with socioeconomic environment index values of 9 and

10). For example, after identifying those schools at a high risk for COD, school policies could include: free and healthy school meals (e.g., rich in fruits and vegetables and low in refined carbohydrates), an appropriate fluoride exposure (e.g., water supply with fluoride or availability of fluoridated products such as mouth rinses, toothpaste), a special dental care for those in need (e.g., visits by dentist with a portable equipment, since access maybe a time issue for some families), promotion of physical and a social activities involving not only the children but the parents in the school environment. Subsequently, a comparison could be performed between schools with an environment that is more or less supportive of health policies to determine the impact this may have on children's oral health.

5.5 Conclusion

To our knowledge, this is the first study investigating the associations between publicly available school deprivation indices and oral health status among Quebec schoolchildren. Moreover, this work contributes to a better understanding of the possible uses of available school-level indicators to identify schoolchildren at higher risk of COD, which may provide an empirical basis for efficient and cost-effective public health interventions towards COD prevention, ultimately leading to reduced oral health inequalities.

6 Additional Results

Analyses were performed in order to test the underlying assumption of a linear regression model, that the outcome is a linear function of the regression parameters of the model. The distribution of residuals from the model were examined, since normally distributed and constant residuals indicate that the linearity assumption of the model is not violated (Munro 2004). These results are not presented in the article, but are included here because they were an integral and important analytical step.

A normal curve in this histogram and a normal plot showed that the residuals from a linear regression model containing the two school socioeconomic variables (socioeconomic environment index and poverty index) with proportion of children with dental caries as the dependent variable were normally distributed. This demonstrated that the linearity assumption was not violated (Figures 6 and 7). However, a second linear regression model with the two school deprivation indices and the other dependent variable, the proportion of children reporting oral pain, resulted in residuals that were not normally distributed (Figures 8 and 9) Thus, because linear regression assumptions were violated, logistic instead of linear regression analyses were performed. To this end, the dependent variable “proportion of children reporting oral pain” was recoded into a binary variable “no oral pain reported vs. some children reporting oral pain”.

Dependent Variable: caries experience

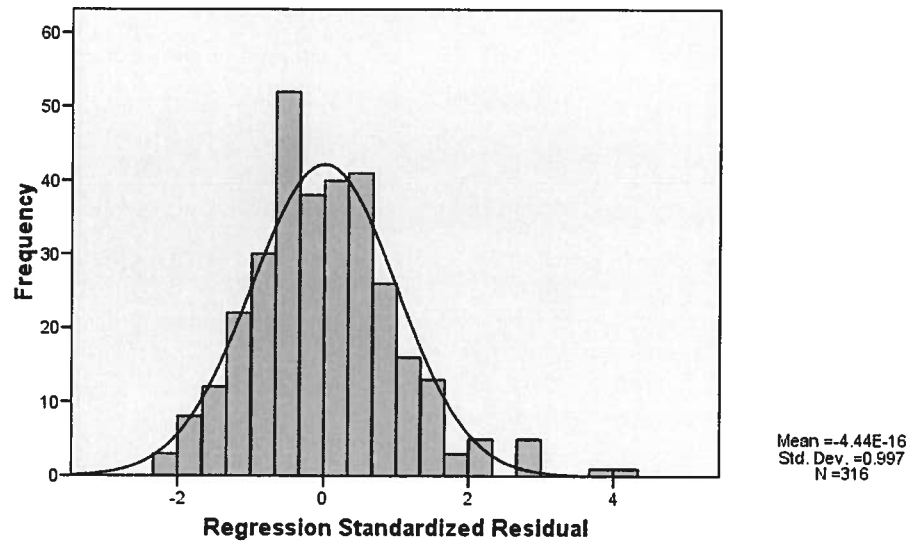


Figure 6. Histogram of residuals from the linear model including school deprivation indices (socioeconomic environment index and poverty index) and the dependent variable Proportion of children with caries experience.

Dependent Variable: caries experience

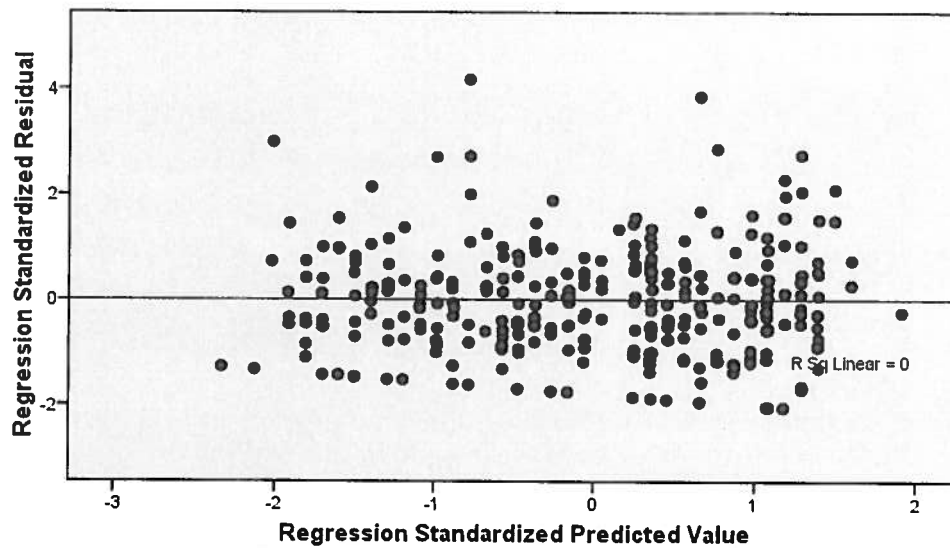


Figure 7. Scatterplot of the residuals from the linear model including school deprivation indices (socioeconomic environment index and poverty index) and the dependent variable Proportion of children with caries experience.

Dependent Variable: proportion douleur

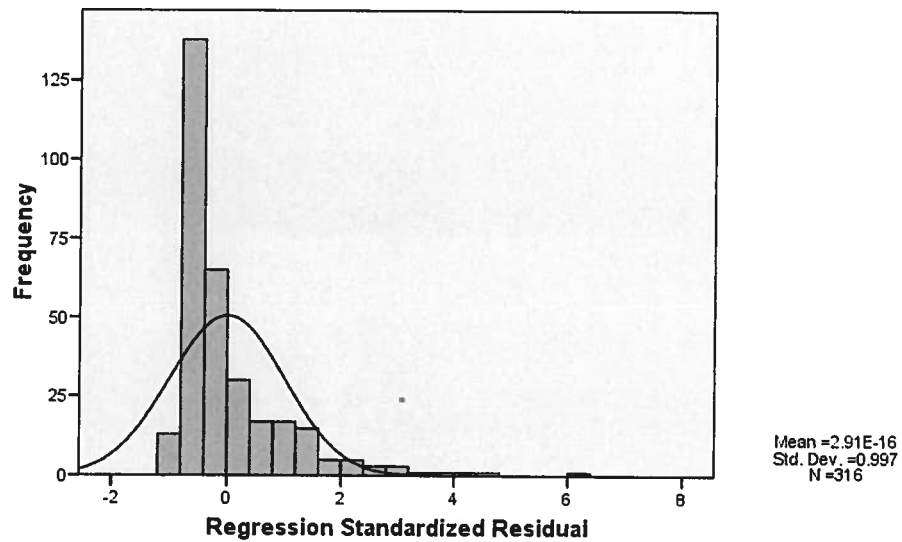


Figure 8. Histogram of residuals from the linear model including school deprivation indices (socioeconomic environment index and poverty index) and the dependent variable Proportion of children reporting oral pain.

