Oral health promoting school environments typology and dental caries status in Quebec children

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I dedicate this work to my loving mom, late Mrs. Jemini. A.K.

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List of abbreviations

CI	Confidence Interval
CAD	Canadian Dollar
CSDH	Commission on Social Determinants of Health
DA	Dissemination Area
DAG	Directed Acyclic Graph
DMF-S	Decayed Missing-Surfaces
DMF-T	Decayed Missing Filled-Teeth
GEE	Generalised Estimating Equations
GIS	Geographic Information System
GLM	Generalised Linear Modeling
HPS	Health Promoting Schools
IRR	Incidence Rate Ratio
MCMA	Montreal Census Metropolitan Area
MEGAPHONE	Montreal Epidemiological and Geographic Analysis of Population Health Outcomes and Neighbourhood Effect
QUALITY	QUebec Adipose Lifestyle InvesTigation in Youth
SES	Socio-Economic Status
SHPPS	School Health Policy and Programs Survey
USD	United States Dollar
WHO	World Health Organization

Abstract

Dental caries are highly prevalent among Canadian children. Limited evidence supports the effectiveness of school-based oral health promotion programs for dental caries reduction; we found one such study from Canada and none from Quebec.

Objectives: 1) To identify distinct types of school environments among schools situated in the Montreal Census Metropolitan Area of the province of Quebec, drawing from a number of factors related to the provision of school-based oral health promotion programs, engagement in oral health promotion activities, and the social and built environment of the school neighbourhood; 2) To estimate the relation between types of oral health promoting school environments and dental caries incidence among 8-10-year-old children over a 2-year period.

Methods: We used data from the baseline and 1st follow-up visits of the QUebec Adipose Lifestyle Investigation in Youth (QUALITY) cohort, which were completed in 2008 and 2011, respectively. This ongoing prospective study on the natural history of metabolic risk in children included 630 children and their families, living in three major urban centres in the province of Quebec. We used a school-based sampling strategy to recruit the participants. We also acquired data from a complimentary study added to the QUALITY cohort in 2008 (School Study), which provided data on schools located in Greater Montreal attended by cohort children.

Structured questionnaires administered to school principals and parents were used to collect data on school environment and socio-demographic factors. In addition, we used 2006 Canadian Census data from a geographic information system to determine the school socio-economic status (SES) and an exhaustive list of businesses to classify the surrounding food environment. The outcome was 2-year dental caries incidence based on dental clinical exams and summarized by the Decayed, Missing-Surfaces (DMF-S) index.

Among the 506 children attending schools in Greater Montreal, complete data were available for 330 children attending 200 schools. We used principal component and cluster analyses to classify school environment, and generalised estimating equations to model the association between school environment and dental caries incidence.

Results: We identified three distinct types of school environments. Type 1 included schools with strong healthy eating policies, weak dental care programs, located in neighbourhoods with high SES and favourable surrounding food environments. Type 2 comprised schools with strong healthy eating policies and strong dental care programs, located in neighborhoods with low SES and unfavourable surrounding food environments. Type 3 included schools with weak healthy eating policies and average dental care programs, located in neighbourhoods with average SES and unfavourable surrounding food environments.

Adjusting for age, sex, parental income and baseline DMF-S, children attending Types 1 and 2 schools had 21% (IRR: 0.79, 95% CI: 0.68 - 0.90) and 6% (IRR: 0.94, 95% CI: 0.83 - 1.07) reduced 2-year incidence of dental caries, respectively, compared to those attending Type 3 schools.

Conclusion: A comprehensive approach to oral health promotion in schools targeting common risk factors (e.g., an unhealthy diet), and allowing the participation of prominent stakeholders (e.g., parents, teachers, school principals and communities) can have a positive effect on children's dental caries status. Neighbourhood SES and the food environment around the school seem to be important factors influencing the dental caries status of schoolchildren. This study adds to the evidence base showing the important role of school environments in oral health promotion and provides Quebec policy makers with directions for preventive action.

Résumé

La prévalence de la carie dentaire est élevée chez les enfants canadiens. Des preuves limitées soutiennent l'efficacité des programmes de promotion de la santé buccodentaire en milieu scolaire pour réduire la carie dentaire ; nous avons trouvé une telle étude menée au Canada et aucune au Québec.

Objectifs : 1) Identifier des types distincts d'environnements scolaires parmi les écoles situées dans la Région métropolitaine de recensement de Montréal de la province de Québec, à partir d'un certain nombre de facteurs reliés à la prestation de programmes de promotion de la santé buccodentaire en milieu scolaire, la participation à des activités de promotion de la santé buccodentaire, et l'environnement social et bâti du quartier de l'école; 2) Estimer la relation entre des types d'environnements scolaires favorisant la santé buccodentaire et l'incidence de la carie dentaire chez des enfants de 8-10 ans sur une période de 2 ans.

Méthodes: Nous avons utilisé des données des visites de référence et de premier suivi de la cohorte QUebec Adipose Lifestyle Investigation in Youth (QUALITY) qui ont été complétées en 2008 et 2011, respectivement. Cette étude prospective en cours sur l'histoire naturelle du risque métabolique chez les enfants inclut 630 enfants et leurs familles, vivant dans trois grands centres urbains dans la province de Québec. Nous avons utilisé une stratégie d'échantillonnage basée sur l'école pour recruter les participants. Nous avons également acquis des données d'une étude complémentaire ajoutée à la cohorte QUALITY en 2008 (School Study), qui a fourni des données sur les écoles situées dans le Grand Montréal fréquentées par des enfants de la cohorte.

Des questionnaires structurés administrés aux directeurs d'école et aux parents ont été utilisés pour recueillir des données sur l'environnement scolaire et des facteurs socio-démographiques. De plus, nous avons utilisé des données du Recensement canadien de 2006 provenant d'un système d'information géographique afin de déterminer le statut socio-économique (SSE) de l'école et une liste exhaustive d'entreprises afin de classifier l'environnement alimentaire autour de l'école. La variable dépendante était l'incidence de la carie dentaire sur une période de deux ans basée sur des examens dentaires cliniques et résumée par l'indice de Faces (ou surfaces) de dents Cariées, Absentes ou Obturées (CAOF).

Parmi les 506 enfants fréquentant des écoles dans le Grand Montréal, des données complètes étaient disponibles pour 330 enfants fréquentant 200 écoles. Nous avons utilisé des analyses en composantes principales et de groupement (cluster) pour classifier l'environnement scolaire, et des équations d'estimation généralisées pour modéliser l'association entre l'environnement scolaire et l'incidence de la carie dentaire.

Résultats: Nous avons identifié trois types distincts d'environnements scolaires. Le type 1 incluait des écoles ayant des politiques d'alimentation saine fortes et des programmes de soins dentaires faibles, situées dans des quartiers avec un SSE élevé et des environnements alimentaires autour des écoles favorables. Le type 2 incluait des écoles ayant des politiques d'alimentation saine fortes et des programmes de soins dentaires forts, situées dans des quartiers avec un SSE faible et des environnements alimentaires défavorables. Le type 3 incluait des écoles ayant des politiques d'alimentation saine faibles et des programmes de soins dentaires dans la moyenne, situées dans des quartiers avec un SSE moyen et des environnements alimentaires autour des écoles défavorables.

En ajustant pour l'âge, le sexe, le revenu parental et le CAOF lors de la visite de référence, les enfants fréquentant les écoles de types 1 et 2 avaient une incidence de carie dentaire sur deux ans réduite de 21% (RTI: 0,79; IC à 95%: 0,68 - 0,90) et de 6% (RTI: 0,94; IC à 95%: 0,83 - 1,07), respectivement, comparativement à ceux fréquentant les écoles de type 3.

Conclusion: Une approche globale de promotion de la santé buccodentaire dans les écoles ciblant des facteurs de risque communs (ex. : une alimentation malsaine), et permettant la participation d'acteurs-clé (ex. : parents, enseignants, directeurs d'école et communautés) peut avoir un impact positif sur le statut de carie dentaire des enfants. Le SSE du quartier et l'environnement alimentaire autour de l'école semblent être des facteurs importants influant sur le statut de carie dentaire des élèves. Cette étude ajoute à la base de connaissances montrant le rôle important des milieux scolaires dans la promotion de la santé buccodentaire et fournit aux décideurs du Québec des orientations pour l'action préventive.

Contributions of co-authors to the manuscript

Anu Edasseri, Master's candidate: conceived objective of the investigation, carried out statistical analysis and wrote the manuscript. She also actively participated in the QUALITY Cohort data collection. Her task included dental clinical examinations, training other dental examiners and overseeing the oral health component of data collection.

Tracie A Barnett, Associate professor, Epidemiology and Biostatistic Unit, Institut National de la Recherche Scientifique – Institut Armand Frappier: designed and supervised the school component of the QUALITY cohort study, obtained funding for the investigation, supervised the conception of the manuscript, contributed to design of analysis, and reviewed and contributed to manuscript writing.

Khady Kâ, Post-doctoral fellow, University of Montreal Hospital Research Centre (CRCHUM), Montreal, QC, Canada: contributed to design of analysis, and reviewed and contributed to manuscript writing.

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1. Introduction

Despite great advances in diagnostic, preventive and treatment modalities, dental caries continue to be highly prevalent in developed countries (2). Dental caries is a determinant of quality of life and a major cause of economic burden to society and to individuals (3). Additionally, the socio-economic inequalities due to dental caries are major concerns, both in terms of prevalence and severity, even in developed countries with generally equitable allocation of resources (4). The continued public health burden associated with dental caries points to the need for health promotion activities targeting its reduction in the population.

Prevention and oral health promotion strategies to reduce dental caries incidence initially focussed on clinical interventions (e.g., sealants and fluorides) and behaviour modification. However, this approach has been largely criticized for isolating oral health from general health. In contrast, novel public health approaches in oral health promotion emphasise the importance of targeting the underlying causes, that are common to many chronic diseases, through comprehensive health promotion strategies (5).

The provision of supportive environment is an important component of health promotion; the school environment is a particularly effective way to reach children. The World Health Organization (WHO) introduced the Health Promoting Schools (HPS) concept in 1995 and it has since been adopted worldwide (6). However, there is limited evidence for the effectiveness of implemented school-based oral health promotion guided by HPS concepts. Moreover, in Quebec, although efforts to promote health through schools are encouraged, their effectiveness with respect to oral health outcomes is unknown. Our study aims to identify distinct types of oral health promoting school environments from a sample of Quebec schools and their effects of on reducing dental caries incidence among primary school children.

2. Literature Review

2.1 Dental caries: a continuing public health burden

Due to their high prevalence rates, impact on quality of life, the very high costs of treating them and the socio-economic disparities in their distribution and severity, dental caries continue to be a problem at the individual as well as the population level. The following section reflects on the burden of the disease and the need for continued public health action to reduce dental caries incidence in the population.

2.1.1 The persistently high prevalence of dental caries

Dental caries is the most common childhood chronic disease affecting the hard tissues of the tooth (7). Worldwide, 60-90% of school-aged children and nearly 100% of adults have experienced dental decay (2). Oral conditions (untreated caries, severe periodontitis and tooth loss) affect nearly 3.9 billion people world wide; untreated decay in the permanent teeth is the most prevalent condition, affecting 35% of the population and ranks the 80th among the top 100 causes of disability adjusted life years (8). Globally, the lifetime caries experience measured by the DMF-T (Decayed Missing Filled-Teeth) index among children is the highest in South East Asian countries (2.97) followed by North American countries (DMF-T=2.08), and relatively low in African (DMF-T=1.06) and western pacific countries (DMF-T=1.05) (9).

There has been a decline in the level of dental caries in many industrialised countries over the last decades as a result of numerous public health measures, and improvements in living conditions. Although dental caries severity and incidence have been lowered to an extent in these countries, the disease is still not under complete control, and remains very common, requiring continued public health attention (10).

Dental caries is highly prevalent in Canadian children. According to the most recent Canadian Health Measure Survey (CHMS) published in 2010, 56.8% of 6-11-year-old Canadian children have experienced dental caries, and 23% of them have dental caries on permanent teeth. The

population average of the number of DMF-T declined from the range of 3-6 to a mean of 0.49 in this age group in the last decades. However, among those who have permanent teeth decay, the average number of DMF-T is 2.1 (11), which is still high, especially considering the young age.

Despite the significant decline in the prevalence of dental caries among Canadian adolescents in the last decades, the disease is still common, affecting more than half of young Canadians. Among 12-19-year-old Canadian youth, 58.8% have at least one permanent tooth affected by caries with an average of 2.49 teeth affected per child and 0.37 (14.4%) teeth remaining untreated (11).

The prevalence of dental caries is very high among Canadian adults; 95.9 % of them have experienced coronal caries. Root caries is prevalent among 20.3% of adults and 30% of these remain untreated. There was no significant improvement in the prevalence of dental caries among Canadian adults during the last decades, changing from 96.1% to 95.9%. However, dental caries severity decreased substantially from 17.5 teeth affected in the 1970s to 10.7 teeth affected in 2007-09 (11).

In comparison to American children, Canadian children have similar levels of DMF-T, with fewer untreated caries and sealed teeth than their American counterparts. Similarly, Canadian and American adolescents have comparable levels of caries, however, with some difference in the prevalence of sealants. Canadian adults have a higher prevalence of dental caries than Americans and Australians, with a lower severity than that in Australia and equivalent to that in the United States (11).

The situation in the province of Quebec is especially severe. Among North American regions, the province of Quebec has the highest dental caries prevalence and severity (12). In Quebec, dental caries was prevalent among 59.1% of 11-12-year-old children in 1997 with a mean of 3.1 permanent teeth per child affected. The average DMF-T of 12-year-old children was higher in Quebec than in the United States, Sweden, United Kingdom and other Canadian provinces (Nova Scotia and Ontario). Although there was an increase in the percentage of caries-free 12-year-old children from 11% to 36% in Quebec, between 1980 and 1997, the prevalence as well as the increase in the proportion of caries-free children remained lower in Quebec compared to several industrialised nations (Table 2.1) (13).

Table 2.1 Dental caries in 12-year-old children in Quebec, other provinces and countries

Country/Province	Year	Mean DMF-T	Percentage caries-free
Quebec	1983-1984	4.4	11
	1989-1990	3.1	23
	1996-1997	2.1	36
Ontario	1994	1.6	
Nova Scotia	1995-1996	1.9	
Canada	1970-72 (12-14 years old)	8.0	17.3
	2007-09	1.0	61.3
United Kingdom	1983	3.1	19
	1993	1.4	47
	1996-1997	1.1	56
France	1987	4.2	
	1990	3	
	1993	2.1	35
United States	1986-1987	1.8	42
	1988-1991	1.4	50
Sweden	1985	3.1	22
	1990	2	40
	1995	1.4	50

*Adapted from 'Étude 1996-1997 sur la santé buccodentaire des élèves québécois de 11-12 et 13-14 ans' (13) and Report on the findings of the oral health component of the Canadian Health Measures Survey 2007-2009 (11).

2.1.2 Dental caries and quality of life

Oral health is an important determinant of general health and quality of life. Oral health problems can affect people physically and psychologically, leading to adverse effects on growth, ability to taste food, eating habits, sleep, self-esteem, socialisation and enjoyment of life (3). Teeth

discolorations may be perceived as a sign of unhygienic and unhealthy lifestyles and deprivation, and can have a great impact on one's social life and interactions (14).

Carious lesions can have very negative effects on children. If left untreated, they may cause severe pain and lead to sepsis (15). Pain from dental caries can affect sleeping, eating and playing, which in turn can impact social development and wellbeing (16). Severe dental caries in young children may have negative influences on their growth. For example, three-year-old children with caries associated with nursing bottle use weigh 1 kg less, compared to children with healthy teeth (17). Dental infections could affect children's growth through different pathways. The infection and pain associated with untreated caries can lead to reduced food intake in children (18). Chronic inflammation from dental pulpitis and abscesses may lead to impaired body metabolism, reduced erythrocyte production and a low level of haemoglobin in the blood, and hence, to suppressed growth (19). Even when growth is not affected, severe dental caries in childhood are largely responsible for diminished quality of life. High caries levels can lead to an increased risk of hospitalisation and emergency treatments, and higher treatment costs (18). In Canada, severe dental caries is the leading cause of day surgery, accounting for 31% of all-day surgical treatments under general anaesthesia among preschool children (20).

Severe caries in children are also associated with school absenteeism, decreased learning abilities and an increased number of days with activity restrictions (18, 21). Indeed, children whose oral health was reported to be fair or poor by their parents were three times more likely to be absent from school because of dental infection or dental pain compared to those reported to have very good or excellent oral health (21). In the United States, a country with relatively lower rates of caries, more than 51 million school hours, equivalent to 117,000 hours per 100,000 school-aged children, are lost every year because of dental problems or related visits (22). Children from low-income families with high observed levels of oral health problems are 12 times more likely to miss schooldays because of these problems as compared to those from high-income families who have better oral health (23). Thus, poor oral health causes an additional disadvantage to those families who are already suffering from low socio-economic living conditions.

In sum, it is evident that oral health is important for physical, social and psychological wellbeing and that it cannot be isolated from general health. Health assessments and health promotion programs should, therefore, acknowledge oral health as an integral part of general health (3).

2.1.3 The economic burden of oral diseases

Oral diseases are one of the four most expensive diseases to treat in developed countries and can cause an enormous economic burden to the individuals as well as society (2). In 2010, the direct costs of treatment of common dental diseases (excluding conditions such as oral cancer, oral infections, developmental disorders and noma) were estimated to be USD $298 billion worldwide, which corresponded to 4.6% of the global health expenditure; 83% of this direct costs were borne by high income countries. In addition, indirect costs related to these diseases (for example, decreased productivity caused by untreated dental caries, periodontal diseases and tooth loss) amounted to nearly USD $144 billion worldwide in 2010 (24).