Dependent Variable: proportion of oral pain

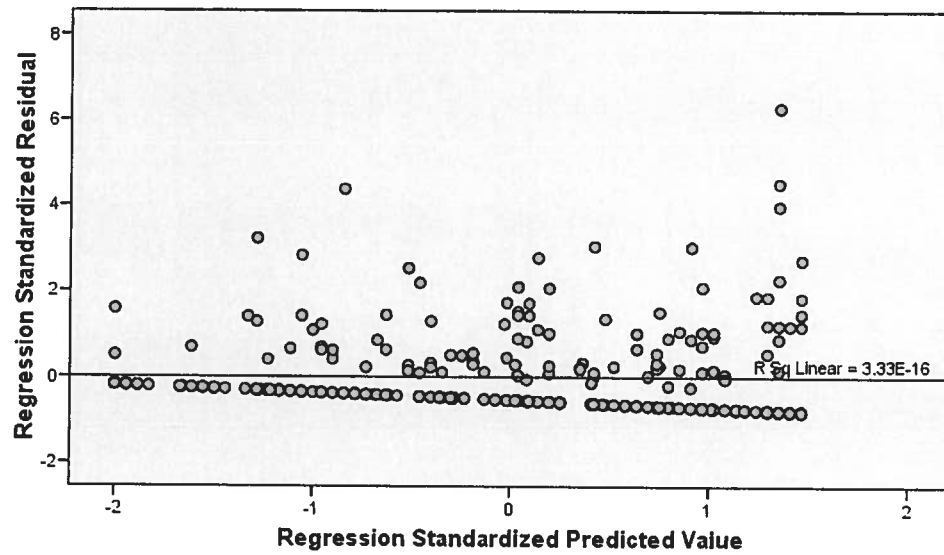


Figure 9. Scatterplot of the residuals from the linear including school deprivation indices (socioeconomic environment index and poverty index) and the dependent variable Proportion of children reporting oral pain.

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RÉSUMÉ DU MÉMOIRE ET DES TABLEAUX EN FRANÇAIS

Par PATRICIA CAMARGO DA ROSA

**Associations entre les indices de défavorisation des écoles
et l'état de santé buccodentaire des élèves au Québec**

Août, 2009

7 Long Résumé

7.1 Introduction

Dans les dernières décennies, une réduction substantielle de la prévalence des maladies buccodentaires chroniques a été observée dans la plupart des pays industrialisés (Petersen 2003; Marthaler 2004). Cependant, ces maladies demeurent une préoccupation majeure en santé publique dans la plupart des régions du monde. La carie dentaire, la maladie buccodentaire chronique la plus répandue, affecte entre 60 et 90% de la population (Petersen 2003) et compte parmi les quatre maladies les plus coûteuses à traiter (Petersen, Bourgeois et al. 2005). De plus, les maladies buccodentaires chroniques exercent un impact majeur sur la santé et le bien-être de façon générale, et constituent un fardeau pour la santé publique (Locker 1996; Sheiham 2005).

Les recherches ont montré de façon constante que les problèmes de santé, incluant les maladies buccodentaires chroniques, sont associés à la position socio-économique individuelle (Hausen, Kärkkäinen et al. 2000), affectant principalement les individus dans les classes sociales inférieures (Lynch, Smith et al. 2000; Brodeur, Olivier et al. 2001; Marmot 2001; Nicolau, Marcenes, Bartley et al. 2003; Marthaler 2004; Thomson, Poulton et al. 2004; Nicolau, Marcenes, Allison et al. 2005). Dans plusieurs populations, la prévalence d'enfants sans carie de la dentition temporaire et permanente est plus élevée chez les enfants d'âge scolaire ayant une position socio-économique élevée, comparativement à ceux ayant une position socio-économique basse (Brodeur, Olivier et al. 2001; Poulton, Caspi et al. 2002; Nicolau, Marcenes, Allison et al. 2005; Nicolau, Marcenes, Bartley et al. 2005). En outre, la position socio-économique à différentes périodes de la vie affecte le risque de maladies buccodentaires chroniques (Thomson, Poulton et al. 2004; Nicolau, Marcenes, Bartley et al. 2005).

Cette polarisation des maladies buccodentaires chroniques selon la position socio-économique a suscité l'utilisation de devis d'étude écologiques afin de permettre l'identification de groupes et de communautés à risque, plutôt que des individus. De telles recherches ont été effectuées pour identifier de façon fiable les personnes qui présentent un risque élevé de maladies buccodentaires chroniques (Crowley, O'Brien et al. 2003;

Muirhead and Marcenes 2004; Muirhead and Locker 2006). Elles permettent d'aller au-delà de la stratégie de santé publique traditionnelle d'identification des individus à haut risque qui, bien qu'elle soit couramment utilisée, présente des limites importantes dans le contexte des maladies buccodentaires chroniques. Les tests de dépistage et de diagnostic des maladies buccodentaires chroniques ont une sensibilité et une spécificité faibles (Batchelor and Sheiham 2006; Milsom, Blinkhorn et al. 2006). De plus, le dépistage exerce un impact minimal sur la consultation dentaire et l'obtention de traitements appropriés (Milsom, Blinkhorn et al. 2006).

La stratégie populationnelle ciblée (*directed population strategy*), selon laquelle les soins de santé buccodentaire sont prodigués à des groupes (ex. : écoles, quartiers) à haut risque de maladies buccodentaires chroniques, a été proposée comme moyen plus efficace de promouvoir la santé buccodentaire (Sheiham 2000). Parmi les groupes cibles potentiels, les écoles sont facilement accessibles et permettent de rejoindre un nombre considérable d'enfants. Elles constituent ainsi un cadre idéal pour les programmes de promotion de la santé et les opportunités de réduction des inégalités en matière de santé, tel que reconnu par la Commission des déterminants sociaux de la santé mise sur pied par l'Organisation mondiale de la santé (WHO 2000).