In Canada, between 1960 and 2008, dental care expenses increased from $110 million to $12.12 billion CAD. After adjusting for inflation, in terms of 1960 CAD, this represents an escalation from $6.16 to $46.26 per capita, a greater than 8-fold increase. During the same period, there was a 2.6-fold increase in Gross Domestic Product expenditure for dental care services and a 37% increase in the share of the nation's total health care expenditures devoted to dental care services. As presented in Table 2.2, the total direct costs for dental care in 1998 were the second highest in Canada, coming close behind cardiovascular disorders and higher than those related to mental illnesses, digestive diseases, respiratory diseases, injuries and cancers (11). Treatment expenses for dental care are also very high at the provincial level. The average expenditure, public and private, per year for dental care in Quebec alone is approximately $2 billion CAD (25).

Table 2.2 Direct costs of treatment of diseases in Canada, 1993 and 1998

	Canadian dollars in billions	
	1993	**1998**
Cardiovascular disorders	7.35	6.82
Dental care	4.93	**6.35**
Mental disorders	5.05	4.68
Digestive diseases	3.33	3.54
Respiratory diseases	3.79	3.46
Injuries	3.12	3.22
Cancer	3.22	2.46

*Adapted from 'Report on the findings of the oral health component of the Canadian Health Measures Survey 2007-2009' (11).

2.1.4 Socio-economic inequalities in dental caries

Socio-economic inequalities due to dental caries are a concern even among developed countries where comprehensive and universal oral health promotion and prevention programs are generally available and utilised. For example, although all children have access to free dental care and comprehensive preventive services in Denmark, the socio-economic status (SES) of parents has an enormous effect on children's risk of dental caries(4). In the United Kingdom, there was a decline in dental caries level during the period of 1983-1993 among 12-15-year-old youth from all social classes. However, the greatest decrease was observed among youth from skilled manual labour backgrounds, and the lowest among those from semiskilled and unskilled manual labour classes. The gap between these groups widened from 0.9 teeth with one or more caries in 1983 to 1.4 in 1993 among 15-year-old adolescents (26).

In Canada, low SES is associated with an approximate two-fold increase in adverse oral health outcomes (11). Adults with low SES have poorer self-reported oral health, a greater number of untreated coronal and root caries, a greater number of missing teeth, a higher percentage of

edentulism, worse oral hygiene and periodontal disease status. They visit dentists less frequently and are more likely to avoid dental visits and treatment because of costs. The percentage of people with treatment needs are 46.6% among the low SES population compared to 25.6% among their higher SES counterparts (11).

Regardless of the indicator examined, youth from low SES backgrounds suffer disproportionately from dental caries. Indeed, the proportion of untreated carious lesions is three times higher in adolescents from low-income families than in those from higher income families. Similarly, this proportion is approximately two times higher among adolescents with public insurance or no insurance compared to those who are privately insured. Likewise, dental caries prevalence and severity are higher among children from families with lower income and education than among those from families with higher income and education (11).

2.2 Dental caries prevention and oral health promotion: change in trends

The last century saw a paradigm shift in the definition and conceptual understanding of dental caries. For a major part of the previous century, research and prevention programs directed at dental caries relied on its narrow definition as an infectious and transmissible disease caused by microorganisms. Although the role of microorganisms is still acknowledged, the current concept of dental caries identifies it as a multi-factorial chronic disease caused by an 'imbalance in the physiologic equilibrium between tooth mineral and biofilm fluid', which in turn is affected by behavioural and socio-economic factors (27). Influenced by the evolving concepts of health, health determinants and the distribution of the disease, dental caries prevention and oral health promotion approaches are constantly changing.

2.2.1 Earlier biomedical model of dental caries prevention

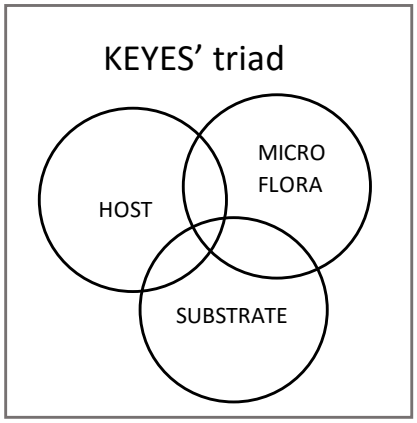
Until recently, the biomedical model of disease prevention, which emphasised the biological and behavioural determinants of disease, dominated the field of dental public health (5, 28). A

popular model explaining the biological process of dental caries formation is 'Keyes' triad'(29), presented in Figure 2.1.

As per this model, the microflora are the agents, the food is the substrate/environment, and the tooth is the host. The colonisation of a tooth by a sufficiently large population of microorganisms along with a frequent supply of appropriate food leads to the metabolism of food particles and acid production, causing the demineralisation of the tooth structure. All three conditions have to be present simultaneously for a sufficient period of time for the process to occur.

Maintaining optimal oral hygiene to reduce plaque accumulation, reducing the amount and frequency of sugary food intake and improving tooth resistance through topical fluorides or other preventive methods are the only options for controlling dental caries incidence (30).

Figure 2.1 Keyes' triad



*Adapted from 'Concepts of health and disease and caries prediction: a literature review' (31).

Prevention strategies based on the biomedical model rely completely on clinical interventions and dental health education (32). The clinical preventive/treatment programs adopt an individualistic approach targeting high-risk people and involving dental health professionals to administer the interventions (33). These mainly consist of chairside clinical interventions such as topical fluorides and sealants (5). Dental health education programs assume that increasing knowledge will result in the modification of individual behaviours (e.g., oral hygiene practices, high sugar consumption and dental visit patterns), thus they are also individualistic in nature and

focus on high-risk groups (33). However, purely clinical and behavioural approaches to the prevention of dental caries have been highly criticised; Watt and Sheiham have discussed the drawbacks of behavioural approaches for oral health promotion (34, 35).

The behavioural approach to oral health promotion isolates behaviours from their context, ignoring the broader socio-economic determinants of health (36). Such efforts have only produced short-term effects (5) that are not sustained without accompanying changes in the socio-economic environment (36). Importantly, this approach does not take into consideration that behaviours are shaped throughout the individual's life span (37-39). Individual behaviours are complex and intrinsically linked to the socio-economic environment where one grows, develops and lives, and thus are not entirely freely chosen. Indeed, oral health promotion targeting behaviour modification does not reduce health inequalities and, on the contrary, may increase the gap by favouring those with the resources to foster newly learned behaviours (40). Moreover, an exclusive individual lifestyle approach requires the involvement of health professionals and is therefore costly (5).

There is also evidence to question the role of the dental health care system in reducing dental caries incidence in the population. Nadanovsky and Sheiham compared the relative contributions of dental care systems and socio-economic factors in bringing about the dental caries reduction observed among 12-year-old children during the 1970s and 80s in industrialised countries. They concluded that dental care systems played a relatively insignificant role; only 3% of the variation in dental caries incidence was explained by dental care systems, whereas 65% could be attributed to socio-economic factors including fluoridated toothpastes (41). Similarly, regular attendance at a dental clinic was not associated with a decreased dental caries level among adults. On the contrary, regular attendance was associated with a comparatively higher DMF-T index (42).

Some argue that the decline in DMF-T values may partly be due to the evolution of treatment and preventive approaches in dentistry, changing from the earlier interventionist approach to a less invasive approach in later years, rather than an actual decrease in dental caries incidence (42). Dental health care systems are essential in emergency care, treatment, cure and provision of comfort, but may play a relatively small role in determining population dental health.

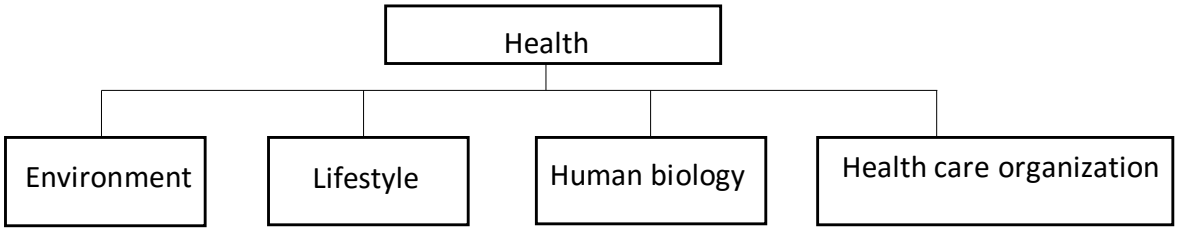
Focussing on individualistic preventive and treatment approaches is not sufficient. Reducing disease in the whole population will require the additional consideration of socio-economic and political factors (42).

2.2.2 The evolution of the concept of comprehensive health promotion

The exclusive focus on biomedical disease prevention models placed the entire burden of disease prevention on health care systems, leading to a rise in medical care expenditures (43). Understanding the limitations of the exclusive medical model of disease prevention and the need for a new approach in health promotion, the Canadian government published the monograph 'A new perspective on the health of Canadians (Lalonde Report)' to guide health policies in 1974 (44).

The author reflected that confining health within the health system was ignoring the important biological, behavioural and environmental determinants of health. The report introduced a new 'health field' model, presented in Figure 2.2, that considered health to be the product of lifestyle, biology, environment and health care organisation. The human biology component refers to all the aspects of health, physical as well as mental, that develop within a human body. The environment refers to all elements outside the human body on which an individual has little control. Ensuring the availability of safe food and water for consumption, controlling water and air pollution, installing effective sewages systems, and ensuring a healthy social context would foster a healthy environment. Lalonde described the lifestyle factors as 'self-imposed risk factors' or 'aggregations of decisions by individuals which affect their health and over which they more or less have control'. In other words, when illness or death happens due to these risk factors, the individual's lifestyle itself is the cause or the contributor. Health care organization was reduced to one of the four elements in the health field model (44). Lalonde argued that greater attention should be given to the first three elements of the health field concept, as they are the cause of most illnesses and deaths. The report insisted that research should focus on understanding basic human biology and behaviours, and that the natural and built environment should be improved to favourably influence the risk taking behaviours of individuals (43, 44).

Figure 2.2 The Health-Field Concept



*Adapted from 'Concepts of health and disease and caries prediction: a literature review (31).

This new concept became widely popular in the western world and countries such as the United Kingdom and the United States made similar efforts to change the public health field. However, Lalonde was criticized for overemphasising 'self-imposed risk factors' and blaming individuals for their ill health. Although the report failed to diverge attention from lifestyle modification, it initiated a movement in the field of public health policy by expanding the definition of health and urging policymakers to think beyond the umbrella of health care systems (43).

A major event in the field of public health was the adoption of the 'Declaration of Alma Ata' at the WHO International Conference on Primary Health Care in Alma Ata, Russia in 1978 (45), which provided the initial framework for the modern concept of health promotion. It called for effective national and international actions to invest in and develop primary health care that is accessible for all (46). Five basic principles were emphasised in the declaration:

- Equitable distribution of health-related resources
- Community participation
- Focus on prevention
- Use of appropriate technology
- A multi-sectoral approach to health promotion

In 1986, Ottawa was the host of the first international conference on health promotion, which led to the seminal 'Ottawa Charter for Health Promotion'. This charter provided a clear definition of health promotion and guidance for the adoption of comprehensive health promotion strategies (47).

The Ottawa Charter defined health promotion as 'the process of enabling people to increase control over and to improve their health' (47). According to this conceptualisation, health promotion should aim to make the political, economic, social, cultural, environmental, behavioural and biological factors favourable for health improvements. Equal opportunities and resources (e.g., supportive environments, access to information, life skills, and opportunities to make healthy choices) must be provided to empower citizens to take control of their health and to achieve equity in health. Health promotion has to go beyond health care systems and include people and organisations from all sectors of life (47). The charter reiterated the need for social justice and equity as the most important prerequisites of health. It also defined the fundamental conditions and resources for health that included peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice, and equity (47).

In addition, the Ottawa Charter defined five health promotion action areas (47):

- Building healthy public policy: public policies from any sector, not only the health sector, have to take into consideration their impact on people's health.
- Creating supportive environments: political, economic and social environments influence people's health and actions can be targeted to create environments that are conductive to health.
- Strengthening community actions: individuals, families and communities have to be encouraged and empowered to take control of health determinants.
- Developing personal skills: health promotion has to go beyond the provision of information to promote an understanding of health by developing personal, social, and political skills that enable people to take action for health promotion.
- Re-orienting health services towards disease prevention and the promotion of health: redirecting attention from exclusive clinical and curative services to health promotion and disease prevention.

The Ottawa Charter proved to be a turning point in the field of health promotion. Subsequent international conferences in this field refined and modified the modern public health approach to health promotion (45).

2.2.3 A look into recent public health models for oral health promotion

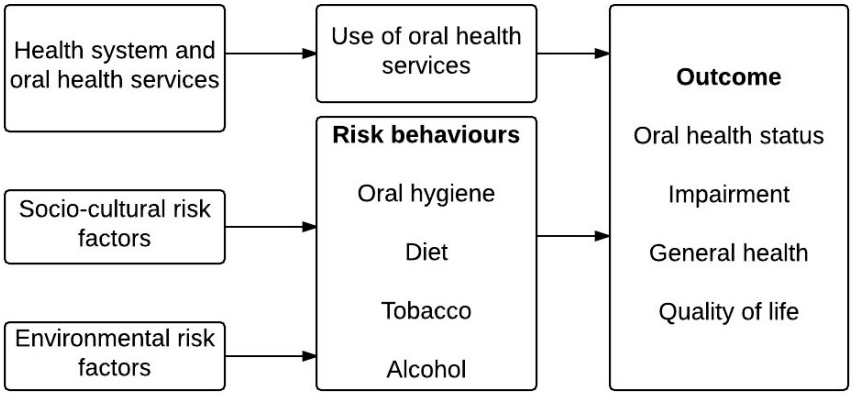
Radical changes have taken place in the field of oral health promotion since the publication of the Ottawa Charter in 1986. The importance of social determinants of oral health and the pressing need to address oral health inequalities have been widely acknowledged. New theoretical frameworks have emerged to guide public health strategies to deliver oral health promotion and reduce inequalities.

The following section discusses the models proposed over the last two decades in the field of oral health, which emphasise the role of environmental factors in oral health promotion. Three main models are discussed: 1) the WHO's risk factor model for oral health promotion, 2) the common risk factor approach in oral health promotion, and 3) the integrated model of common risk factors and social determinants.

2.2.3.1 The WHO's risk factor model for oral health promotion

To address the crisis of non-communicable diseases in both developed and developing worlds, the WHO framed a global strategy for the prevention of chronic diseases in 2000 (48). This strategy gave importance to diseases sharing common preventable lifestyle risk factors including chronic oral diseases. The document proposed a risk factor model for oral health promotion addressing the major socio-environmental and intermediate modifiable risk factors in oral diseases. The model (see Figure 2.3) shows how the distal social, cultural, environmental and health policy aspects act through the intermediate modifiable risk factors to affect oral health and quality of life (49).

Figure 2.3 The risk factor approach in oral health promotion.



*Adapted from 'The World Oral Health Report 2003: continuous improvement of oral health in the 21st century-the approach of the WHO Global Oral Health Programme' (49).

Factors such as low socio-economic living conditions, lack of cultural beliefs and ideologies that support oral health promotion comprise the *socio-cultural risk factors*. Examples of *environmental risk factors* that would pose danger to oral and general health include the absence of fluoridated drinking water, polluted environments, and shortages of clean water to practice good oral hygiene behaviours. *Health systems and oral health services* might also be important determinants on the distal end. Health systems could contribute to disease reduction if they are oriented towards primary health care and prevention. The intermediate factors consist of modifiable health related behaviours, which in turn determine oral health outcomes and quality of life. The WHO's risk factor model stressed the important role played by distal environmental factors and emphasised the need for a comprehensive approach to deliver oral health promotion (49).

2.2.3.2 Common risk factor approach in oral health promotion

The risk factor model was further modified by the addition of the common risk factor approach, which emphasised the need to integrate health promotion actions across health disciplines (Table 2.3) (50). Many intermediate risk factors such as diet, smoking, alcohol consumption,

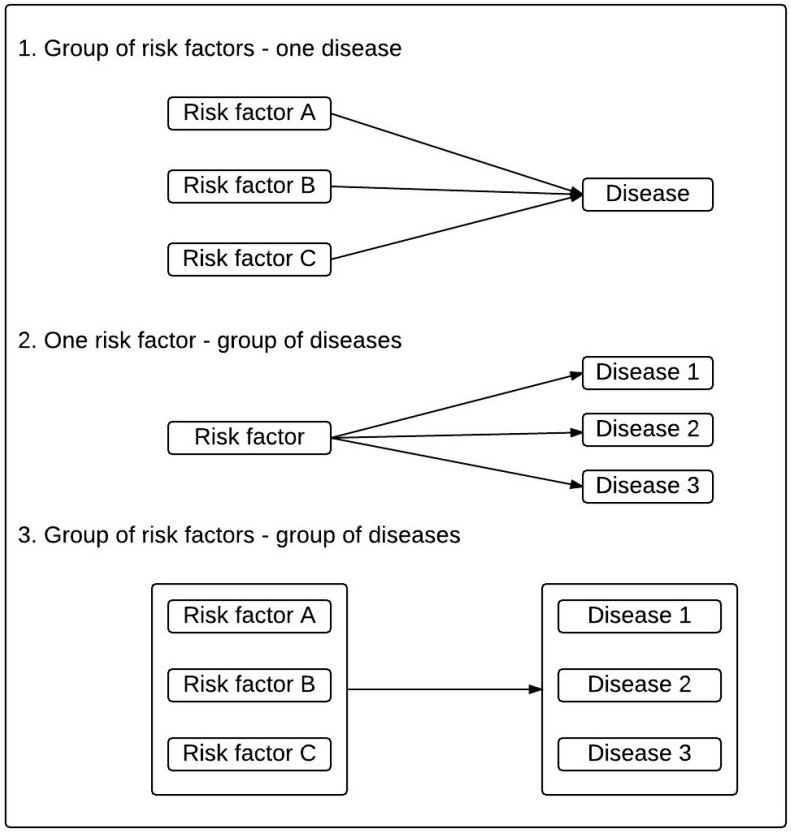
psychological stress and hygiene are common to several chronic diseases including cardiovascular diseases, stroke, obesity, periodontal diseases and dental caries. Targeting a small number of risk factors that are common to many diseases will have a larger effect and a greater efficiency (51).