Des études ont montré que des indicateurs scolaires pouvaient être utilisés comme facteurs prédictifs de maladies buccodentaires chroniques. Des caractéristiques du milieu scolaire tels que les résultats à des tests de performance (ex. : tests d'anglais, de mathématiques, de lecture et d'écriture), les programmes de repas gratuits et le milieu socio-économique ont été associés à la prévalence de maladies buccodentaires chroniques (Muirhead and Marcenes 2004). De même, une étude canadienne pour laquelle ont été utilisés des indicateurs disponibles auprès du système d'éducation de la province de l'Ontario (ex. : résultats à des tests de performance) a établi la faisabilité et la validité d'utiliser de tels indicateurs comme mesures de substitution pour estimer le besoin de traitements dentaires au niveau de l'école (Muirhead and Locker 2006).

Néanmoins, les données demeurent limitées et l'utilité des indicateurs publiquement disponibles pour l'identification des enfants à haut risque de maladies buccodentaires chroniques doit être évaluée dans différentes populations. Le but de cette étude était de

déterminer si des indices de défavorisation des écoles publiquement disponibles pouvaient être utilisés comme facteurs prédictifs du statut de santé buccodentaire chez des élèves de la province de Québec, au Canada.

7.2 Logique sous-tendant l'étude

Malgré un déclin substantiel de la carie dentaire observé dans plusieurs pays au cours des dernières décennies et des efforts pour réduire les inégalités en santé buccodentaire, les programmes de soins de santé buccodentaire requièrent encore des améliorations. La carie dentaire exerce un impact important sur la vie des gens et demeure commune parmi les groupes de faible niveau socioéconomique et les jeunes enfants. Puisque les ressources pour offrir des soins de santé buccodentaire à la population sont limitées, une stratégie centrée sur les groupes à haut risque paraît optimale. Toutefois, avant que ceci ne puisse être accompli, des prédicteurs potentiels des groupes à haut risque au niveau de la population doivent être examinés.

Peu d'études ont exploré l'association possible entre les caractéristiques socioéconomiques des écoles et la maladie buccodentaire chronique, si bien que les données dans ce domaine demeurent limitées. De plus, peu d'information existe sur l'utilité d'indicateurs publiquement disponibles pour identifier des enfants à haut risque de maladie buccodentaire chronique dans la province de Québec. Dans ce contexte, la présente étude visait à combler les lacunes actuelles dans les écrits scientifiques, en utilisant des données existantes comme moyen rapide et économique de combler ces lacunes.

L'objectif principal était d'identifier des indicateurs des populations d'enfants à haut risque de maladie buccodentaire chronique au niveau de l'école. Plus spécifiquement, les indices de défavorisation scolaire produits par le Ministère de l'Éducation, du Loisir et du Sport du Québec ont été examinés comme indicateurs de la carie dentaire et de la douleur buccodentaire chez des élèves québécois. Nous avons supposé qu'un milieu socio-économique scolaire défavorable serait relié à une prévalence accrue de maladie buccodentaire chronique.

Nos résultats pourraient fournir aux décideurs une base empirique pour mettre sur pied des interventions de santé publique efficaces et économiques afin de prévenir la maladie buccodentaire chronique et devraient en fin de compte contribuer à réduire les inégalités en santé buccodentaire.

7.3 Méthode

Cette étude écologique a utilisé 316 écoles primaires publiques comme unités d'observation. Des indices de défavorisation des écoles ont été obtenus à partir de bases de données publiquement disponibles et produites annuellement par le Ministère de l'Éducation, du Loisir et du Sport du Québec. Des données sur la santé buccodentaire d'élèves de 7-8 ans ont été obtenues de l'Étude 1998-1999 sur la santé buccodentaire des élèves québécois de 5-6 ans et de 7-8 ans (ESBEQ) (Brodeur, Olivier et al. 2001) et ont été agrégées au niveau de l'école. Ces bases de données ont été appariées en utilisant le nom, l'adresse et le code postal de l'école, ainsi que l'identifiant unique attribué à chaque école par le Ministère de l'Éducation, du Loisir et du Sport.

7.3.1 Indices de défavorisation des écoles

Le Ministère de l'Éducation, du Loisir et du Sport a catégorisé l'ensemble de la province de Québec en 1445 unités territoriales, dans lesquelles la population est relativement homogène en termes de caractéristiques sociales, économiques et familiales. Ces unités territoriales sont utilisées pour produire des mesures du niveau de défavorisation basées sur le territoire pour chaque école publique dans la province (Ministère de l'Éducation du Loisir et du Sport 2003). Deux indices de défavorisation des écoles sont produits annuellement par le Ministère de l'Éducation, du Loisir et du Sport: l'indice de milieu socio-économique et l'indice de faible revenu, tous deux estimés à partir des données du recensement.

L'indice de milieu socio-économique est basé sur la sous-scolarisation des mères (avec un poids des deux tiers de l'indice) et l'inactivité d'emploi des parents (un tiers de l'indice) dans l'unité territoriale de chaque école. La proportion de mères sous-scolarisées est définie comme le nombre de mères (femmes avec enfants âgés entre 0 et 18 ans) sans

diplôme du secondaire divisé par le nombre de mères dans l'unité territoriale de l'école. De même, la proportion de parents inactifs est calculée en divisant le nombre de familles dans laquelle aucun des parents ne travaille par le nombre total de familles dans l'unité territoriale de l'école (Ministère de l'Éducation du Loisir et du Sport 2005).

L'indice de faible revenu utilise le seuil de faible revenu établi par Statistique Canada, qui est le niveau de revenu auquel les familles consacrent 70 % ou plus de leur revenu à des biens de première nécessité (nourriture, logement et habillement) (Statistics Canada 2001). Le seuil de faible revenu varie selon la taille du secteur de résidence et le nombre d'individus dans la famille. L'indice de défavorisation représente la proportion de familles vivant autour ou sous le seuil de faible revenu dans l'unité territoriale de chaque école.

Les indices de défavorisation des écoles publiques du Québec sont produits à des fins d'allocation des ressources et de recherche. Les indices continus sont divisés en déciles, et les écoles sont classées selon le rang décile auxquelles elles appartiennent. Un rang décile de 10 est attribué aux écoles les plus défavorisées. Les indices de défavorisation scolaire sont publiquement disponibles sur le site internet du Ministère de l'Éducation, du Loisir et du Sport (Ministère de l'Éducation du Loisir et du Sport 2009). Ce projet a utilisé les indices de défavorisation produits pour l'année académique 2000-2001 à partir des données du recensement de 1996.