This approach proposes an integrated strategy for disease prevention rather than separating diseases into different boxes and designing isolated interventions (50). We can adopt and implement the common risk factor approach in many ways (Figure 2.4). For example, because most chronic diseases have multifactorial aetiology, we can target one disease by tackling many risk factors at the same time through an integrated approach. Conversely, we can target one risk factor common to many diseases, thus integrating actions across different diseases. Because risk factors (e.g., smoking, alcohol consumption and an unhealthy diet) tend to cluster in the same individuals, modifying one of the risk factors may change others; thus we could also target multiple risk factors and multiple diseases at the same time. A common risk factor approach should focus on reducing risk factors common between diseases, promoting health and providing a supportive environment to thrive even when risk factors are already present. It urges for a shift from the conventional biomedical and lifestyle approach in oral health promotion to a focus on common risk factors and their underlying social determinants (Table 2.3) (50).

Table 2.3 Health promotion strategic framework based on the common risk factor approach

1. Focus upon common underlying determinants of health, avoiding a victim blaming approach.
2. Community participation rather than professionally dominated activities.
3. Emphasis on addressing health inequalities to achieve sustainable improvements in oral health.
4. Work on partnerships across sectors and disciplines.
5. Adoption of a range of complimentary public health policies rather than individually focused health education.

Figure 2.4 Common risk factor approach



* Adapted from 'Oral health policy and prevention' (1).

2.2.3.3 Integrated framework of common risk factors and social determinants

A major milestone in the field of oral health promotion was the conceptualisation and popularisation of the common risk factor approach. It played a key role in integrating oral health into general health promotion. However, despite the wide attention it received, this concept was largely misunderstood. The importance of underlying social determinants was mostly ignored and oral health promotion programs concentrated solely on the common behavioural risk factors and behaviour modification interventions targeting them. This situation created a need to reinstate the principles underlying the common risk factor approach (34).

In 2012, Sheiham and Watt (34) further emphasised the need to focus on social determinants of health and argued that this is the only way that oral health promotion programs can be completely integrated within the main stream of health promotion. They proposed a new model, combining the common risk factor approach with the social determinants framework, to tackle the crisis of increasing health inequalities.

2.2.3.3.1 Social determinants framework in health promotion

In 2005, the WHO set up the 'Commission on Social Determinants of Health' aiming at fostering a global movement to strive for social justice and health equity. To attain these goals, the Commission urged all organisations, governments and the civil society worldwide to work together to frame policies and programs to influence the social determinants of health. Accordingly, a social determinants framework was proposed to guide actions to promote health and reduce health inequalities (Figure 2.5) (52).

Despite continued efforts, dealing with inequalities is still a major challenge in health promotion. Inequalities in health are caused by socio-economic disparities in the contexts in which individuals are born, grow, live, work and age (53). Social and economic conditions affect people even before their birth. Parents' low socio-economic conditions increase the chances of low birth weight babies, which in turn predicts many health conditions, including oral health later in life (54, 55). Childhood family circumstances will influence one's educational attainment, future

employment, job security, status in society, access to resources, choices of health behaviours and so on (54). Indeed, health behaviours such as oral hygiene and level of sugar in diet show socio-economic gradients (56, 57). The socio-economic conditions at each stage of one's life leave an imprint on the biological, behavioural as well as social aspects of life, and these exposures accumulate over the lifetime (54). According the to the Commission on Social Determinants of Health, health promotion actions should target the factors affecting daily life as well as the structural drivers that determine the distribution of these factors (52). Differential exposure to disease causing factors (e.g., social and physical environments, work, and social stratification, among others) constitute the daily living circumstances. Healthcare systems and their approach to health promotion, disease prevention, and treatment also affect the daily life of people. These in turn influence one's material conditions, psychosocial support, opportunities and behaviours, and thus health. The structural drivers include the nature and extent of social stratification in society; customs, beliefs, and biases within society; and the governing processes and policies at local, national, and global levels (52).

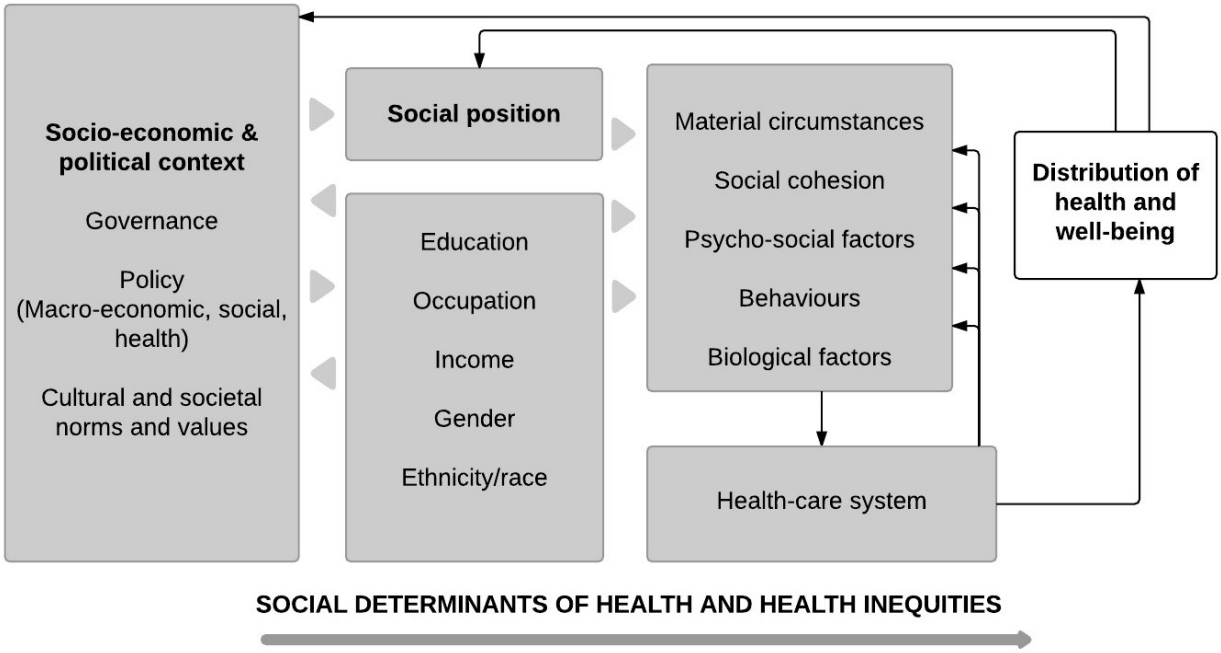
Reducing inequalities across the population will require a universal and proportionate delivery of resources according to the level of disadvantage, across different socio-economic sectors of the society (proportionate universalism). Focussing merely on the most disadvantaged may not be sufficient to reduce inequalities; actions will have to focus on reducing the steepness of the socio economic gradient as well as accelerating the health improvements of the most disadvantaged (58).

Three principal action areas were proposed by the Commission on the Social Determinants of Health (52):

- Improve daily life conditions - the circumstances in which people are born, grow, work and age.
- Tackle the inequitable distribution of power, money and resources - the structural drivers of the conditions of daily life - globally, nationally and locally.
- Measure the problem, evaluate actions, expand the knowledge base, develop a workforce trained on the social determinants of health, and raise public awareness about the social determinants of health.

These actions are complementary and should occur simultaneously. A combination of top-down and bottom-up approaches, ranging from governance and policy matters to community actions at global, regional, and sub-national levels must be undertaken to abolish health inequalities and bring about social justice (52).

Figure 2.5 Social determinants framework

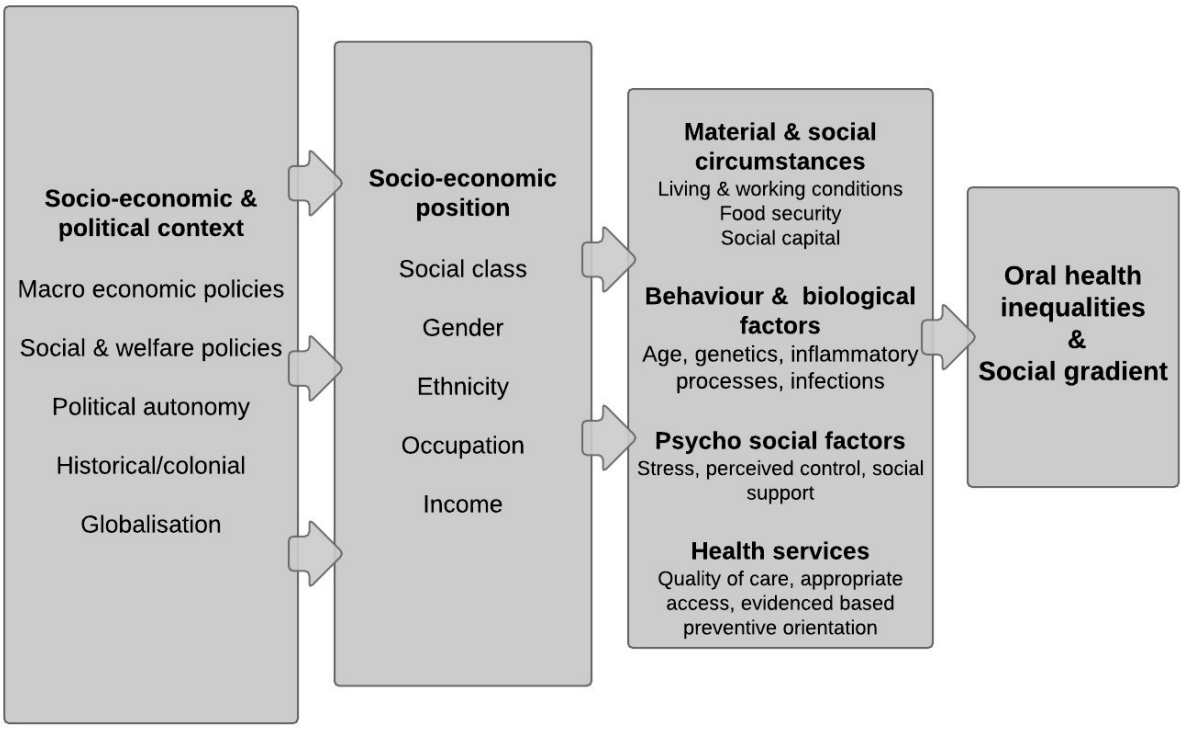


*Adapted from 'CSDH final report: closing the gap in a generation: health equity through action on the social determinants of health' (52).

2.2.3.3.2 Integrating the common risk factor approach into the social determinants framework

The integrated framework of common risk factors and social determinants is an adaptation of the social determinants framework to the field of oral health promotion, as described in Figure 2.6. Similar to the social determinants framework, the integrated framework views socio-political environments as the structural drivers of the intermediate determinants such as working and living conditions, psychological, behavioural, and biological factors. Additionally, here, the behavioural factors include the common risk factors described in the common risk factor approach. This urges oral health promotion actions to adopt multiple complimentary strategies, acting at national, regional as well as local levels to make changes in the 'causes of causes' (34).

Figure 2.6 Integrated framework of common risk factors and social determinants



*Adapted from 'Integrating the common risk factor approach into a social determinants framework' (34).

2.2.4 Target population and strategies in the public health approach

According to Rose et al, there are two types of oral health promotion strategies: the high-risk and the population-based approach (59). The high-risk approach targets high-risk individuals, that is, those at the tail of the disease distribution. These individuals can sometimes be identified through screening so that preventive measures can be directed towards them (32). The population-based approach strives to utilize public health measures to reduce the risk of diseases in the entire population. This approach advocate to target the underlying causes of disease in the whole population, and aims to shift the entire disease distribution to the left.

A third approach, the directed population strategy, involves a combination of both approaches described above. This strategy targets only part of the population, but rather than using screening

methods to identify high-risk individuals, it utilizes epidemiological and/or socio-demographic data to identify subgroups of the population that have a high risk of disease (32, 60).

Population and directed population approaches focus on factors causing the disease incidence (e.g., healthy eating), whereas high-risk approaches focus on the disease itself (e.g., dental sealants).

Choosing the best strategy for oral health promotion depends on the context and the disease distributions in the population. High-risk strategies have been dominant in the field of dental caries prevention typically focussing on clinical treatments such fluorides and sealants, and lifestyle approaches (32). An advantage of this approach is that there is no need to intervene on people who are at lower risk for the disease and the high-risk group will be more motivated to participate and take action. The high-risk approach may conserve resources by targeting a small group where the potential benefits of the interventions are high (1).

Nevertheless, there are many limitations to the high-risk strategy in dental caries prevention. It completely relies on the sensitivity and specificity of the screening methods used for identifying the target population and assumes that the preventive interventions, clinical or behavioural, are effective and appropriate for their socio-economic circumstances (32). Moreover, this approach leads to labeling people as belonging to distinct categories, and considering the disease as a problem of the high-risk categories alone. While most of the population is labeled 'safe', and therefore disease is not considered a population problem, dental caries can increase throughout the population and may not be confined to high-risk individuals (60).

In addition, high-risk approaches are palliative and temporary in nature, and do not consider the underlying socio-economic determinants of health. In other words, the approach does not prevent new cases of disease and high-risk groups will keep on emerging in the population (32, 60). The cost-effectiveness of these strategies is also questioned (4). High-risk approaches require a sustainable mechanism to identify high-risk individuals as early as possible using a validated screening method and thus require a recurrent investment of time and resources for their continued implementation (60).

Sheiham argues that the improvements in oral health observed over the last decades have been mostly due to changes at the population level (1). Although individualistic prevention may have made a small contribution, the majority of these changes can be attributed to improvements in socio-economic circumstances such as social norms (changes in dietary patterns and oral hygiene), the availability of resources (fluoridated toothpaste, sufficient food of good quality), and technology advancements (clean water, water fluoridation) (1).

Hence, from a public health perspective, it may be more appropriate for policies aiming to reduce dental caries to adopt a population or directed population strategy (4, 32, 60).

2.3 Delivering oral health promotion: the settings-based approach

The idea of health promotion through a 'whole system' or setting originated from the WHO's strategy of 'Health for All' in 1980 (61). The healthy settings approach was given a clear definition and structure in the Ottawa Charter for health promotion in 1986 (47). The Sundsvall Statement of 1992 (62) and Jakarta declaration in 1997 (63) further built on it and emphasised the importance of healthy settings.

A 'setting for health' is defined as 'the place or social context in which people engage in daily activities in which environmental, organisational, and personal factors interact to affect health and wellbeing' (64). Settings are usually characterised by physical boundaries and personnel assigned with duties to function within an organizational structure. The basic principles of healthy settings include 'community participation, partnership, and empowerment'. The first successful example of a settings approach was the 'healthy cities' introduced by WHO in 1986 (65). Following this success, health promotion efforts in various other settings such as villages, hospitals, workplaces and schools were carried out worldwide (66).

2.3.1 Schools: ideal settings to reach children and to promote oral health

Schools are an ideal setting for health promotion activities because they allow access to the majority of the child population. Globally about 90% of children attend primary schools (67) and

in Canada, nearly 100% of the primary school aged children are enrolled in schools (68). Moreover, schools can be used to provide children with a supportive environment at relatively early stages of their lives and continuously monitor and reinforce healthy behaviours for a relatively long period (69). This is of the utmost importance because childhood is a stage of rapid development and the formative period for health behaviours. The behaviours, attitudes and beliefs developed during this period may be sustained lifelong (70).

School is also an important centre for the implementation of the five primary action areas proposed in the Ottawa Charter. By ensuring safe and health conductive physical, psychological and social environments in schools and encouraging the involvement of parents, teachers, community leaders and others, schools can provide *supportive environments* for growing children. Schools may also act as a way to reach to the local community. Health promotion activities may be extended to home and the community around the schools; for example, health promotion messages could be spread through children to family members (69). They can also collaborate with *community* to implement and sustain oral health promoting programs. Schools are ideal places to *develop personal skills* to maintain healthy lifestyles, and thus reduce the risk of oral health diseases. *Health care services can be oriented* towards outreach care and made accessible in health promoting school settings (69).

2.3.2 Global health initiative through schools

WHO launched the global school health initiative in 1995 with the goal to increase the number of health promoting schools worldwide (6). A health promoting school (HPS) is defined as a 'school constantly strengthening its capacity as a healthy setting for living, learning and working'. It aims to use all the available resources to develop schools as settings not only for learning, but also fostering health. It emphasizes a unified effort from students, teachers, staff and community to promote a healthy school environment through a multitude of actions, such as health education, health services, community-based programs, nutrition programs, physical activity promotion programs, mental health promotion programs, implementation of health policies and practices. One of the distinguishing features of HPS is the school-home-community interaction (6). Oral health is an important component of school-based health promotion. Indeed, WHO has

released a manual on how to incorporate oral health promotion in HPS (69, 71). Table 2.4 describes the characteristics of an oral health promoting school as proposed by the WHO.

Table 2.4 Characteristics of an oral health promoting school proposed by WHO

School health policy

- Developed with input from all stakeholders (parents, teachers, students, school nurses, dental staff, community, health workers, etc.)
- Provides the framework for all oral health activities

Healthy school environment

- Presence of healthy choices for food, drinks, and snacks
- Access to safe water and sanitation
- Ban on vending machines providing sugary drinks
- No access to sweets on school premises
- Ban on tobacco use
- Safe playground and sports facilities
- Exposure to adequate fluoride levels using relevant fluoride vehicles

Oral health education

- Integrated into existing curriculum
- Continuous
- Age-specific
- Child-centred
- Skills-based
- Community oriented

*Adapted from: Promoting oral health of children through schools – Results from a WHO global survey 2012 (67).

2.3.3 Studies on oral health promotion effectiveness

The earlier reviews (72-74) on oral health promotion programs including those conducted in school settings concluded that these programs are ineffective. Most interventions were health education programs aiming to modify health behaviours. Dental education may increase knowledge level; however, there is no evidence that this increased knowledge improves behaviours or clinical outcomes. Moreover, evidence to support the cost-effectiveness of dental education programs is not available. School-based tooth-brushing campaigns and mass media communication are ineffective in bringing about behaviour modifications. Interventions involving water fluoridation and fluoride toothpastes are effective in dental caries reduction presumably due to their therapeutic effects (32, 75). A relatively recent review reported that school-based oral health promotion programs may lead to short-term improvements in plaque level and gingival health during the trial period. However, we need further evidence for long-term sustainability (76). Moreover, interventions were mostly tested using experimental study designs and none of the studies tested policy development, or any other non-educational health promotion action (76). Similar results were reported in a systematic review on primary school-based behavioural interventions in 2011 (77). In addition, the interventions lacked any theoretical basis (77).

Reviews of randomised controlled trials show that topical fluorides reduce approximately 25% of dental caries (range between 24% to 26%) whereas water fluoridation usually reduces 14% of caries (32). Fissure sealants were shown to reduce 85% of dental caries at 12 months and 57% at 48 months and their effectiveness depended on baseline caries risk (32). Indeed, fissure sealant programs are effective in reducing dental caries incidence in children and adolescents, and have been recommended in school-based programs (78). The average duration of dental caries risk reduction after sealant application compared to no sealant was reported to be 48 months and the effectiveness of sealants depended on retention (79).

A school-based sealant program for children from low socio-economic backgrounds showed a significant protective effect only among those diagnosed as high-risk at baseline, and only about half of the sealants were retained after one year (80). A 4-month school-based screening

intervention that included a referral to the dentist, information leaflets or letters to the parents, was ineffective in increasing the frequency of dental visits or decreasing levels of active caries (81).

Although individual clinical preventive measures, such as sealants and fluorides, are generally effective in reducing dental caries, these interventions are palliative in nature and do not address the underlying cause of the disease (32). Moreover, clinical prevention requires the involvement of dental health professionals and are usually costly, and hence may not reach those in higher need. The need for follow up and reapplications may further increase the cost of implementation. There is no evidence to support the cost effectiveness of clinical preventive methods (82).

Only a few studies have looked at the effectiveness of comprehensive school-based programs in reducing dental caries. In Brazil, children from schools which adopted a 'comprehensive curriculum', including food and smoking policies, a participatory approach to health education, actions to maintain a clean and healthy physical school environment, and provision of health services, had better oral health compared to those from schools without such an approach (83). In Ireland, the 'Boost Better Breaks' school policy, allowing consumption of milk and fruits only during break time was not effective in reducing dental caries incidence or improving healthy eating behaviours (84, 85). School-based oral health programs that adopted a HPS concept had positive effects on oral health related quality of life among primary school children in Malaysia (86). The schools that participated in the 'healthy school program' in Ontario, Canada, had lower proportions of children with tooth decay and the effect was higher among schools in low socio-economic neighbourhoods (87).

A cross-sectional study evaluated if university students in Kuwait exposed to a school clinical preventive program in childhood had better oral health and behaviours later in life. They did not find any differences between exposed and unexposed groups in oral health knowledge, behaviours, self-reported oral diseases, or reporting of oral health affecting social functioning or conversational abilities. However, the students exposed to the program seemed to be more satisfied with their oral health and reported fewer oral health problems than non-exposed students. Nonetheless, the researchers used basic statistical tests and did not adjust for any

potential confounders in inferring associations. Hence, chances of bias may be high (88). An assessment of the effect of exposure to a clinical preventive program during school years among a group of 20-year-old adults in Japan showed that the caries prevalence was lower among those who had received fluoride mouth rinse and pit and fissure sealants compared to those who had only received fluoride mouth rinse. Here again, this was not adjusted for any confounders and there is a high possibility of bias (89). For example, those who received combined programs may have been from high SES backgrounds.

In conclusion, the majority of the studies tested isolated oral health promotion interventions. Exclusive dental health education programs are generally ineffective and expensive. Clinical prevention programs are generally effective in reducing dental caries; however, clinical prevention alone is palliative in nature and its cost-effectiveness is questionable. Also, there is limited evidence for the effectiveness of implemented school-based oral health promotion programs in reducing dental caries. Finally, most of the studies on implemented school-based programs were cross-sectional.

2.3.4 School neighbourhood factors and children's oral health

2.3.4.1 School socio-economic neighbourhood and dental caries in children

The association between individual socio-economic conditions and dental caries has been well studied. Apart from one's individual and family SES, neighbourhood socio-economic conditions can also affect health outcomes. Some studies have looked at the relation between school SES as well as other school level factors and the oral health of schoolchildren. School performance results, free meal programs and socio-economic environments may be used as indicators of the oral health of school children (90). The percentages of grade 3 and grade 6 children scoring below the provincial average in reading, writing and mathematics are associated with increased dental treatment needs among Canadian children. The school performance variables might act as surrogates for other contextual factors such as home environment factors, parental involvement, and neighbourhood factors (91). In Quebec, dental caries prevalence shows an inverse

association with school socio-economic environment. Schools with less favourable socio-economic environments have a 7% higher prevalence of dental caries experience and a higher percentage of children reporting dental pain (92).

School SES may also influence outcomes of oral health promotion activities conducted in school settings. Ontarian schools participating in a healthy school program had a significantly lower percentage of children with preventive and urgent treatment needs and higher dental caries levels than non-participating schools; this effect was greater among those from low-income schools. Seemingly, children in low-income schools benefitted more from a healthy school program. However, this was a cross-sectional study and evidence from longitudinal studies are required to confirm this finding (87).

The above findings suggest that school SES should be taken into consideration when planning and delivering school-based oral health promotion programs. Moreover, studies investigating the association between school-based health promotion and oral health outcomes should consider the neighbourhood SES.

2.3.4.2 Surrounding retail food environment and eating behaviours of children

The influence of the built environment on health and health related behaviours have been gaining increased attention in recent years. An important environmental factor that could affect a person's food purchasing and eating behaviours is the type of food stores present in their residential or working neighbourhood. In the case of children, the school neighbourhood will be an important consideration.

Children are exposed to the retail food environment around schools on their way to and back from schools as well as during lunch hours, if the schools have open lunch policies. This could potentially affect their food purchasing and consumption habits. In Quebec, higher numbers of fast food and convenience stores in comparison to healthy food stores in proximity of schools have undesirable effects on children's diet habits (93). A 2014 systematic review concluded that existing findings on the relationship between the retail food environment around schools and

the food purchasing and/or consumption habits of children are equivocal. However, there is some evidence for the negative influence of retail food environment around the school on obesity in children. The authors concluded that the available evidence is mostly from cross-sectional studies and identified the need for further longitudinal studies to understand these relationships (94). Only one out of the 14 studies examining the impact of the surrounding food environment on children's diet was longitudinal; it concluded that the proximity of schools to unhealthy food stores might negatively affect the diet of children. The effects were small, but statistically significant. More studies are required to confirm these findings (95).

None of the studies assessing the effectiveness of school-based oral health promotion considered the potential impact of the retail food environment around the school on children's oral health. Therefore, future studies should consider this factor as a potential environmental determinant of children's oral health behaviours that could modify the effects of school-based health promotion activities on children's oral health.

2.4 Public health approaches in oral health promotion: the situation in Quebec

Traditionally oral health has been given a minor role in Canadian public health. Oral health does not come under the Canada Health Act, which ensures 'publicly administered, universal, portable, accessible and comprehensive' health care to people. Although the landscape has been improving in recent years, more work is needed to include oral health as an important component of public health programs (96). Only 6% of Canadians have public insurance to cover their dental expenses. Sixty-two percent have private insurance, whereas 32% have no insurance coverage. The low-income people who suffer from the greatest burden of disease have the least access to dental care; 52% of them have no insurance coverage (11). In Quebec, basic diagnosis, restorative treatments and oral surgery are free for children under 10 years of age. Even so, this does not include any preventive measures such as fluoride applications, pit and fissure sealants or scaling (97).

Quebecers have limited access to drinking water fluoridation. There are only 12 water fluoridation plants in Quebec that ensure the required level of 7-ppm fluorides in drinking water (adjusting for the fluorides reaching the body through other sources such as fluoridated toothpastes). Many water systems distribute drinking water that naturally has the optimal amount of fluorides; however, the majority have lower than required levels of fluorides in their water supply (98). Only 3% of Quebec's population had access to fluoridated drinking water in 2010, as opposed to 7% in 2006 and 12% in 1993. Apparently, access to fluoridated water is decreasing over the years due to the reluctance of some municipalities to fluoridate water and to the cessation of existing fluoridation programs (25). The average level of fluorides in Montreal's drinking water is less than 2 ppm, much below the recommended level (98).

Efforts are in place to promote the overall health of children through schools. The Quebec government published guidelines for school-based health promotion in 2005 (99). It is constantly encouraging schools to promote healthy habits in children including healthy eating and physical activity (100). In 2007, about 14% of Quebec schools adopted school-based health promotion concepts (101) and the number had increased to 35% by 2014 (102). A survey that assessed the food environment in Quebec schools reported that there was a considerable improvement in the availability of healthy food through schools in comparison to that reported in 2002. However, school cafeterias are still not free of unhealthy food and there is a need for further change. Only the provision of food was assessed; other school aspects such as healthy eating policies and the commitment of teachers, parents, or community to the promotion of healthy eating were not considered in the study (103). Our search did not identify any studies assessing the effect of school-based health promotion in reducing dental caries incidence in Quebec children.

3. Summary of the background /rationale

Dental caries, a common disease, is very costly to treat and places a major economic burden on society. The prevalence rates remain high in developed countries with Quebec having the highest rate among North American countries. As most chronic conditions, dental caries is unequally distributed, leading to major oral health inequalities. Hence, it is an issue requiring public health attention.

The public health approach towards dental caries prevention has evolved over the last decades and the novel model calls for a comprehensive integrated approach to oral health promotion. School-based programs offer an opportunity to implement such a public health approach. These programs can easily reach the population of children at a very crucial stage of life when their health related habits are forming, leaving long-term impacts on their health and wellbeing. Moreover, children will be available for a relatively long period, allowing for monitoring and reinforcing of the skills required for living a healthy life. Schools also act as a link to the families and the local community and provide the opportunity to work in collaboration with them to build a healthy supporting environment for children, starting from a very young age of their life. Indeed, the WHO HPS concept proposed in 1995 encompasses the essential elements of comprehensive health promotion, including oral health promotion.

The effectiveness of oral health promotion has been widely researched and evaluated. School-based dental health education interventions are generally ineffective and most of them lack a theoretical basis. The results from effectiveness studies on implemented school-based programs are mixed. Comprehensive and participatory health promotion programs are generally effective in dental carries reduction; however, negative results were also reported. Most of the studies are cross-sectional; one longitudinal study found school oral health policy ineffective in reducing dental caries or changing health behaviours. Only a few studies have looked at the modifying effect of the school SES on oral health promotion. The food environment around the school, which is a potentially important variable affecting children's diet, has not been studied in relation to oral health promotion and dental caries.

Although Quebec policy makers have made efforts to promote the health of children through schools, we could not find any study assessing their impact on dental caries incidence in children. Evaluation is an important element in health promotion, to justify the time and resources invested as well as to identify areas of improvement (75). Our study seeks to provide policy makers with feedback on the effect of school environments on dental caries incidence in Quebec children.

Hence, our aim was to estimate the relation between school environments, categorized based on socio-economic and oral health promoting environmental factors, and 2-year dental caries incidence among 8-10-year-old Quebec children.

4. Objectives

1. To identify distinct types of school environments among schools situated in the Montreal Census Metropolitan Area of the province of Quebec, drawing from a number of factors related to the provision of school-based oral health promotion programs, engagement in oral health promotion activities, and the social and built environment of the school neighbourhood.

2. To estimate the relation between types of oral health promoting school environments and dental caries incidence among 8-10-year-old children over a 2-year period.

5. Methods

5.1 Overview of the study

We used data from an ongoing prospective study, the QUebec Adipose and Lifestyle InvesTigation in Youth (QUALITY) cohort. Briefly, the study aims to understand the natural course of obesity and its vascular and metabolic consequences in youth. A total of 630 Caucasian children, aged 8-10 years, and their family were recruited from schools located in the three major urban centres in the province of Quebec. A detailed description of the QUALITY cohort can be found elsewhere (104). This study uses data collected in visits 1 (children aged 10-12 years) and 2, which were completed in 2008 and 2011, respectively.

We also acquired data from the School Study, which was a complimentary study added to the QUALITY cohort in 2008. The study included schools attended by QUALITY cohort participants and was restricted to Montreal Census Metropolitan Area (MCMA). Hence, our final sample included only those children from QUALITY cohort attending schools located in the Montreal MCMA, which comprised more than 80% of QUALITY participants. Data for school and neighbourhood environments were collected only for the baseline visit.

5.2 Study population

5.2.1 Inclusion and exclusion criteria for QUALITY cohort baseline visit

QUALITY cohort included 8-10-year-old children of Caucasian in origin with a Western European ancestry. The sample was restricted to Caucasian children to reduce the genetic admixture. Both biological parents had to be available and willing to participate in all the study procedures, such as filling out questionnaires and carrying out biological measurements. Moreover, at least one of the parents had to be obese (i.e., body mass index≥30Kg/m^2 or waist circumference >102cm

in men and >88cm in women, based on self-reported measures of height, weight and waist circumferences) for the child to qualify for the study.

Children with the following conditions were excluded: 1) previous diagnosis of type 2 diabetes; 2) following a diet highly restricted in energy (<600 kcal/day); 3) a serious illness (cancer, inflammatory bowel syndrome, anorexia nervosa, inborn errors of metabolism, cerebral palsy, and others); 4) taking antihypertensive medication or steroids (except topically applied or inhaled), because these conditions could modify the natural history of obesity and its metabolic consequences; and 5) psychological conditions or cognitive disorders that could hinder participation in some or all of the study components, or could modify the natural history of obesity and its vascular and metabolic consequences. Moreover, children were excluded if their mother was pregnant or breastfeeding at the baseline evaluation, or the family had pending plans to move out of province.

5.3 Recruitment procedures

We describe below the recruitment procedures, which involved the recruitment of children and their parents to the QUALITY cohort, and the recruitment of schools to the complimentary School Study

5.3.1 Recruitment procedures for the QUALITY cohort

The recruitment procedures for the QUALITY cohort included a systematic approach through a school-based sampling strategy. Initially letters were sent to the school boards administering the primary schools located within 75 kilometers of Montreal, Sherbrook and Quebec City. After getting permission from the school boards, the schools were directly approached to get permission for recruitment of participants. Schools with more than 50% non-Caucasian children and intellectually disabled children were not approached. A total of 1040 schools, including 44 private schools, agreed to participate, which constitute 89% of the schools approached.

About 400,000 pamphlets containing information on the study objectives, methods and expectations were distributed to parents of the children in grades 2-5 consecutively for three years. Families who were interested in the study were invited to contact the research assistants by telephone to assess eligibility. The parents were then provided a tape, on which the cut-offs were indicated, and instructions on how to measure their waist circumference. If basic selection criteria were met (8-10-year-old child of Caucasian origin with both biological parents available, and at least one parent being obese), they were invited for a pre-selection visit at the hospital where height, weight and waist measures were confirmed and study objectives, procedures and expectations were explained in detail. Fat and sugar levels in the blood were also assessed during this appointment. Consent and assent forms were mailed to families who showed willingness to participate at the selection visits.

Among the 3,350 families contacted, 1,320 met the inclusion criteria. Among these, 634 families participated in the baseline visit between September 2005 and December 2008 (48% of eligible families). Among non-participants, 81% were not interested, the biological parents disagreed on participation or were unavailable among 11% of the families, 4% of the children refused to participate, 2% of the families lived too far, 1% did not have sufficient time to invest in the study, and 1% reported miscellaneous other reasons. Four children (0.6%) were later excluded by the research team as either the child or the parents refused or were unable to complete most of the data collection procedures despite providing consent to participate.

Finally, 630 families including children attending schools in the province of Quebec and both biological parents completed the baseline visit; of these, 564 families also completed the follow up visit (89% retention rate).

5.3.2 Recruitment procedures for the School Study

The QUALITY School Study was restricted to children attending schools in the MCMA. Among 630 children participating in QUALITY, 512 children lived in MCMA. Of these, 506 children attended 296 schools divided under 18 school boards in MCMA (6 children attended schools outside MCMA). This comprised the target schools for the school study.

Initially, letters were sent to the school boards including information about the new study component. Their permission was requested to contact the principals of schools attended by QUALITY cohort children. We obtained permission to administer a questionnaire of approximately 30 minutes' duration to the school principals. The questionnaire covered issues related to school's health and physical activity promotion policies, infrastructures and opportunities available for children's health promotion. We also requested permission to conduct an onsite visit to qualitatively and quantitatively assess the infrastructure available in schools for promoting physical activity.