7.3.2 Données sur la santé buccodentaire

L'Étude sur la santé buccodentaire des élèves québécois de 5-6 ans et de 7-8 ans (ESBEQ) a été menée en 1998-1999 auprès d'enfants de 5-6 et de 7-8 ans (Brodeur, Olivier et al. 2001). L'objectif de cette étude transversale, co-dirigée par l'Université de Montréal et la Direction de la santé publique de Montréal-Centre, était de dresser un portrait du statut de santé buccodentaire d'élèves de maternelle et de deuxième année dans la province de Québec. Cette étude a été décrite ailleurs (Brodeur, Olivier et al. 2001). Brièvement, en utilisant un échantillon aléatoire stratifié par région, par zone de résidence et par niveau socio-économique de la zone de résidence, un échantillon représentatif d'enfants de maternelle et de deuxième année a été tiré pour chaque école.

L'échantillon de l'étude incluait 2901 élèves de maternelle et 5526 élèves de deuxième année avec un taux de participation de 85%. Un questionnaire administré par un hygiéniste dentaire a été complété par les enfants au sujet de leurs comportements liés à la santé (habitudes alimentaires et hygiène buccale) tandis que les parents ont reçu par la poste un questionnaire portant sur leur statut socio-économique (ex. : niveau d'éducation, revenu familial annuel, etc.). De plus, les enfants ont été examinés cliniquement à l'école par des équipes de recherche composées d'un dentiste en santé publique et d'un hygiéniste dentaire. Les professionnels dentaires ont complété une formation approfondie et une session de calibration avant l'étape de collecte des données. Le statut de santé buccodentaire des enfants (expérience de la carie) a été évalué en utilisant l'examen dentaire de type 3 de l'Association dentaire américaine (*American Dental Association*). En outre, la douleur buccodentaire a été évaluée en interrogeant les enfants à propos de tout symptôme dentaire dans la semaine précédant l'entrevue. Pour la présente étude, seulement les données pour les élèves de deuxième année ont été utilisées. Les données de santé buccodentaire ont été agrégées au niveau de l'école, incluant le nombre moyen de faces permanentes cariées, absentes ou obturées (CAO-F) par école, la proportion d'enfants atteints par la carie et la proportion d'enfants rapportant une douleur buccodentaire.

7.3.3 Données sur la fluoration de l'eau

Des données sur la fluoration de l'eau ont été fournies par le Ministère de la Santé et des Services Sociaux du Québec pour toutes les municipalités participant au programme de fluoration de l'eau potable. Chaque école a été considérée comme étant dans une municipalité avec ou sans fluoration de l'eau sur la base de sa localisation.

7.3.4 Analyses statistiques

Les indices de défavorisation des écoles et les données sur la santé buccodentaire et la fluoration de l'eau ont été appariées et analysées en utilisant le logiciel *Statistical Package for Social Science* (SPSS) version 15.0. Après des statistiques descriptives, des corrélations entre les indices de défavorisation scolaire (variables ordinales avec des valeurs variant de 1 à 10 pour les indices de milieu socio-économique et de faible revenu)

et les indicateurs de santé buccodentaire au niveau de l'école (proportion d'enfants atteints par la carie et proportion d'enfants rapportant une douleur buccodentaire) ont été examinées en utilisant le coefficient de corrélation sur les rangs de Spearman.

Les associations entre chaque indice de défavorisation scolaire et les problèmes de santé buccodentaire ont été évaluées en utilisant la régression linéaire. L'hypothèse de linéarité a été vérifiée en inspectant la distribution des résidus (Munro 2005), qui étaient normalement distribués pour la carie dentaire, mais pas pour la douleur. Par conséquent, une analyse de régression linéaire a été réalisée pour la carie dentaire, tandis qu'une analyse de régression logistique a été effectuée pour la douleur buccodentaire.

Dans l'analyse de régression linéaire, les variables indépendantes correspondant aux indices de défavorisation scolaire (indices de milieu socio-économique et de faible revenu) ont été incluses dans le modèle comme variables ordinales en déciles, et la variable dépendante correspondant à la proportion de caries dentaires a été incluse comme variable continue. Des modèles univariés ont été construits en premier, puis les deux indices de défavorisation scolaire ont été mutuellement ajustés l'un pour l'autre. Afin de vérifier si ces associations différaient selon la présence ou l'absence de fluoruration de l'eau dans la municipalité, la variable de fluoruration de l'eau et un terme d'interaction ont été ajoutés aux modèles.

Afin de répondre à la question de recherche concernant les indices de défavorisation scolaire et la douleur buccodentaire, des analyses de régression logistique ont été réalisées avec les indices de milieu socio-économique et de faible revenu catégorisés en tertiles (favorable, intermédiaire, défavorable) et la proportion d'enfants rapportant une douleur buccodentaire comme variable dépendante dichotomique (aucune douleur buccodentaire rapportée vs. douleur buccodentaire rapportée par certains enfants). Pour les indices de défavorisation, les valeurs spécifiques catégorisées dans chaque tertile étaient les suivantes : indice de milieu socio-économique [1-5 = favorable, 6-8 = intermédiaire, 9-10 = défavorable] et indice de faible revenu [1-4 = favorable, 5-7 = intermédiaire, 8-10 = défavorable]. La présence d'un effet modificateur du statut de fluoruration de l'eau a été vérifiée en ajoutant cette variable et un terme d'interaction dans les modèles.

7.4 Résultats

Les indices de défavorisation scolaire étaient disponibles pour toutes les écoles primaires publiques du Québec. Les données de santé buccodentaire agrégées au niveau de l'école ont été obtenues pour 319 écoles. Cependant, trois écoles ont été exclues de l'échantillon final en raison d'informations manquantes sur des variables (ex. : adresse de l'école et code postal) qui étaient essentielles pour apparier les fichiers de données. L'échantillon final était donc composé de 316 écoles incluant 4903 élèves.

Les distributions de fréquences pour les indices de défavorisation scolaire et les problèmes de santé buccodentaire sont présentées dans le Tableau 1. Les deux indices de défavorisation scolaire présentaient une distribution approximativement normale, et variaient de 1 à 10. L'indice de milieu socio-économique moyen était de 6,3 (écart-type = 2,7), alors que l'indice de défavorisation moyen était de 5,6 (écart-type = 2,7). Quant à la santé buccodentaire, la moyenne de faces permanentes cariées, absentes ou obturées (CAO-F) au niveau de l'école était de 0,7 (écart-type = 0,5); les composantes obturées et absentes étaient respectivement de 0,6, (écart-type = 0,5) et près de zéro. La proportion moyenne d'enfants atteints par la carie et rapportant une douleur buccodentaire étaient respectivement de 25% et de 3,4%. Dans la plupart des écoles (67%), aucun enfant n'a rapporté de douleur buccodentaire, mais dans le quartile supérieur, 5,3% ou plus des enfants ont rapporté une douleur buccodentaire, avec une valeur maximale de 44%.