After getting permission from the concerned school boards, we contacted the school principals, initially, through letters, followed by phone calls after 1 week, to request for participation in the study. During the phone calls, the research coordinator explained the project, answered all the questions and requested their participation in the study. Most of the times the research co-ordinators had to make multiple attempts before getting a chance to speak to the school principals. Once they expressed their willingness, a trained research assistant visited the school, explained objectives, procedures, and expectations of the study to the school principal and conducted the data collection.

As some schoolboards did not grant permission, not all school principals were contacted for the School Study; moreover, some schools disagreed to participate. Of the 296 eligible schools in the MCMA, attended by at least 1 child from QUALITY cohort, 247 participated in the study corresponding to 430 children.

5.4 Ethics and confidentiality

The QUALITY cohort study obtained ethics approval from the Ethics Review Boards of the 'Centre Hospitalier Universitaire' Sainte-Justine, McGill University, and Laval University. Parents and school principal signed consent forms, while children provided assent.

Results and interpretations of the following tests along with recommendation of follow-up as per the current standard of care, if required, were sent to the families: blood pressure, fasting glucose

and lipids for parents and child; 2-h post load glucose, aerobic fitness, and bone mineral density for child only. The families also received a Canada's Food Guide to Healthy Eating and Physical Activity Guidelines for Children and Youth. All children received instructions on oral health behaviours and an advice to visit a dentist, if required.

The School Study obtained ethical approval from Ethics Review Board of the 'Centre Hospitalier Universitaire' Sainte-Justine. Informed consent was obtained from the school boards as well as the school principals.

All information was dealt with high confidentiality. Data containing nominal information were encrypted and password protected. Investigators had to sign a confidentiality agreement before accessing any data.

5.5 Data collection and variable definitions

This section describes the data collection procedures and the variables used in this project. It is divided into: 1) individual level data: the QUALITY cohort, and 2) School data: School Study.

Individual level data included socio-demographic information of children and their parents (data from the baseline visit only were used); and dental examination to measure the outcome, dental caries incidence in children (data from both visits 1 and 2).

The School Study provided data on school environment and neighbourhood social and built environment, which were only collected for the baseline visit.

5.5.1 Individual level data collection for the QUALITY cohort

Data were collected during a full day visit at the clinical research units of 'Centre Hospitalier Universitaire' Sainte-Justine or Hôpital Laval (Quebec City). It involved questionnaires, oral examinations and other biologic and physiologic measurements. The same procedures were followed in visit 2.

5.5.1.1 Socio-demographic data from children and parents

Information on socio-demographic characteristics including the child age, family income and parental education were obtained from parental self-report questionnaires (Appendix II).

We measured parental SES using two variables: parental education and parental income. Parental education was collected as a 7-category variable based on completion of elementary school, primary school, high school, vocational/trade school, college and university education. This was later combined for two parents and classified into three categories as follows: (i) 1 or 2 parents with high school or less; (ii) 1 or 2 parents with CEGEP/vocational or trade school; (iii) 1 or 2 parents with university degree.

Family income was defined as total income in the last fiscal year (before taxes and deductions) from all the people living and sharing expenses in the household where the child lived the majority of the time. The annual household income before taxes was measured in an ordinal scale containing 12 categories (see parents' questionnaire in the Appendix). This variable was later adjusted for the number of people living in the house by dividing the middle point of each of the 12 categories by the square root of total number of people in the household (105); later, it was grouped into four categories based on percentile distribution.

$$\text{Adjusted family income} = \frac{\text{Family income}}{\sqrt{\text{Number of people in the house hold}}}$$

5.5.1.2 Dental examination of the children

Dental caries were recorded by a trained dentist in a clinical setting with the child lying on a dental chair with an artificial source of light. The United Kingdom Children Dental Health Survey diagnostic criteria was used for oral health examination (106). Any lesions extending from initial caries (visible change in enamel and/ or dentine due to caries, visible after applying dry air on to tooth surface for 30 seconds) to advanced caries were counted as a decayed surface.

Two-year dental caries incidence was measured as the difference in Decayed, Missing, Filled Surfaces (DMF-S) indices between visits 2 and 1. Surfaces not examined either in visit 1 or 2 were excluded from the DMF-S index calculation in both visits. Five observations had negative DMF-S incremental values; some of the initial caries lesions in visit 1 were replaced by sealants in visit 2 and thus were not counted in visit 2 DMF-S index, which lead to negative differences. As this is equivalent to a difference of 0, in these cases the dental caries incidence over two years was also recorded as 0.

5.5.2 Data collection for the School Study

The school study collected data on three broad components: (i) school environment used questionnaires administered to school principals and direct visits; (ii) neighbourhood built environment used direct visits and Geographic Information System; (iii) school neighbourhood socio-demographics information was obtained through Canadian census data.

We used a subset of data on school environment, neighbourhood food environment, and SES of schools from the School Study, as described in the following sections.

5.5.2.1 School environment

Structured questionnaires administered to the school principals collected information on several factors related to school environment. In this project, we used data related to school's healthy eating policies and dental care programs (Appendix III). Questions related to assessment of healthy eating promotion policies in schools were derived from the Institute of Medicine Recommendations for Schools to Address Childhood Obesity (107), the School Health Index (108), the School Health Policy and Programs Survey (SHPPS) (109) and the Coalition for School Nutrition (110). The questionnaire was piloted with four school principals and responses to open ended questions were used to construct categories; these categories were later included in the final questionnaires. Table 5.1 provides the details of the school oral health promotion variables.

Table 5.1 Explanation of variables used to measure school oral health promotion activities inside the school

The questions used	**Scale**
Availability of a dental health professional to visit the school(yes/no) Presence of dental hygiene education programs in the school(yes/no) Presence of activities other than the provision of dental hygiene education (yes/no)	Binary
Presence of any formal healthy eating promoting initiatives in schools(yes/no)	Binary
Willingness to participate in healthy eating promotion of: School management Teachers Managers Community Parents	Ordinal: 4 level Likert scale (Very true to very false)
School: Sells drinks and snacks according to healthy eating principles during fund raising programs Has strict rule for approval of school menu catering service by a nutritionist Frequently informs parents about health promotion activities in schools Has agreement with the community to participate in healthy eating promotion for students Educates teachers on the importance of promoting healthy living Makes room for families to engage in volunteer activities Regulate food during school trips	Ordinal: 5 level Likert scale (Strongly agree to disagree and NA)

5.5.2.2 School Socio-economic neighbourhood

We used socio-demographics information from 2003 Canadian census data to calculate the SES of school neighbourhood and computed a material deprivation index using Pampelon's method as described below.

Deprivation indices are calculated for basic spatial subunits called 'dissemination area' (DA). This DA unit consists of one or more neighbouring blocks of houses with a population of 400-700 persons. The demographics information for DA within 1000 metres of the schools were used for this study. Six indicators of deprivation identified in the literature and known to be related to health were used to create theses indices: the proportion of persons without a high school diploma, the employment-population ratio, the average personal income, the proportion of persons living alone, the proportion of individuals separated, divorced or widowed, the proportion of single parented families. All these indicators except the last one were measured for people aged 15 or above. A principal component analysis was then performed on these variables and two components were identified after applying a varimax rotation.

The first component loaded on the variables measuring education, income and employment (namely, the proportion of individuals without a high school diploma, the proportion of employed people and the average income, for people ≥15 years old in census dissemination areas). We named this variable 'material deprivation index' because it represents financial capacities and resources. The other component loaded on the measure of social wellbeing (the proportion of persons living alone, separated, divorced or widowed, or single parented families) was termed 'social deprivation index' (111).

We only used the component 'material deprivation index' for this study as our interest was to calculate the SES of the school-environment. This continuous variable, with higher value representing lower deprivation, was further classified into tertiles ranging from (0) high to (2) low deprivation.

5.5.2.3 Food environment around the schools

The information on retail food environment around the schools were collected through geographic information system (GIS) available in the Montreal Epidemiological and Geographic Analysis of Population Health Outcomes and Neighbourhood Effect (MEGAPHONE) database (112).

MEGAPHONE included an exhaustive list of spatial information of business and services in the MCMA, acquired from Tames Inc., containing information until May 2005. A validity study, which verified the information on food establishments from MEGAPHONE by onsite field visits, reported good agreement (0.73), sensitivity (0.84) and positive predictive value (0.90) (113). We obtained business name, address, postal code and Standard Industry Classification codes from MEGAPHONE. A geographer supervised by a health geographer, geocoded all the businesses using GeoPinPoint^{TM}, version 2007.3.

The School Study utilised proximity and density based indicators as well as direct counts to characterise the food environment in the school neighbourhood. For our study, we considered the direct counts of fast food stores and convenient stores within 500-meter road network buffers from the school. We used this neighbourhood catchment area because it is within the walkable distance from the school where children have higher chance of being exposed to unhealthful food stores, regularly, during an academic year. For the purpose of analysis, we further classified the number of convenience stores and fast food stores into binary variables: (1) at least one convenience/fast food store within 500-meter (unfavourable) and (2) none within 500-meter (favourable).

5.5.3 Confounders

To estimate the total effect of types of school environments on 2-year dental caries incidence in schoolchildren, we identified a minimum set of confounders using a Directed Acyclic Graph (DAG) (114). It included age, sex, baseline DMF-S status of children, and parental socio-economic

characteristics. The following two sub-sections describe the DAG in general and the variable selection and modeling process using DAG in the context of this study.

5.5.3.1 Directed acyclic graph (DAG)

DAGs are graphical representations of causal relationships between and among variables (114, 115). The term *directed acyclic* graph has been given due to the following reasons. It is called 'directed' because only unidirectional arrows are used to link two nodes (variables) and each edge (arrow) represents a causal effect. The cause happens before its effect; therefore, an arrow starting from a variable cannot complete a cycle and come back to the same variable. Hence, the name 'acyclic' (115).

DAGs can be used to identify a minimum number of confounders to be adjusted in an analysis, from a set of potential confounding variables, to estimate the total or direct effects of an exposure on outcome. All the potential variables that could potentially affect the relationship between the exposure and outcome are entered into a DAG and connected using appropriately directed arrows; a stepwise strategy is used to finally select the minimum number of confounders to be included in the analysis (116).

Figure 5.1 displays the basic steps to identify a minimum set of confounders using a DAG. The letters E and D represent exposures and outcomes, respectively, and the rest are covariates that could potentially affect this relationship (115). Any path from E to D, starting from an arrow pointed toward E is called a back door path. A collider is a variable where an arrow enters and leaves though arrowheads. Blocking a backdoor path implies adjusting for one or more variables in the backdoor pathway. A path is considered blocked if it is intercepted by a collider. The basic steps for adjusting for confounding using DAGs are as follow:

- Block all the unblocked back door paths from E to D.
- Block for any new back door path that is created as a result of 'step 1'.

- Any variable that is an effect of E (or a descendent of exposure) should not be adjusted.

Figure 5.1 An example for DAG

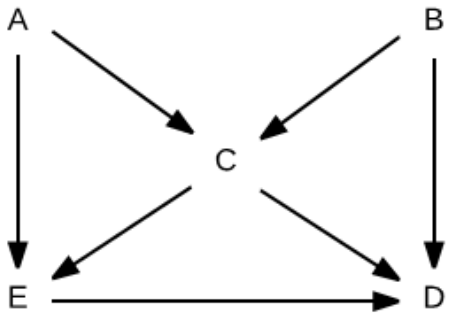
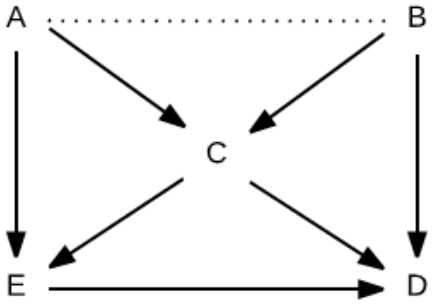


Figure 5.2 Spurious association between A-B when only C is adjusted



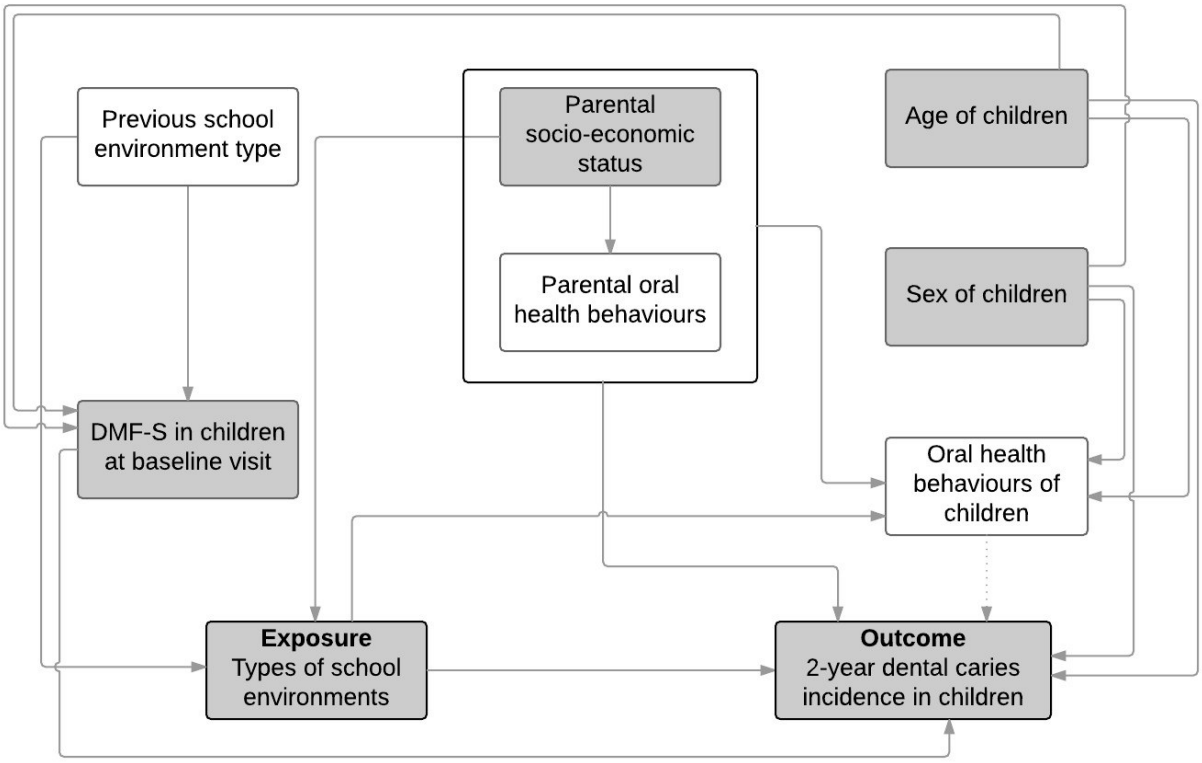
There are four backdoor paths in Figure 5.1: 'EACD', 'ECDB', 'ECD', and 'EACBD'. Path EACBD is blocked by the collider 'C' (C is not a collider in other three paths). Then, there are three unblocked paths left. Intuitively, to block the other three paths, we only need to adjust for 'C'. However, A and B are causally associated to C; adjusting for C, the common descendent, will lead to a spurious association between A and B; which in turn, will lead to opening of a new backdoor path 'EABD' from E to D leading to bias (Figure 5.2). Accounting additionally for this new path, the minimum set of confounders to be adjusted here is either, A and C or B and C (115). DAGs in real life may be complicated and methods that are more elaborate will be required to identify the minimum set of confounders (116).

5.5.3.2 Variable selection and modeling using DAG

All the variables that could potentially affect the association between oral health promoting school environment and dental caries incidence were entered into the DAG (Figure 5.3). In addition to the exposure (oral health promoting school environments) and outcome (2-year dental caries incidence), variables included were parental SES, parent's oral health behaviours, previous school environment type and child's age, sex, oral health behaviours, and DMF-S index in baseline. From the literature, we know that SES is an important determinant of oral health behaviours and utilisation dental resources (4). Parental SES and oral health behaviours can, in turn, influence children's oral health behaviours as well as their oral health (4, 117). We also assumed that parental SES influences the choice of school and oral health promotion activities in schools. Finally, we included the baseline DMF-S in DAG because it will capture the variations in the baseline caries risk of children; previous dental caries experience itself is a predictor of future dental caries (1). Also, it will act as a proxy for any effect from previous school based oral health promotion activities that the children received. The arrows in the DAG (Figure 5.3) represent each of the above-mentioned relationships.

The minimum set of confounders needed to estimate the association between oral health promoting school environment and 2-year dental caries incidence in children based on this DAG were age, sex, parental SES and baseline DMF-S (identified with the aid of 'DAGGITY' software (118)).

Figure 5.3 DAG for the association between types of oral health promoting school environments and 2-year dental caries incidence in 8-10-year-old Quebec children



Note: All relationships are represented as gray lines with arrows. Shaded boxes represent exposure, outcome, or confounders used in the final statistical model.

5.6 Overview of analytical methods

This project used a combination of analytical strategies to fulfil its objectives. First, preliminary descriptive analysis was carried out to identify the main patterns. The average values, dispersion, distribution shape and presence of outliers of each variable at both visits was examined. Subsequently, we performed principal component analysis, cluster analysis and generalised estimating equations. The following sections describe in details these methods and provide the explanations for our choices.

5.6.1 Principal component analysis

Principal component analysis is a statistical method used to reduce the dimensionality of a data set containing a large number of interrelated variables, while retaining the maximum variance present in original data. The original variables are converted into a set of principal components that represent uncorrelated linear combinations of the optimally weighted observed variables. The first component will capture most of the variation present in all of the original variables (maximal overall variance). The second component will capture maximal variance not captured by the first component and will be uncorrelated to the first one, and further components are formed in similar way. The optimal weighting is given to the observed variables in a manner that the resulting principal component would explain the maximal variance in the data set. The maximum number of components formed will be equal to the total number of variables entered to the analysis (119).