L'indice de milieu socio-économique scolaire était significativement corrélé avec l'expérience de la carie ($r_{\text{Spearman}} = 0,22$, $p < 0,001$), ainsi qu'avec la douleur buccodentaire ($r_{\text{Spearman}} = 0,15$, $p < 0,001$). Aucune association statistiquement significative n'a été trouvée entre l'indice de faible revenu et les problèmes de santé buccodentaire (expérience de la carie: $r_{\text{Spearman}} = 0,06$, $p = 0,25$; et douleur buccodentaire: $r_{\text{Spearman}} = 0,07$, $p = 0,20$).

Tableau 1. Statistiques descriptives pour les variables indépendantes – indices de défavorisation des écoles – et dépendantes – proportion d’enfants atteints par la carie et rapportant une douleur buccodentaire – dans 316 écoles du Québec, 1998-99.

	Moyenne (ÉT)	Variation	Quartiles		
			25 ^e	50 ^e	75 ^e
Indice de milieu socio-économique scolaire	6,3 (2,7)	1-10	4,0	7,0	9,0
Indice de faible revenu scolaire	5,6 (2,7)	1-10	3,0	6,0	8,0
Proportion d’enfants atteints par la carie	24,7 (14,1)	0,0-80,0	14,3	25,0	33,3
Proportion d’enfants rapportant une douleur buccodentaire	3,4 (6,4)	0,0-44,0	0,0	0,0	5,3

Les résultats des analyses de régression linéaire simple et multiple (Tableau 2) ont démontré que l’indice de milieu socio-économique scolaire était associé avec l’expérience de la carie dentaire, alors que l’indice de faible revenu ne l’était pas. L’ajustement mutuel des deux indices a augmenté seulement légèrement l’association avec l’indice de milieu socio-économique, pour lequel une augmentation d’une unité (des valeurs plus élevées indiquant un milieu plus défavorable) a entraîné une augmentation de 1,3% (intervalle de confiance à 95%: 0,6-1,9%) dans l’expérience de la carie dentaire. Quand l’effet modificateur de la fluoruration de l’eau a été vérifié, cette association ne différait pas selon la présence ou l’absence de fluoruration de l’eau dans la municipalité où était située chaque école. En conséquence, la variable de fluoruration de l’eau et les termes d’interaction n’ont pas été inclus dans les modèles. Ce modèle expliquait 5% de la variation dans la carie dentaire.

Tableau 2. Différences non-ajustées et ajustées dans la proportion d'enfants atteints par la carie dentaire par unité des indices de défavorisation scolaire pour 316 écoles du Québec, 1998-99.

	Non-ajusté	Ajusté*	
	β (IC à 95%)	β (IC à 95%)	R^2
Indice de milieu socio-économique	1,08 (0,52 – 1,63)	1,26 (0,58 – 1,94)	0,05
Indice de faible revenu	0,42 (-0,16 – 0,99)	-0,32 (-1,01 – 0,37)	

* Modèle de régression linéaire incluant les variables pour l'indice de milieu socio-économique et l'indice de faible revenu.

Les rapports de cotes (*odds ratios*, RC) et les intervalles de confiance à 95% des modèles de régression logistique effectués pour évaluer les associations entre les indices de défavorisation scolaire et la douleur buccodentaire rapportée ont montré que les écoles dans les milieux socio-économiques les plus défavorables avaient deux fois plus de chances d'avoir des enfants rapportant une douleur (RC = 2,08; IC à 95% = 1,06-4,08) comparativement aux milieux scolaires plus favorables. Aucune association n'a été trouvée entre l'indice de faible revenu et la proportion d'enfants rapportant une douleur buccodentaire (Tableau 3). De façon semblable aux modèles de régression linéaire pour la carie dentaire, aucun effet modificateur de la fluoruration de l'eau n'était présent et les modèles finaux de régression logistique n'incluaient pas la fluoruration de l'eau.

Tableau 3. Rapports de cotes (*odds ratios*, RC) pour les associations entre les indices de défavorisation scolaire et la douleur buccodentaire dans 316 écoles du Québec, 1998-99.

	RC non-ajusté (IC à 95%)	RC ajusté (IC à 95%)*
Indice de milieu socio-économique		
Favorable (1-5)	1,00	1,00
Intermédiaire (6-8)	1,49 (0,84-2,64)	1,55 (0,85 – 2,84)
Défavorable (9-10)	1,96 (1,08-3,56)	2,08 (1,06-4,08)
Indice de faible revenu		
Favorable (1-4)	1,00	1,00
Intermédiaire (5-7)	1,16 (0,66-2,03)	0,95 (0,52-1,72)
Défavorable (8-10)	1,24 (0,69-2,20)	0,88 (0,45-1,70)

* Modèle de régression logistique incluant les variables pour l'indice de milieu socio-économique et l'indice de faible revenu.

7.5 Discussion

En utilisant des indicateurs scolaires publiquement disponibles, nous avons observé une association positive entre l'indice de milieu socio-économique scolaire et les problèmes de santé buccodentaire. Nos résultats démontrent que la prévalence de l'expérience de la carie dentaire est presque 12% plus élevée dans le milieu scolaire le plus défavorable, comparativement au milieu le plus favorable. De plus, dans les écoles dont le milieu socio-économique est plus défavorable, nous avons observé un pourcentage plus élevé d'enfants rapportant une douleur buccodentaire. Inversement, aucune association n'a été

trouvée entre l'indice de faible revenu scolaire et l'expérience de la carie ou de la douleur buccodentaire.

Ces résultats fournissent un certain soutien en faveur de l'utilisation de l'indice de milieu socio-économique scolaire comme indicateur des problèmes de santé buccodentaire chez les élèves québécois. En effet, des études écologiques menées dans d'autres populations ont rapporté des résultats semblables. Muirhead et Locker ont trouvé que l'utilisation de résultats à de tests de performance scolaire aisément accessibles (ex. : résultats en mathématiques ou en anglais) était une stratégie réalisable pour identifier les écoles avec des besoins élevés en traitement dentaire en Ontario, au Canada (Muirhead and Locker 2006). Au Royaume-Uni, les repas gratuits fournis par l'école, les scores Jarman (un indice composite utilisé pour mesurer la défavorisation matérielle), et la réussite académique étaient associés avec l'expérience de la carie dentaire et les besoins en soins dentaires (Crowley, O'Brien et al. 2003; Muirhead and Marcenés 2004).

Bien que nos résultats rapportent une association statistiquement significative entre l'indice de milieu socio-économique scolaire et les problèmes de santé buccodentaire, aucune association n'a été trouvée avec l'indice de faible revenu scolaire. Une explication possible pour ces résultats contrastés pourrait être liée au fait que tous les enfants du Québec de moins de 10 ans ont un accès gratuit aux soins dentaires. Ainsi, l'indice de faible revenu, basé uniquement sur le revenu familial dans le secteur de l'école, pourrait très bien ne pas être pertinent saisir les besoins en santé buccodentaire de la population scolaire. En fait, nos résultats montrent que la composante « faces permanentes obturées » de l'indice CAO-F représente approximativement 83% de l'indice entier, suggérant une utilisation élevée des ressources en soins dentaires dans cette population.

Une autre explication possible pour ces résultats concerne la définition sous-jacente de chacun des indices de défavorisation des écoles. Bien qu'ils aient tous deux été créés afin de résumer le milieu socio-économique scolaire, ils reflètent probablement des dimensions différentes. Par exemple, les variables de base utilisées dans le calcul de l'indice de milieu socio-économique sont le niveau de scolarisation maternelle et le statut d'emploi parental. Ces variables, et plus spécifiquement le niveau de scolarisation maternelle qui compte pour les deux tiers de l'indice, pourraient être particulièrement

importantes dans les secteurs économiquement faibles de la population. Dans de tels groupes, le niveau de scolarisation maternelle a été associé avec la santé de façon constante dans de nombreuses études (Cleland and Van Ginneken 1988). L'éducation formelle mène à la collecte d'informations et à une meilleure compréhension de celles-ci, à l'apprentissage de nouveaux concepts, et à la découverte de moyens d'accéder à l'information. L'éducation peut donc accroître les ressources cognitives, et celles-ci auront en retour un impact majeur sur la santé, incluant la santé buccodentaire (Nicolau, Marcenés, Hardy et al. 2003). Les enfants fréquentant des écoles avec un pourcentage élevé de mères éduquées pourraient posséder davantage de ressources éducationnelles qui influent, par exemple, sur les choix et les comportements liés à la santé (Behrman and Stacey 1997). Le revenu, par contre, se traduit en pouvoir financier d'acheter des ressources, de la nourriture, un logement et d'accéder aux soins de santé (Winkleby, Jatulis et al. 1992). Toutefois, l'éducation peut modifier l'effet du revenu, puisque les parents hautement scolarisés pourraient dépenser davantage pour de la nourriture saine et des comportements de soins de santé.

L'indice de milieu socio-économique expliquait seulement 5% de la variation dans l'expérience de la carie dentaire dans les analyses de régression linéaire. Ce résultat pourrait être lié au fait que cet indice ne mesurait pas tous les aspects qui peuvent influencer sur la santé buccodentaire, telles que les caractéristiques au niveau individuel. Il est largement rapporté que la santé de la population est déterminée par une combinaison de facteurs individuels (ex. : bagage génétique, genre, culture, ethnicité) et environnementaux (ex. : réseaux de soutien, environnement social et physique) qui agissent ensemble pour influencer sur la santé de la population (Krieger 2008). Les deux indices de défavorisation examinés dans notre étude étaient disponibles au niveau de l'école, et leur intérêt résidait dans le fait qu'ils soient produits annuellement par le Ministère de l'Éducation, du Loisir et du Sport. Cependant, il ne fait aucun doute que d'autres variables au niveau du groupe (quartier, famille, réseau social) et de l'individu pourraient avoir contribué à expliquer les différences dans l'expérience de la carie dentaire. En tant qu'exemple d'un facteur au niveau du groupe, il aurait été possible de s'attendre à ce que le statut de fluoruration de l'eau influe sur les associations observées, mais un tel effet modificateur n'a pas été observé. Afin de trouver des indicateurs

publiquement disponibles pouvant être utilisés pour prédire les besoins en soins dentaires, d'autres variables au niveau de l'école et du groupe qui pourraient compléter l'indice de milieu socio-économique devraient être explorées.

7.6 Forces

Cette étude est, à notre connaissance, la première au Québec à utiliser des indices de défavorisation scolaire publiquement disponibles afin d'identifier des populations d'élèves présentant un risque plus élevé de maladies buccodentaires chroniques. Cette étude ne montre pas seulement que les deux bases de données utilisées incluent des indicateurs fiables produits par le Ministère de l'Éducation, du Loisir et du Sport du Québec et par la plus récente Étude sur la santé buccodentaire des élèves québécois, mais aussi qu'utiliser de l'information publique facilement accessible sur une page web gouvernementale est une façon opportune et économique de mener une recherche en santé publique. Premièrement, nous aimerions souligner la faisabilité de l'étude, puisque les deux bases de données utilisés étaient aisément accessibles pour effectuer une recherche et étaient faciles à apparier l'une à l'autre. Deuxièmement, cette étude introduit l'idée d'intégrer des données publiquement disponibles auprès de différentes instances gouvernementales (Direction de la santé publique et Ministère de l'Éducation, du Loisir et du Sport) même si elles ont été créés à d'autres fins, telles que d'allouer des ressources aux écoles (ex.: indices de défavorisation scolaire) ou de mesurer la prévalence des maladies buccodentaires chroniques (ex.: Étude sur la santé buccodentaire des élèves québécois). Enfin, cette étude montre comment des résultats issus de ce type de recherche peuvent être utilisés par le système de santé publique: ces résultats peuvent mener à de nouveaux outils pour planifier des stratégies de prévention et d'intervention de santé publique auprès des groupes présentant un risque plus élevé de maladies buccodentaires chroniques. Ceci peut aisément être fait de façon rapide et économique, améliorant la pratique des professionnels en santé buccodentaire publique. Ce type de recherche constitue une application directe des activités de transfert des connaissances où des liens symbiotiques entre les écoles et les chercheurs universitaires peuvent être établis.

7.7 Limites

Cette étude écologique a été conçue dans le but d'évaluer la relation entre les indices de défavorisation scolaire et le statut de santé buccodentaire des enfants au niveau de l'école. Une des limites bien connues de ce devis de recherche est qu'il ne permet pas d'interpréter au niveau individuel les associations trouvées. Une telle interprétation erronée de résultats obtenus au niveau du groupe à un niveau individuel est connue sous le nom d'erreur écologique (*ecological fallacy*). Cependant, comme l'objectif de l'étude était d'identifier des indicateurs de maladies buccodentaires chroniques au niveau de l'école, le devis écologique était le devis le plus approprié à utiliser. Selon Schwartz, les corrélations résultant des études écologiques ne constituent pas des substituts pour celles qui seraient observées au niveau individuel, mais ce devis est important dans une perspective de santé publique puisqu'il permet d'évaluer l'effet de variables au niveau du groupe sur la santé de la population. Ainsi, les études écologiques fournissent de l'information essentielle pour comprendre les caractéristiques de la maladie au niveau du groupe et pour compléter les études menées au niveau individuel (Schwartz 1994).