For a set of 'p' random variables 'x', let the first principal component be α_1'x, which is a linear function of 'x' having maximum variance represented as (119):

$$\alpha_1'x = \alpha_{11}x_1 + \alpha_{12}x_2 + \ldots\ldots + \alpha_{1p}x_p = \sum_{j-1}^{p} \alpha_{1j}\, x_j$$

The second component will be α_2'x capturing the remaining maximum variance and uncorrelated to the first one. The process continues and at Kth stage the principal component, α_k'x capture the maximum variance with the condition of being uncorrelated to α_1'x… α_{k-1}'x components. The maximum possible value for k is 'p'. The principal component coefficients and variances are derived as Eigen vectors and Eigen values decomposing a covariance/correlation matrix (119). The solution of Eigen problem gives principal component weights α_k (or factor loadings), linear combinations α_k'x (scores) and Eigen values λk.

However, principal component analysis is performed on the underlying assumption that the variables are continuous and normally distributed. The principal component analysis involving binary, ordinal or discrete data violates this basic assumption. One of the methods suggested to deal with ordinal, including binary, variables is to use 'polychoric correlation matrix' as the base for principal component analysis. This method, uses a maximum likelihood estimate to derive the

correlation coefficient, and gives more consistent estimates of the explained variable proportions compared to other methods used for dealing with discrete variables. (120). STATA calculates polychoric estimates as follows: if the two variables are ordinal, a maximal likelihood estimate for correlation is calculated assuming that the ordinal variables were obtained by categorising continuous, normally distributed variables and that those two unobserved variables have a normal bivariate distribution. Binary variables may be considered as ordinal variable with just two categories and the correlation between two binary variables is referred to as tetrachoric (121). Once the correlation matrix is formed, further steps for principal component analysis are the same as that for the usual Pearson moment correlation structure for continuous variables, using Eigen vectors and Eigen values (120).

5.6.2 Cluster analysis

Cluster analysis is a statistical method used to find groups in a dataset so that the observations in a group share common characteristics according to some defined distance/dissimilarity measures. Commonly, two broad categories of cluster analysis algorithms are described: partitional and hierarchical clustering (122).

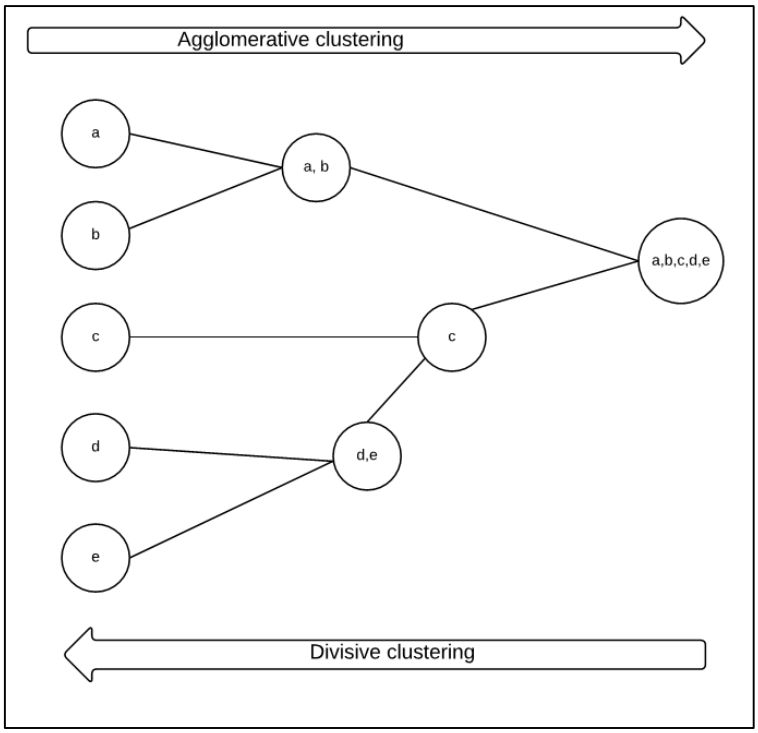
5.6.2.1 Partitional clustering:

It is an algorithm where the data are divided into disconnected groups. Some random points are selected as initial centres of clusters, and an iteration process starts by assigning the closest points, based on proximity measures, to the closest centre. Once the first iterations end, new points will be computed as the centre of the clusters. The iteration process continues until a convergence is reached. Partitioning method will construct k number of clusters, which is fixed and given by the user. However, the algorithm can be run several times with different values of k to select the best cluster solution. One of the most common method is K-means clustering, which is based on least squared algorithm (123).

5.6.2.2 Hierarchical clustering

Here, the groups are connected and nested within each other. There are two types of hierarchical clustering: divisive and agglomerative (Figure 5.4). In divisive clustering, the grouping starts with the entire observations as a whole cluster; then at each step of the algorithm, bigger clusters are divided into a pair of smaller ones until the final smallest cluster contains just one point. In agglomerative clustering, process occur in reverse, the grouping starts from a single point and the small clusters join together to form bigger clusters; at each step of the algorithm, the pair of clusters are combined into a single cluster, until all the clusters fuse to form the final large cluster. The hierarchical cluster analysis gives a 'dendrogram' which is a graph showing the pattern of nested cluster formation (122). In our analysis, we used hierarchical agglomerative clustering, thus we describe below the technique and explain the reasons for our choice.

Figure 5.4 Hierarchical clustering



*Adapted from Finding groups in data (122).

5.6.2.2.1 Agglomerative clustering

It is the most popularly used clustering method. Here, the steps involve calculating proximity between points and fusing the points/clusters that are near/or similar to each other. This process continues in chain fashion. Once a cluster is formed, this step cannot be reverted. The final big cluster will include all the observations in the data. Based on the algorithms used to calculate inter cluster proximity (Figure 5.5), agglomerative clustering can be further classified. Some of them are (123):

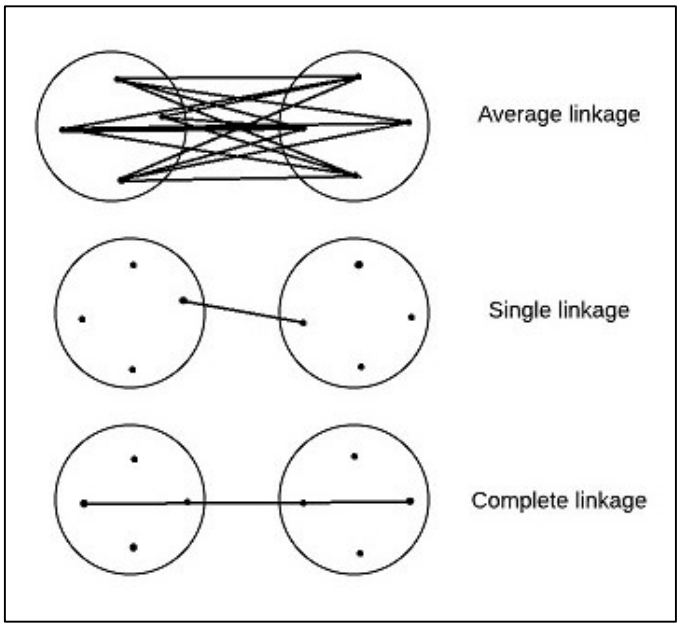
Minimum distance/ single linkage clustering: clusters are fused based on the proximity between two points in two clusters that are the closest to each other.

Maximum distance/complete linkage clustering: clusters are fused based on the proximity between two points in two clusters that are the farthest to each other.

Average linkage clustering: clusters are fused based on the average proximity between all points in two clusters.

Ward's linkage clustering: a method developed by Wards based on the least squared errors (124).

Figure 5.5 Algorithms to measure cluster proximity



*Adapted from Finding groups in data (122).

5.6.2.2.2 Proximity measures to calculate the distance or dissimilarity between points

The calculation of proximity between two points is an essential step to assign points into different clusters. When the data only contains continuous variables, usually distance measures are used. However, if the data is binary or ordinal, the concept of distance will no longer be sensible; 'dissimilarity indices', a measure of how dissimilar one point is from another, is used. Below are some of the common distance/dissimilarity indices used based on the type of variables (122):

Continuos variables : Euclidian distance, Manhattan distance

Binary variables: Matching coefficient, Jaccards Index

Mixed data (binary, ordinal and/or continuous): Gower's dissimilarity index

5.6.2.2.3 Choosing the best number of clusters

Cluster stope rules are available in STATA to determine the best number of clusters after hierarchical clustering. The most commonly used methods are Calinski–Harabasz pseudo-F index, Duda–Hart and Je (2)/Je (1) indices. As per Calinski–Harabasz pseudo-F, higher the value of the

index the more distinct the cluster is. Duda–Hart and Je (2)/Je (1) indices are usually considered together; higher value of Duda–Hart index combined with a lower value of Je(2)/Je(1) index represents more distinct clustering (121).

In our analysis, we used a hierarchical agglomerative average linkage clustering, with Gower's dissimilarity index. We chose a hierarchical cluster analysis, as we did not have a predetermined notion about the number of clusters; and the concept of assigning a center for a cluster of schools seemed less suitable. We only considered an agglomerative analysis, as opposed to divisive clustering, due to feasibility reasons; divisive clustering is computationally complicated and was not available in STATA. We adopted an average linkage clustering as this method works well in most of the situations and produce reasonably robust clusters (122). We used binary as well as ordinal variables in the cluster analysis, thus we chose Gower's index for calculating dissimilarity measures, which is suitable for mixed variables.

5.6.3 Generalised estimating equations

Generalised Linear Modeling (GLM), a method used to model univariate data, follows exponential family distributions. Using GLM it is possible to model variables with normal, inverse Gaussian, gamma, Poisson, binomial, geometric, and negative binomial distributions by choosing a suitable link function. Generalised Estimating Equations (GEE) are extensions of GLM to accommodate for the correlation between observations. GEE use a marginal mean model, which calculates an average response for observations that share the same set of covariates. The correlation between observations are accounted by the use of an empirical variance estimator such as sandwich/robust variance estimators. A working correlation matrix is assumed for the correlated observations (125).The marginal mean model for GEE:

$g\,(E\,[Y_{ij}|x_{ij}]) = x'_{ij}\beta$

Where, $x_{ij'}$ = p times 1 vector of covariates; β= p regression parameters of interest; g(.) = the link function; $Y_{ij\,=}$ the j^{th} (for j=1…j) outcome for the i^{th} subject

Commonly used link functions are:

g(a)=a (identity link for normally distributed continues variables)

g(a)=log (a) (log link for count data)

g(a)=log(a/(1-a)) (logit link for binary data)

In addition to the mean model, the covariance structure for the correlated data has to be modeled. With the assumption of no missing data, the correlation structure t×t of Y can be modeled as:

$V_i = \emptyset A_i^{1/2} R(\alpha) A_i^{1/2}$

Where Ø = GLM dispersion parameter; A= diagonal matrix of variance functions; R (α) = working correlation matrix of Y (125).

Various working correlation matrices structures can be specified for GEE such as independence, exchangeable, unstructured, auto regressive, M-dependent and fixed correlation matrices. Although the selection of working correlation matrix may have to consider many factors, some general rules are suggested. An exchangeable correlation matrix may be advisable for clustered observations with no specific ordering for observations in a cluster. If number of observations is small per cluster and the data are balanced and complete, an unstructured correlation matrix can be considered. For measurements that are mistimed, correlation matrix such as autoregressive, may be a good choice, which account for correlation as a function of time between observations (125).

To perform GEE, we need to specify three models, the family, the link function and the working correlation matrix. As far as the mean model is correctly specified and there are no missing data, misspecification of working correlation matrix will not lead to inconstant parameter estimates or variance. However, correctly specifying the correlation matrix will increase the efficiency (125).

We used GEE in our analysis to account for potential correlation between outcome measures of multiple children attending the same schools.

5.7 Identifying school environment types and modeling dental caries incidence

Statistical analyses included exploratory principal component analysis and cluster analyses to identify distinct types of school environments, descriptive analyses, and GEE to model the association between school environment types and dental caries incidence.

We performed an exploratory principal component analysis using a polychoric correlation matrix because our variables were either binary or ordinal. The variables included measured the involvement of the school management, the teachers, the childcare managers and the community in promoting healthy environment within the school and the schools' approach toward encouraging parental involvement, training teachers and ensuring provision healthy food in school. Subsequently, an agglomerative hierarchical average linkage cluster analysis, using the components identified from principal component analysis and other school related variables, was performed to identify distinct school environments. Finally, GEE with a binomial link function, exchangeable correlation matrix and school as the grouping variable was used to model the association between school environment types and 2-year dental caries incidence in children after adjusting for potential confounders. All analyses were preformed using STATA /SE version 12 (Sata Corp LP, College station, Texas, USA) statistical package.

6. Manuscript

Oral health promoting school environments typology and dental caries status in Quebec children

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Keywords: dental caries; oral health promotion; schools; schoolchildren; socio-economic factors; food environment.

Abstract

Objectives: To estimate the relation between oral health promoting school environment types and 2-year dental caries incidence among 8-10-year-old Quebec children.

Methods*:* We used data from the QUebec Adipose Lifestyle Investigation in Youth (QUALITY) cohort, which is an ongoing prospective study of 630 Caucasian children with at least one obese biological parent. Children were assessed at baseline (ages 8-10 years) and 2 years later. Individual (socio-demographic, health behaviour, household socio-economic status (SES)), school (oral health programs, eating policies) and neighborhood (disadvantage, convenience stores, and fast food restaurant) were examined. Dental caries was assessed by clinical exam. Data were available for in 330 children attending 200 schools. We used principal component and cluster analyses to classify school environment, and generalised estimating equations to model the association between school environment and dental caries incidence.

Results: We identified three distinct types of school environments. Adjusting for potential cofounders, children attending type-1 (high SES, favourable surrounding food environment, strong healthy eating policy, weak dental care programs) and type-2 schools (low SES, unfavourable surrounding food environment, strong healthy eating policy and strong dental care programs) had 21% (IRR: 0.79, 95% CI: 0.68 - 0.90) and 6% (IRR: 0.94, 95% CI: 0.83 – 1.07) reduced 2-year incidence of dental caries, respectively, compared to those attending type-3 schools (average SES, unfavourable surrounding food environment, weak healthy eating policy, average dental care programs).

Conclusion*:* Holistic and common risk factor approaches adopted in school-based oral health promotion could reduce dental caries in children; favourable neighbourhood can have additional benefits on caries reduction.

Introduction

Despite improved detection and treatment modalities, dental caries remain the most common chronic oral disease among children and a major public health concern affecting 60-90% of school-aged children(2). Fifty-nine percent of 12-19 year-old Canadian youth experience dental caries (11) and more than half of 12 year-old children in Quebec have the disease, with a higher rate of tooth decay compared to US, Sweden, United Kingdom and other Canadian provinces (Nova Scotia and Ontario) (13).

Moreover, oral health is a determinant of general health and plays an important role in quality of life. If left untreated, dental caries can cause severe pain and complications due to sepsis, and in children, also affect school attendance and social functioning (3). Oral disease is the fourth most expensive condition to treat and hence a major economic burden to both society and individuals (2). However, dental caries are mostly preventable, and even reversible, if detected in early stages.

Although many intervention to prevent dental caries and promote oral health have been carried out, their effectiveness in improving oral health outcomes is questionable (32, 76). Dental health education may increase knowledge, but whether it translates into better oral health behaviours is still a matter of debate (32, 76, 77). In fact, information giving alone may be ineffective and may even increase health inequity because people with the highest need are frequently less educated, with a lower level of health literacy and fewer economic resources to make healthier choices (34, 35). Also, focusing on clinical preventions, such as sealants and topical fluorides, alone is palliative (32) and not cost effective (82).

Health promotion strategies that go further than the individual level to integrate elements of social policy may be more effective for disease prevention, than isolated behaviour-specific interventions (32, 49). The World Health Organization (WHO)'s concept of Health Promoting Schools (HPS) highlights the importance of the environment, and advocates for a comprehensive approach that goes beyond health education and prevention, to include policy making and encouraging the participation of parents, teachers, and communities, in transforming schools as healthy settings (71). Considering oral health promotion as an integral component of HPS, WHO

has proposed guidelines for oral health promoting schools (69). Schools worldwide have attempted to adapt these ideas and implement school-based oral health promotion programs.

These initiatives have obtained mixed results. Brazilian children attending schools which adopted a 'comprehensive curriculum', including food and smoking policies, a participatory approach to health education, actions to maintain a clean and healthy physical school environment, and provision of health services, had better oral health compared to children attending schools without a comprehensive approach (83). In Ireland, the 'Boost Better Breaks' school policy, allowing only consumption of milk and fruits during break time was not effective in improving dental caries status (84) or healthy eating behaviours in children (85). The 'Doktor-Muda' program in Malaysia, which adapted concepts from the WHO's HPS guidelines, were successful in improving oral health related quality of life outcomes in children (86). Encouragingly, schools participating in the 'healthy-school program' in Ontario, Canada, had lower proportions of children with tooth decay (87). Although the Quebec government published guidelines for school health promotion in 2005 (99), we did not find any studies evaluating its effect on oral health outcomes.

Apart from oral health promotion activities, other school related variables may also play important roles in determining children's health and health behaviours, notably socio-economic characteristics. For example, the school socio-economic environment is inversely related to dental caries in Quebec schoolchildren (92). In addition, school socio-economic status (SES) appears to modify the association between oral health promotion and dental caries reduction, with the effect being stronger among low SES schools (87), where the need is the greatest.