Le nombre d'enfants ayant contribué aux statistiques sur la santé buccodentaire par école est un aspect important à considérer. Pour ce qui est des données de santé buccodentaire, la taille d'échantillon originale a été calculée pour les besoins de l'Étude sur la santé buccodentaire des élèves québécois. Il existait dans cette enquête de grandes variations dans le nombre d'enfants de 2^e année contribuant aux valeurs agrégées au niveau de l'école, variant de 2 à 36 enfants par école parmi les 316 écoles incluses dans cette analyse écologique. Conséquemment, les valeurs agrégées pourraient avoir été catégorisées de façon plus ou moins erronée selon les taux de réponse spécifiques à chaque école et la représentativité des élèves participants. Si les participants n'étaient pas représentatifs de la population d'élèves de 2^e année dans certaines écoles, c'est-à-dire si les enfants qui étaient absents ou qui ont refusé de participer avaient une prévalence de maladies buccodentaires chroniques plus élevée ou plus faible que ceux qui ont participé, la prévalence de problèmes de santé buccodentaire pourrait avoir été sous-estimée ou surestimée dans l'échantillon de l'étude.

Le petit nombre de variables explicatrices incluses dans l'étude constitue une autre limite. Évaluer un plus grand nombre d'indicateurs scolaires publiquement disponibles aurait pu nous permettre d'identifier de meilleurs et/ou de plus nombreux indicateurs des élèves québécois présentant un risque élevé de maladies buccodentaires chroniques. L'étude avait originellement été conçue en incluant les résultats de performance scolaire, les retards de graduation, de l'information sur les repas scolaires, et la fréquentation des classes spéciales d'intégration comme variables explicatrices potentielles. Aucune de ces variables n'a été utilisée dans la présente étude; les paragraphes qui suivent en fournissent les raisons.

Les résultats de performance scolaire sont compilés par le Ministère de l'Éducation, du Loisir et du Sport, uniquement au niveau de l'école secondaire. Ces documents rapportent la proportion d'étudiants ayant réussi les examens québécois du Ministère parmi tous les étudiants qui ont fait les examens, par école. Ces statistiques au niveau de l'école sont disponibles pour tous les examens groupés ensemble, pour les examens de français dans les écoles francophones, et pour les examens d'anglais dans les écoles anglophones (Ministère de l'Éducation du Loisir et du Sport 2004). Bien qu'elles auraient théoriquement pu présenter un intérêt comme indicateurs potentiels du risque de maladies buccodentaires chroniques, ces statistiques n'ont pu être utilisées dans la présente étude puisque la population à l'étude était constituée d'élèves de 2^e année (enfants de 7-8 ans) et que les résultats de performance scolaire se rapportaient à l'école secondaire (adolescents).

Les retards de graduation présentaient un intérêt en tant qu'autre indicateur potentiel des maladies buccodentaires chroniques. Pour chaque école, des statistiques sont produites afin de documenter l'âge des élèves lorsqu'ils graduent du premier (1^{re}-2^e années) aux second (3^e-4^e années) et troisième (5^e-6^e années) cycles de l'école primaire. Ces statistiques permettent de déterminer la proportion d'enfants qui graduent avec un certain retard comparativement à la progression « normale ». Malheureusement, elles n'étaient pas disponibles pour l'année scolaire qui nous intéressait, et sont toujours considérées comme non fiables et non robustes parce qu'elles ont été introduites assez récemment (2001-2002).

Des statistiques similaires sont disponibles pour documenter le retard de graduation de l'école primaire à l'école secondaire, décrit comme la proportion d'enfants qui passent au secondaire à l'âge de 12 ans ou moins au moment de leur inscription à l'école secondaire. En raison du fait que cette variable n'était pas disponible pour l'ensemble des 316 écoles (n=286), elle n'a pas été incluse dans cette étude.

De l'information sur les repas fournis par les écoles a été le sujet d'intérêt principal d'études antérieures, et elle s'est avérée être un bon indicateur des besoins de soins dentaires (Muirhead and Marcenes 2004). Pour la présente étude, cette information n'était pas disponible, puisque les écoles et les commissions scolaires n'ont pas à communiquer cette information au Ministère de l'Éducation, du Loisir et du Sport. Par conséquent, collecter cette information pour l'ensemble des 316 écoles aurait été à l'encontre de l'objectif d'utiliser de l'information aisément accessible auprès du Ministère de l'Éducation, du Loisir et du Sport.

Enfin, la proportion d'élèves par école qui avaient fréquenté des « classes spéciales d'intégration » pour immigrants, calculée comme la proportion d'élèves de niveau primaire fréquentant ou ayant fréquenté une classe spéciale (classe d'accueil), était disponible mais ne pouvait être utilisée parce que dans la vaste majorité des écoles incluses dans l'échantillon de l'étude, la proportion d'élèves fréquentant des classes spéciales d'intégration était extrêmement faible. Conséquemment, nous ne disposions pas d'une variabilité suffisante pour effectuer des tests statistiques.

7.8 Stratégies de santé publique pour prévenir les maladies buccodentaires chroniques

Deux stratégies de santé publique pour prévenir les maladies et améliorer la santé buccodentaire sont : la stratégie du risque élevé et la stratégie populationnelle. Cette dernière inclut la stratégie populationnelle ciblée (*directed population strategy*) et son cadre conceptuel est basé sur l'approche des facteurs de risque communs.

La stratégie du risque élevé est traditionnellement centrée sur la maladie. Elle vise à identifier les individus ou les groupes qui présentent un « risque élevé » de développer

certaines maladies de façon à offrir des interventions de prévention et de traitement. Comme exemple d'une telle stratégie, le programme de soins dentaires à l'école est l'une des interventions de santé publique les plus importantes dans plusieurs pays dans lesquels les scellants dentaires sont appliqués aux individus catégorisés à risque élevé de caries dentaires. L'identification des individus à « risque élevé » ou à « risque plus faible » de présenter des caries dentaires dans le futur est accomplie par un examen clinique (examen de dépistage) et ensuite basée sur le niveau d'expérience de la carie dentaire (ex.: CAO-F élevé). La supposition est que les nouvelles lésions de carie dentaire se produiraient plus fréquemment parmi ceux du groupe à « risque élevé », de telle sorte que seuls les élèves considérés à « risque élevé » recevraient des interventions préventives (ex.: fluor topique, scellants dentaires) et des traitements dentaires (ex.: obturations). En conséquence, il serait attendu que l'incidence de la carie dentaire soit réduite. L'autre partie du groupe, catégorisé à « risque faible », ne recevrait pas cette intervention. Toutefois, il a été argumenté que cette stratégie ne serait pas efficace pour réduire les futures caries dentaires, puisque deux facteurs importants doivent être pris en considération (Batchelor and Sheiham 2006). Premièrement, il existe des preuves indiquant que l'incidence de la carie dentaire est en fait plus élevée chez les individus à « risque faible » que chez ceux à « risque élevé ». Par exemple, une étude examinant les nouvelles caries dentaires sur une période de 4 ans chez des enfants de 7 ans recevant des soins préventifs a montré que les enfants catégorisés comme à « risque faible » étaient ceux qui présentaient la plus grande part des nouvelles lésions (plus de 90 %) (Batchelor and Sheiham 2006). Deuxièmement, en tant que maladie multifactorielle, la carie dentaire ne pouvait être prédite sur la base du CAO-F comme seul indicateur de risque. Il a ainsi été montré que la stratégie du « risque élevé » exerce un impact minimal sur l'assiduité aux soins dentaires et sur la réception d'un traitement approprié (Milsom, Blinkhorn et al. 2006), alors qu'une stratégie reposant sur l'identification de groupes ou de populations plutôt que d'individus aurait un meilleur impact sur l'incidence de la carie dentaire (Batchelor and Sheiham 2006).

La stratégie populationnelle est centrée sur l'amélioration du statut de santé de la population ou d'une sous-population plutôt que celui d'individus. Étant donné que la plupart des maladies chroniques sont évitables et possèdent des facteurs de risque communs, Geoffrey Rose a suggéré que la distribution de l'exposition au risque dans une

population est façonnée par les conditions contextuelles (ex.: accès à des fruits et à des légumes frais, politiques sur le tabagisme dans les lieux publics, etc.) (Rose 1993). La fluoruration de l'eau du robinet constitue un exemple d'une telle stratégie utilisée pour réduire les maladies buccodentaires chroniques au niveau de la population. Cette stratégie est établie en appliquant les principes de l'approche du risque commun qui propose que les interventions en matière de santé doivent s'attaquer aux facteurs de risque communs à la santé générale et à la santé buccodentaire (ex.: des repas santé à l'école réduiraient l'obésité et le diabète ainsi que la carie dentaire) (Sheiham and Watt 2000). Une fois qu'une population ou une sous-population à risque est identifiée, l'approche populationnelle ciblée peut être utilisée. Elle vise à fournir des soins de santé buccodentaire préventifs et curatifs aux groupes de la population qui sont à haut risque, tels que des écoles ou des groupes d'âge spécifiques. L'identification des écoles dans lesquelles les enfants présentent un risque élevé de maladies buccodentaires chroniques, en utilisant un indicateur public comme ceux étudiés ici, constitue le premier pas vers la mise en application de l'approche populationnelle ciblée dans le domaine de la santé buccodentaire.

7.9 Recherches futures

Comme suite à cette étude, d'autres recherches seront nécessaires afin de confirmer les résultats obtenus et de déterminer s'ils peuvent être appliqués aux politiques de planification en matière de santé publique.

Des études similaires à la nôtre, mais incluant davantage de variables explicatrices au niveau de l'école, pourraient être conduites auprès de la population québécoise. Les résultats de performance scolaire sont disponibles pour les écoles secondaires (ex.: les résultats pour les examens de français, d'anglais et de mathématiques) et pourraient être évalués si des données de santé buccodentaire étaient disponibles pour ce groupe d'âge. De plus, certains indicateurs tels que les proportions d'élèves graduant avec un retard au second cycle de l'école primaire (3^e-4^e années) ainsi qu'à l'école secondaire sont disponibles pour les plus récentes années scolaires, comme discuté plus haut.

En outre, en tant que maladie complexe déterminée par des facteurs multifactoriels situés à différents niveaux (niveaux individuel et de groupe), l'étiologie de la carie dentaire doit être mieux comprise. Une analyse multiniveaux pourrait être effectuée afin d'identifier des facteurs de risque pour les maladies buccodentaires chroniques au niveau du groupe (ex.: caractéristiques du quartier) et au niveau individuel (ex.: revenu familial, structure familiale). La relation entre ces facteurs et les maladies buccodentaires chroniques pourrait donc être étudiée pour comprendre tous les facteurs impliqués dans l'étiologie des maladies buccodentaires chroniques en même temps plutôt que de les considérer comme des risques individuels (ex.: uniquement le régime alimentaire). L'identification de tels facteurs nous permettrait d'explorer des interventions et des stratégies pour réduire ces risques d'une façon plus large et économique. Par exemple, une étude longitudinale dans laquelle serait effectuée une identification des facteurs de risque des maladies buccodentaires chroniques dans la famille de l'individu de même que dans son environnement social mesuré à deux/trois moments dans le temps résulterait non seulement en une meilleure compréhension du développement de la maladie, mais aussi en une connaissance plus large des risques auxquels l'individu est exposé et des moyens de les réduire.

Finalement, les résultats de cette étude pourraient être utilisés afin de mettre en application des stratégies de promotion de la santé et des programmes de prévention pour réduire les maladies buccodentaires chroniques dans les écoles présentant un risque élevé de ces maladies (ex.: Écoles québécoises ayant un Indice de milieu socioéconomique de 9 ou 10). Par exemple, après avoir identifié les écoles présentant un risque élevé de maladies buccodentaires chroniques, les politiques scolaires pourraient inclure: des repas scolaires sains gratuits (ex.: riches en fruits et légumes et faibles en glucides raffinés), une exposition appropriée au fluor (ex.: approvisionnement en eau avec fluor ou produits fluorés tels que rince-bouche, dentifrice), des soins dentaires spéciaux pour ceux dans le besoin (ex.: visites d'un dentiste avec de l'équipement portatif, puisque l'accès peut être une question de temps pour certaines familles), la promotion d'activités physiques et sociales impliquant non seulement les enfants, mais aussi les parents dans l'environnement scolaire. Par la suite, une comparaison pourrait être effectuée entre les

écoles possédant un environnement soutenant plus ou moins les politiques de santé afin de déterminer l'impact que ceci pourrait avoir sur la santé buccodentaire des enfants.

7.10 Conclusion

À notre connaissance, il s'agit de la première étude utilisant des indices de défavorisation des écoles publiquement disponibles comme facteurs prédictifs du statut de santé buccodentaire chez des élèves québécois. En outre, ce travail contribue à une meilleure compréhension de la relation entre le milieu scolaire et la santé buccodentaire, ce qui pourrait fournir une base empirique à des interventions de santé publique efficaces et économiques pour la prévention des maladies buccodentaires chroniques, menant en fin de compte à une réduction des inégalités en matière de santé buccodentaire.

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