The food environment around the school is another important factor to consider due to its potential influence on children's dietary habits. Some evidence exists of the adverse effects of unhealthy food environment around schools on pediatric obesity, which is a diet related disease (94). In Canada, a higher number of 'unhealthful' compared to 'healthful' food stores in the proximity of schools had undesirable effects on children's dietary habits (93). However, the link between the surrounding food environment and children's dietary habits is not well understood.

Studies report conflicting findings and are mostly cross-sectional; there is a need for further longitudinal studies (94).

To summarize, despite major criticism of traditional preventive and behavioral approaches, many interventions targeting isolated behaviours persist. Few studies have looked at comprehensive programs in schools that incorporated policy elements and participatory approaches (83, 85, 87); we found only one such study from Canada (87) and none from Quebec. In addition, fewer studies have considered school SES (83, 87) and we identified no studies that included the surrounding food environment in their assessment of the oral health promoting school environment. Hence, our aims were to identify distinct school environments based on oral health promoting and neighbourhood environmental factors, and to estimate the relation between school environment types and 2-year dental caries incidence among 8-10-year-old Quebec children.

Methods

Study design and sample selection

Data were from an ongoing prospective study, the QUALITY (Quebec Adipose Lifestyle InvestigaTion in Youth) cohort, which investigates the natural history of metabolic risk in youth. A full description of this study can be found elsewhere (104). Briefly, the QUALITY cohort recruited 630 Caucasian children aged 8-10 years to the baseline by distributing flyers in schools located within 75 Km of three major urban centres in the province of Quebec. Both biological parents had to be available for the study and at least one of them had to be obese (body mass index ≥ 30Kg/m^2 or waist circumference > 102cm in men and > 88cm in women, based on self-reported measures of height, weight and waist circumferences) for inclusion into the study. Only schools located in the Montreal Census Metropolitan Area (MCMA) provided data on the school environment. However, this comprises more than 80% of QUALITY participants. Among the 296 schools (attended by 506 child participants of the QUALITY study) in the MCMA, 247 schools (attended by 430 children) agreed to participate in the study. This article uses data collected in visit 1 (baseline) and visit 2 (children aged 10-12 years), which were completed in 2008 and 2011, respectively.

The QUALITY cohort study obtained ethics approval from the following Institutional Review Boards: the 'Centre Hospitalier Universitaire' (CHU) Sainte-Justine, McGill University, and Laval University. Parents and school principals signed consent forms, while children provided assent.

Data collection and definition of variables

Trained dentists performed the clinical oral health examination in a dental office. We used the UK Children Dental Health Survey diagnostic criteria to record dental caries (106). Any lesions extending from initial caries (change in enamel and/ or dentine due to caries, visible after applying dry air on to tooth surface for 30 seconds) to advanced caries were counted as a decayed surface.

Two-year dental caries incidence was measured as the difference in Decayed, Missing, Filled-Surfaces (DMF-S) index between visits 1 and 2. We excluded surfaces that were not examined in either visits from the DMF-S index calculation. Five observations had negative DMF-S incremental values; some of the initial caries lesions in visit 1 were replaced by sealants in visit 2 and thus were not counted in visit 2, leading to negative differences. As this is equivalent to a difference of 0, the 2-year dental caries incidence in these cases was also recorded as zero.

Data on age, sex and parental SES were collected using structured questionnaires administered to parents at visit 1. Parental SES was measured using two variables: parental education and parental income. Parental education, collected as a 7-category variable, was later combined for two parents and categorised into (i) 1 or 2 parents with high school or less; (ii) 1 or 2 parents with CEGEP/vocational or trade school; (iii) 1 or 2 parents with university degree. The annual household income before taxes was collected as 12 categories ranging from CAD<10,000 to 140,000 or more. This was later adjusted for the number of people living in the house by dividing the middle point of each of the twelve categories by the square root of the total number of people in the household (105) ; the variable was further grouped into quartiles.

Trained research assistants collected data on school environment by interviewing school-principals with the aid of structured questionnaires. Questions related to healthy eating promotion policies in schools were derived from the Institute of Medicine Recommendations for

Schools to Address Childhood Obesity (107), the School Health Index (108), the School Health Policy and Programs Survey (109), and the Coalition for School Nutrition (110).

School neighbourhood SES information was obtained from the 2006 Canadian Census. We constructed a material deprivation index of the area within 1000 meters of street network around the school. The index comprises 'the proportion of individuals without a high school diploma, the employment population ratio and the average personal income' for people ≥15 years old in census dissemination areas, with a higher value representing lower deprivation (111). We further classified this variable into tertiles ranging from high (0) to low (2) deprivation. We calculated the numbers of convenience stores and fast-food stores within 500 meters around each school using the geographic information system available in the Montreal Epidemiological and Geographic Analysis of Population Health Outcomes and Neighbourhood Effect database which contains information until May 2005 (112). These variables were then dichotomized into (1) at least one store within 500 m (unfavourable) and (2) none within 500 m (favourable).

Statistical analysis

Statistical analyses included principal component and cluster analyses to identify distinct types of school environments, descriptive analyses, and Generalised Estimating Equations (GEE) to model the association between school environment types and dental caries incidence.

We used principal component analysis (PCA), with a polychoric correlation matrix, to group variables measuring schools' healthy eating promotion policies. We applied an oblimin oblique rotation to differentiate the components and those with eigen value greater than 1 were retained.

Subsequently, we performed a hierarchical agglomerative average linkage cluster analysis using the components identified by PCA, along with variables that measured presence of dental health/hygiene programs and formal healthy eating promotion initiatives, school's surrounding food environment and SES. We used cluster stop rules (Calinski–Harabasz pseudo-F index, and Duda–Hart and Je (2)/Je (1) indices) to select the optimal number of clusters.

After preliminary descriptive and exploratory analyses, we used GEE with a binomial link function, exchangeable correlation matrix, and school as the grouping variable, to model the association between school environment types and 2-year dental caries incidence in children, adjusting for potential confounders. All analyses were preformed using the Stata /SE version 12 (Stata Corp LP, College station, Texas, USA) statistical package.

Results

Out of the 430 children (from 247 schools) for whom school data were available, 357 had data on dental caries for both visits. We further excluded 27 children because of missing data for other variables. The mean age for the final sample of 330 children was 9.2 years (SD=0.9) at visit 2. The mean DMF-S for visits 1 and 2 were 0.6 (SD=1.4) and 2.0 (SD=2.9), respectively (Table 6.4).

PCA and cluster analyses included 226 schools (21 schools were excluded due to missing values). Table 6.1 displays the 10 variables used in the PCA, which loaded on three components; Table 6.2 describes the loading pattern. We identified three distinct types of school environments based on cluster analysis (Table 6.3). Type 1 included schools located in neighborhoods with high SES, favourable surrounding food environments, strong healthy eating promotion and weak dental care programs (50.9 %). Type 2 included schools located in neighborhoods with low SES, unfavourable surrounding food environments, strong healthy eating promotion and strong dental care programs (36.1 %). Type 3 comprised schools located in neighborhoods with average SES, unfavourable surrounding food environments, weak healthy eating promotion, and average dental care programs (13.0 %).

The first two school environment types had higher levels of health eating promotion activities as compared to type 3, which included: greater support for healthy eating promotion from school authorities, teachers, other staff and communities, encouragement of parents' involvement in school activities, greater attention to training teachers on healthy lifestyle behaviour, greater attention to provision of healthy food during school hours and presence of a formal initiative for healthy eating promotion.

Finally, we used GEE to model the association between the three variables representing school environments types and 2-year dental caries incidence. Using type 3 as a reference, children attending type 1 and type 2 schools had 21% (IRR: 0.79, 95% CI: 0.68 - 0.90) and 6% (IRR: 0.94, 95% CI: 0.83 - 1.07) reduced 2-year incidence of dental caries, respectively, after adjusting for age, sex, parental SES and baseline DMF-S index (Table 6.5).

Discussion

We identified three distinct school environment types in the MCMA. Type 1 schools, located in neighbourhoods with the highest SES and the most favourable food environment, had strong healthy eating promotion inside the schools, however, with weak dental care programs. Type 2 schools, located in neighbourhoods with the lowest SES, unfavourable food environment, scored high in healthy eating promotion as well as dental care programs. Type 3 schools were located in medium SES neighbourhood with an unfavourable food environment; they had weak healthy eating promotion and however, scored medium in dental are programs. Type 1 school environments can be considered the most oral health promoting, as they reduced children's dental caries incidence over two years. Type 2 schools was also moderately protective in reducing dental caries incidence as compared to Type 3; the effect was only borderline. The direction, none the less, is encouraging suggesting that the positive effect may become stronger and significant over time.

Our results showing a reduction in dental caries are similar to those of previous studies from Brazil and Canada, investigating the impact of comprehensive oral health promotion approaches (83, 87). Nonetheless, the above studies used a cross-sectional study design and hence, an ambiguity exists in the direction of this association. Another school-based study in Ireland used a participatory approach, involving parents, teachers and communities in policymaking to reduce sugar intake of children, but it failed to bring about any change in diet behaviours or reduction of dental caries. This failure may have been attributable to the narrow scope of the policy, which restricted children's food intake to fruits and milk during school breaks rather than focusing on overall diet behaviors. Moreover, the program did not include measures to raise the awareness of teachers, children, or parents regarding a healthy diet (85). Additionally, the broader built and

social environments around the schools, which could potentially influence children's food habits, was not considered while planning the intervention. This, in turn might have further affected the impact of this intervention.

In our study, Type 1 schools, the most protective had strong healthy eating environment inside the schools and a favourable food environment around the schools. This finding strongly suggests that an environment promoting healthy eating, that considers the socio-environmental and policy aspects of health promotion, may play an important role in reducing dental caries. This observation aligns with the common risk factor approach to oral health promotion, which advocates for an integrated strategy, targeting risk factors (e.g., high sugar diet) that are common to multiple chronic diseases, and their underlying determinants (34).

Moreover, our study results highlight the importance school neighbourhood factors on dental caries incidence in school's children. Type 1 schools were located in the highest SES neighbourhood and had favourable surrounding food environment; while Types 2 and 3 schools, located in neighbourhood with relatively low SES, had unfavourable surrounding food environment. The additional protective effect of the Type 1 schools may be attributable to the better neighbourhood food environment characteristics of the schools. A previous study on QUALITY cohort children found some negative influence of the unhealthful stores around the schools on the dietary characteristics of the school's children (93), which might provide some hints on the potential mediating pathway.

Moreover, consistent with previous findings, our study also points towards a potential inequality in access to healthy food environment around the schools, which might also influence dental caries in children (126). In our study, children from schools located in low SES neighbourhood had higher likelihood of getting exposed to unhealthy food stores within a walkable distance around the schools, which may have had some negative influence on their caries incidence.

It is also notable that despite scoring the lowest in dental health specific programs, the Type 1 school environment was the most successful in reducing dental caries incidence. The reference group with comparatively stronger dental health programs performed poorly, possibly because these were isolated programs, which were not integrated with other initiatives (e.g., healthy

eating initiatives) and did not have strong involvement of parents, teachers, and communities; additionally, they had unfavourable food environment around the schools. Dental care programs may play a role in reducing dental caries incidence, however, they would do better if implemented with a common risk factor approach in mind and taking social and environmental factors into consideration (34). Indeed, role of dental care programs alone in reduction of caries incidence is questionable (42); a more prominent role could be attributed to the socio-economic contexts (42, 127). This suggests that successful oral health promotion requires a coherent, overall strategy; moreover, that dental care initiatives may not succeed without supportive environmental contextual factors.

There are some limitations to our study. The generalisability of our results may be limited due the study's selection criteria, which included only Caucasian children at higher risk of obesity. A comparison with the general population at baseline showed that our study population came from a relatively higher socio-economic sector of the society (104). Thus, study participants may already be at a lower risk for dental caries. Despite this, we found a significant improvement in dental caries status for children from healthier school environments after adjusting for individual SES. We can reasonably assume that, if we had included a more representative population of children from Montreal with a relatively lower SES, the protective effect would have been higher than or at least as strong as the one we observed. However, potential selection bias due to voluntary entry into the study cannot be ruled out, as is the case with most studies.

Another potential limitation is the possibility of bias due to a relatively high percentage of missing values, which may not be distributed completely at random. We performed a sensitivity analysis by imputing missing values through multiple imputation using chained equations (supplementary materials). There was no significant difference in point estimates for Type 1 school environments, which showed the highest effect in reducing caries incidence in children. However, the point estimate for the Type 2 school environments, which was moderately successful in reducing caries incidence, moved away from the null, indicating our results may have under estimated the actual protective effect; the effect measure remained marginally significant.

Additionally, some of the information on the school environment was reported by school principals; social desirability may have resulted in over reporting of positive attributes. Nonetheless, the chance that this potential issue would introduce bias is low, as over-reporting would occur in all the schools included in the study. Another consideration is the classification of school environments and possible mis-specification of clusters. We used multiple factors to classify school environments and these factors could not have been manually assigned to different clusters. Therefore, there is a possibility of a mixing in terms of their oral health-promoting environment. However, given the complexity inherent to such a classification, we see this limitation as inevitable.

One of the main strengths of this study is the use of a prospective design. The school environment was assessed at baseline and the outcome was dental caries incidence in the following two years, hence, the basis for causal inference is much stronger. We also carried out a comprehensive assessment of the school environment, which allows us to disentangle, to an extent, the effects of environments within and outside the school and of SES on dental caries incidence.

Public health implications

Our findings indicate that school environments with a comprehensive, integrated and participatory approach to oral health promotion may be effective in reducing dental caries incidence in children.

Interestingly, favourable food environment seems to be a strategic component of oral health action, rather than dental care programs itself. The results do not suggest that dental care programs are unnecessary, but rather that such programs are less effective in isolation. Moreover, if implementation of dental care programs is not feasible because of cost, diverting the available resources towards a general approach, targeting common determinants, such as diet, and the socio-environmental factors, can have a positive impact on children's oral health.

Better neighbourhood characteristics around the schools seems to have a strong influence on reduction of dental caries incidence. Although socio-economic aspects may not be directly modifiable, environmental level policies can be implemented to modify the built environments around the schools, which in turn may buffer some of the socio-economic inequalities. For

example, policies to restrict poor food choices in the school neighbourhood (e.g., fast food stores, corner stores) and to make the default food choices healthier and available at low cost (e.g., healthful stores selling water, fresh fruits and vegetables, dairy). While our study was not designed to directly recommend policy changes, our results are adding more evidence in support of it.

Furthermore, our results provide a feedback to the policy makers. The Quebec government has been encouraging schools to promote a healthy food environment, mostly to deal with the obesity crisis (100). An evaluation study from Quebec concluded that, despite an improvement observed over the last years, the goal of providing only healthy food through schools was inadequately met (103). We call the policy makers attention to the fact that promoting a healthy eating environment in Quebec's schools may have effects beyond obesity reduction, benefitting children's oral health. Rather than focusing only on dental programs for caries reduction, they could re-allocate some resources to less costly strategies including common risk factor and participatory approaches, with a special emphasis on socio-economically poor neighbourhoods. Future studies could target a more representative sample including a higher proportion of participants from lower socio-economic sectors to confirm our findings.

Tables

Table 6.1 Variables measuring school health promotion used in principal component analysis

Questions used	**Scale**
1. Willingness to participate in healthy eating promotion of: 1. a School management 1. b Teachers 1. c Day care managers 1. d Community	Ordinal: 4 level Likert scale (Very true to very false)
2. School: 2. a Sells drinks and snacks according to healthy eating principles during fund raising programs 2. b Has strict rule for approval of school menu catering service by a nutritionist 2. c Frequently informs parents about health promotion activities in schools 2. d Has agreement with the community to participate in healthy eating promotion for students 2. e Educates teachers on the importance of promoting healthy living	Ordinal: 5 level Likert scale (strongly agree to disagree) Dichotomised as: strongly agree=1 others=0
3. School makes room for families to engage in volunteer activities	Ordinal: 5 level Likert scale (strongly agree to disagree)

Table 6.2 Variable loading pattern in principal component analysis.

	Variable	C 1	C 2	C 3	Unexplained variance
Component 1(C1)	Willingness to participate in healthy eating promotion of:				
	school management	0.4876			.1524
	teachers	0.4423			.2016
	day care managers	0.4740			.1964
	community	0.4478			.2851
	Agreement with community to promote healthy eating within school	0.3448			.5884
Component 2 (C2)	School makes room for families to engage in volunteer activities		0.5879		.5096
	Frequently informs parents about health promotion activities in schools		0.5509		.4839
	Educates teachers on the importance of promoting healthy living		0.5655		.4078
Component 3 (C3)	Strict rule for approval of catering service menu by a nutritionist			0.6770	.3284
	School sells drinks and snacks in accordance with principles of healthy eating during fund raising programs			0.6909	.3417

Table 6.3 Description of the school environment types based on the variables used in the cluster analysis (total 200 schools included in the complete case analysis)

Variables used in cluster analysis	Cluster 1 (n=99)	Cluster 2 (n=75)	Cluster 3 (n=26)
School material deprivation Index			
Mean (SD)	1.22 (0.80)	0.67 (0.72)	0.92 (0.84)
Range	0 - 2	0 - 2	0 - 2
Presence of a convenience store or a fast food store within 500 m around the school (yes=1/no=0)			
Mean (SD)	0 (0)	1 (0)	1 (0)
Range	0 - 0	1 – 1	1 – 1
Formal school initiatives to promote healthy eating (yes=1/no=0)			
Mean (SD)	0.84 (0.37)	1 (0)	0 (0)
Range	0 – 1	1 – 1	0 – 0
Component 1: Willingness of school to promote healthy eating within school and involvement of community partners			
Mean (SD)	5.34 (0.73)	5.38 (0.85)	5.05 (1.12)
Range	2.99 – 6.33	1.71 – 6.45	1.07 – 6.31
Component 2: Encouraging teachers and parents to promote healthy lifestyles in children			
Mean (SD)	3.36 (0.55)	3.26 (0.55)	2.97 (0.63)
Range	1.34 – 3.89	1.88 – 3.88	1.98 – 3.82
Component 3: Great attention to providing healthy food within school			
Mean (SD)	0.83 (0.54)	0.68 (0.56)	0.42 (0.49)
Range	-0.24 – 1.59	-0.31 – 1.56	-.24 – 1.52
Visit by any dental health professional at school (yes=1/no=0)			
Mean (SD)	0.89 (0.32)	0.95 (0.23)	0.92 (0.27)
Range	0 – 1	0 – 1	0 – 1
Programs providing dental hygiene education (yes=1/no=0)			
Mean (SD)	0.80 (0.40)	0.87 (0.34)	0.85 (0.37)
Range	0 – 1	0 – 1	0 – 1
Programs other than the provision of dental hygiene education (yes=1/no=0)			
Mean (SD)	0.46 (0.50)	0.37 (0.49)	0.54 (0.51)
Range	0 – 1	0 – 1	0 - 1

Table 6.4 Distribution of socio-demographic characteristics and average DMF-S in children within each school environment cluster

	Total **n=330 (100%)**	**Type 1** **n=168 (50.9%)**	**Type 2** **n=119 (36.1%)**	**Type 3** **n=43 (13.0%)**
Age, Mean (SD)	9.2 (0.9)	9.2 (0.9)	9.3 (0.9)	9.0 (0.9)
Sex, n (%)				
Boys	191 (57.9)	93 (55.4)	73 (61.3)	25 (58.1)
Girls	139 (42.1)	75 (44.6)	46 (38.7)	18 (41.9)
Household income, n (%)				
< $ 29,070	78 (23.6)	38 (22.6)	33 (27.7)	7 (16.3)
$ 29,070 - $ 42,579	79 (23.9)	40 (23.8)	30 (25.2)	9 (20.9)
$ 42,580 -$ 56,271	85 (25.8)	33 (19.6)	38 (31.9)	14 (32.6)
> $ 56,271	88 (26.7)	57 (33.9)	18 (15.1)	13 (30.2)
Parental Education, n (%)				
One or both parents hold a high school degree or less	25 (7.6)	15 (8.9)	10 (8.4)	0
One or both parents completed CEGEP/vocational or trade school	121 (36.7)	67 (39.9)	39 (32.8)	15 (34.9)
One or both parents hold a university degree	184 (55.8)	86 (51.2)	70 (58.8)	28 (65.1)
DMF-S Index, Mean (SD)				
Baseline DMF-S	0.6 (1.4)	0.5 (1.2)	0.7 (1.6)	0.8 (1.5)
DMF-S visit 2	2.0 (2.9)	1.6 (2.3)	2.3 (3.3)	3.0 (3.5)

Table 6.5 GEE estimating the association between school environment types and 2-year dental caries incidence (n=330).

	Change in DMF-S over 2 years Mean (SD)	**IRR* (CI)**
School environment		
Type 1	1.1 (1.7)	0.79 (0.68 - 0.90)
Type 2	1.7 (2.6)	0.94 (0.83 - 1.07)
Type 3	2.3 (2.7)	1

*Adjusted for age, sex, parental education and household income, and baseline DMF-S.

6.1 Supplementary materials

6.1.1 Multiple imputation of missing values

The percentage of missing values in our dataset was 23.25% (Table 6.6). This high percentage may not be distributed completely at random, and thus represents a potential source of bias in our estimates. Therefore, we imputed the missing values using multiple imputation by chained equation (128); then we performed a sensitivity analysis pooling the estimates of GEE across the multiply imputed data sets.

Table 6.6 Percentage of missing values per variable in our dataset.

Variable name	**Missing n (%)**
School environment variables:	
a. Will from day care providers to promote healthy eating	7 (1.63%)
b. Summary variable for dental health programs in school (visit by any dental health professional at school + programs providing dental hygiene education + programs other than the provision of dental hygiene education)	7 (1.63%)
Material deprivation index of the school neighbourhood	22 (5.12%)
DMF-S in visit 1	17 (3.95%)
Incidence of new caries over 2 years	73 (16.98%)
Parental income	2 (0.47%)
Parental education	1 (0.23%)

We developed a multiple imputation model by entering all the variables used in the final analysis (GEE), along with some additional variables that could potentially predict the missing values.

Variables already included in the model: baseline DMF-S, incidence of new caries over 2 years, age, sex, parental income and parental education.

The additional variables included: children's dietary characteristics reported in visit 1 (total number of snacks and mean milliliters of high sugar drinks consumed in a day); body mass index of children in visit 1 (z-score); children's frequency of brushing per day as reported in visit 1; school neighbourhood socio-economic variables (weighted average income of families, and weighted rate of people aged 24 to 64 without any qualifications, without a high school diploma, without a university degree, within 1000 m network buffer around the school).

Our main exposure variable, types of school environments, was derived after principal component and cluster analyses on school environment variables. Hence, the exposure variable was not directly included in the imputation model. However, we entered all the original school environmental variables that contributed to the principal component and cluster analyses, except for one variable, teachers' willingness to participate in healthy eating promotion. This variable was excluded due to collinearity.

As a rule of thumb, the number of imputations should be at least equal to the percentage of missing data (128). We had approximately 23% missing data; hence we created 25 imputed datasets after multiple imputation.

6.1.1.1 Identifying final clusters after multiple imputation

Once multiple datasets were created after imputation, we used a method similar to that proposed by Basagaña et. al (129) to select the final clustering pattern of school environments. Principal component and cluster analyses were run separately for each imputed dataset; three clusters, representing three types of school environments, were created separately for each of them. We carefully examined the clusters in each of the imputed datasets and the clustering patterns were similar in all of the 25 imputations. We retained this clustering pattern to run the final analysis and pool the estimates across the 25 imputed datasets.

6.1.2 Pooled estimates and confidence intervals after multiple imputation

Stata uses Rubin's rules (128) to compute the pooled estimates and confidence intervals across the 25 multiple imputed datasets. Table 6.7 displays a comparison of the effect measures before and after the multiple imputation.

There was no significant difference in the point estimate for Type 1 school environments, which had the greatest effect in reducing dental caries incidence in children. However, the point estimate for Type 2 school environments, which was moderately effective in reducing dental caries incidence in children, moved away from the null and remained marginally significant after multiple imputation. This suggests that our estimates might have underestimated the real protective effect of the Type 2 school environments in reducing dental caries incidence in children.

Table 6.7 Associations between school environment types and 2-year dental caries incidence in children before and after the multiple imputation

	IRR (CI) - Complete case analysis n=330	**IRR (CI) - After imputation n=430**
School environment		
Type 1	0.79 (0.68-0.90)	0.78 (0.64-0.95)
Type 2	0.94 (0.83-1.07)	0.88 (0.75-1.04)
Type 3	1	1

7. Discussion

7.1 Restating the rationale and objectives

Despite overall improvements in living conditions and advancements in prevention and treatment over the last decades, dental caries remains highly prevalent in Canada among all age groups (11). Quebec children have the highest prevalence in North America (12). Being a highly prevalent disease, population-based or directed population-based strategies have been suggested as the appropriate way to prevent dental caries and promote oral health (1, 60). Moreover, oral health promotion should be broad and inclusive, taking into consideration the context where people engage in their daily activities (32, 34).

School settings have been recognised as one of the best environments in which to deliver health promotion, including oral health promotion, targeting children. A popular and holistic approach, the health promoting school proposed by the WHO, focuses on providing supportive environments through schools. This approach integrates actions across multiple health disciplines, encourages a participatory approach to health promotion, and includes policy elements as well as individualised programs to provide children with skills and enable them to take control of their health determinants (6, 69).

Despite criticisms, many oral health promotion effectiveness studies have focussed exclusively on individualised approaches such as oral health education and clinical prevention. Health education alone may not only be ineffective and costly, but may also increase health inequalities (5, 40). Clinical interventions, such as sealants and fluorides, alone may be seen as palliative in nature, because they may prevent dental caries for a short time period, but do not address the underlying causes of the disease; moreover, their cost-effectiveness is questionable (32). Some comprehensive school-based oral health promotion programs have been evaluated (83-85, 87) and the results are inconclusive. Only a few studies investigating these programs included important contextual variables (e.g., school SES) and we identified no studies that included neighbourhood food environment. Moreover, most studies were cross-sectional. Finally,

although the Quebec government encourages school-based health promotion programs (99, 100), we could not find any studies evaluating their effectiveness in terms of oral health outcomes. Hence, our study aimed to identify distinct school environments based on oral health promoting and neighbourhood environmental factors in Quebec, and to estimate the relation between school environment types and 2-year dental caries incidence among 8-10-year-old Quebec children.

7.2 Summary of the findings and discussion

We identified three distinct school environments. Type 1 included schools with strong healthy eating promotion and weak dental care programs, located in neighborhoods with high SES and favourable surrounding food environments (50.9 % of schools). Type 2 included schools with strong healthy eating promotion and strong dental care programs, located in neighborhoods with low SES and unfavourable surrounding food environments (36.1%). Type 3 comprised schools with weak healthy eating promotion and average dental care programs, located in neighborhoods with average SES and unfavourable surrounding food environments (13.0%).

Using Type 3 as reference, children attending schools in Type 1 and 2 school environments had 21% (IRR: 0.79, 95% CI: 0.68 - 0.90) and 6% (IRR: 0.94, 95% CI: 0.83 - 1.07) reduced 2-year incidence of dental caries, respectively, after adjusting for age, sex, parental SES and baseline DMF-S index. Type 1 school environment was the most successful in reducing dental caries incidence in children over 2 years. Although type 2 school environment also showed a moderate effect on reduction of dental caries incidence, the upper limit of the confidence interval was slightly above 1; the direction is nevertheless encouraging, suggesting that over time this rate ratio may become stronger and significant.

Our results are similar to those of previous studies investigating the effects of comprehensive health promotion programs in schools on children's oral health (83, 87). Brazilian supportive schools defined according to their health promotion policies, participatory approach to health education, health services, maintenance of physical school environment, commitment towards

safety, strong social relationships, and friendly environment, had lower proportions of children with dental caries compared to non-supportive schools (83).

Similarly, a 'healthy-schools' program targeting 'healthy eating, physical activity, bullying prevention, personal safety and injury prevention, substance use and abuse prevention, healthy growth and development, and mental health activities' was successful in improving Canadian children's oral health (87). Both studies were cross-sectional and hence, a strong conclusion about the direction of this association cannot be made. However, our prospective study design highlighted the effects of oral health promoting school environments on children's dental caries status over two years. Thus, our findings provide stronger evidence to support the essential role played by schools in promoting children's oral health.

These results can be contrasted with those of the Boost Better Breaks policy (85), which restricted children's food to milk and fruits during school breaks. Although Irish policy makers implemented it using a participatory approach involving parents, teachers and food suppliers, the program failed to reduce students' dental caries incidence. Indeed, children in participating schools increased their consumption of sugar snacks outside the school environment, and experienced an increase in dentine decay over the two-year follow up period, suggesting that the program worsened the children's caries experience. This failure may be attributed to the program's focus on restricting diet, without raising the awareness of students, teachers or parents about healthy eating, or providing students with opportunities to practice healthy eating (85). Additionally, the broader built and social environments around the schools, which could potentially influence children's food habits, was not considered while planning the intervention. This, in turn might have further affected the impact of this intervention.

Moreover, our study provides some evidence supporting the importance of the surrounding food environment for the success of school oral health promotion programs. We observed that Type 1 schools were located in neighbourhoods with the most favourable food environments, and that children attending these schools experienced the greatest effect on dental caries reduction. The favourable food environments may have contributed to the higher protective effect on dental caries reduction in this group of schools. We could not find any other studies that included neighbourhood food environment in the assessment of school-based oral health

programs and their effects on dental caries. A previous study also conducted as part of the QUALITY cohort observed that the unhealthful food environment around the school can negatively affect children's diet behaviours (93). A systematic review recently concluded that unhealthy food environments around schools may adversely affect obesity in children; however, the available evidence was inconclusive regarding their effect on diet and food purchasing behaviours (94).

We also observed that children attending schools in average and low socio-economic neighbourhoods (Types 2 and 3 schools) had a greater likelihood of exposure to unhealthful food stores within a walkable distance around the schools than those in high socio-economic neighbourhoods. This points to potential inequality in access to healthy food environments around the schools and is consistent with previous findings that clustering of unhealthful food stores around schools is greater in lower socio-economic neighbourhoods than in wealthier ones (126).

Our results are also in line with the integrated common risk factor approach, which advocates targeting the risk factors common to many chronic diseases and their socio-economic determinants (34). In our study, Type 1 school environments, which showed the most protective effects on caries incidence, was characterised by: greater involvement of significant people in children's lives (e.g., parents, teachers), greater community involvement in school-based oral health promotion, more frequent effort to provide only healthy food in schools, and initiatives to increase awareness regarding healthy eating. Additionally, Type 1 schools with the greatest protective effect on dental caries reduction, had the most favourable food environment around the schools. The existence of a healthy eating environment seems to have been a key factor in the reduction of dental caries in children over two years. An unhealthy diet is a common risk factor for a multitude of chronic diseases (e.g., dental caries, obesity and cardiovascular disorders). Rather than targeting one disease at a time, planning interventions to target risk factors common to many diseases, accounting for socio-economic determinants, will be an effective and efficient strategy for oral health promotion and the reduction of oral health inequalities. Such an approach not only helps in setting wider health goals, but is also cost-

effective and thus, more feasible in low socio-economic areas where access to resources may be limited (34).

The results also highlight the importance of the social environment for effective oral health promotion targeting children. Children's health and health behaviours are strongly influenced by the social circle around them, including their family, caretakers, school, peers and community (130). Parents' role in determining children's dental caries status is well recognised. Parental SES, knowledge and attitudes, oral health behaviours, and parenting styles can influence children's oral health behaviours and dental caries status (131). School teachers are also an integral part of oral health promotion aimed at children; and oral health promotion through schools requires their constant support and participation (69). Additionally, communities can play an important role in shaping children's health (130). Schools' collaborations with the community could help to influence health promoting activities and public policies such as clear labelling of food items, water fluoridation, control on media advertisements, welfare activities among others (71). Making even a single change in a child's health behaviour may require a well-planned approach, taking into account a multitude of influencing factors. For example, changing the specific behaviour of frequent sugar intake in children will be dependent on the characteristics of their parents, peer influences, food policies in schools, school teachers' knowledge and attitudes, social norms and policies, and so on (132). Hence, it is essential to consider these social contexts to plan effective oral health promotion programs for children.

Furthermore, we observed that Type 1 schools, where children experienced the highest reduction in caries incidence over two years, had the weakest dental care programs compared to Type 2 and 3 schools. Although these programs may have played a role in children's oral health, social and healthy food environment as well as socio-economic context seem to be more important. Similar findings have been previously reported in the literature. Dental caries in children were strongly associated with social factors (e.g., mother's education and place of residence), but not with dental care programs (127). Indeed, the role of the dental health system in preventing dental caries is questionable (41, 42). Our study points to a similar conclusion. Although it is not possible to isolate the effects of individual school environment components, it

seems that dental care programs were more effective when they were accompanied by a good school social environment and measures to promote healthy eating.

In conclusion, our results suggest that a comprehensive approach to oral health promotion in schools, targeting common risk factors (e.g., an unhealthy diet) and allowing the participation of prominent stakeholders (e.g., parents, teachers, school principals and communities), can have a positive effect on children's dental caries status. The socio-economic neighbourhood and food environment around the schools seems to be important factors influencing dental caries status of schoolchildren.

7.3 Methodological considerations

7.3.1 Selection bias

'Selection bias is a systematic error in a study that stems from the procedures used to select subjects and from factors that influence study participation' (133). A structural explanation to biases using visual diagrams clearly differentiate between selection bias and confounding bias (addressed later) in epidemiology. The selection bias arises when exposed and non-exposed groups are non-comparable or non-exchangeable due to *conditioning* on factors that are the common *effects of both* the outcome and the exposure (or their predecessors). However, if this non-exchangeability occurs due to factors that are common *causes of both* the exposure and the outcome (or their predecessors), it will lead to a confounding bias (134). In cohort studies, selection bias can be either an 'immigration bias' or an 'emigration bias'. Immigration bias occurs at the time of entry into the cohort, usually due to criteria used for selection (e.g., self-selection during voluntary entry), or non-participation. Emigration bias may occur due to loss to follow up, non-response or missing data.

7.3.1.1 Immigration bias

The QUALITY cohort selection criteria [child's age (8-10 years old), family of Caucasian origin, both biological parents were available and at least one of them was obese] were not common

effects of the exposures or outcome. For example, type of school environments or dental caries incidence in children cannot affect Caucasian origin or parental obesity status. So, this would not have led to a selection bias. On the other hand, some of the selection criteria may act as common causes of both exposure and outcome, i.e. confounders, as follows: parental characteristics, which were included in the selection criteria, could be considered as surrogate measures of SES, and thus, could have influenced both exposure (type of school environments) and outcome (dental caries incidence in children). Thus, by including them in selection criteria, we have conditioned on common causes, i.e. confounders; it may be equivalent to restricting study entry to account for confounding. This may limit extrapolation of findings to the general population, but is not a source of selection bias.

However, selection bias (volunteer bias) may have occurred because not all families invited to take part in the study agreed to participate. The QUALITY cohort team approached 89% of the schools located within 75 Km of the 3 urban centres in Quebec and 48% of the eligible families agreed to take part in the study. Although the reasons given for non-participation in the study are unlikely to be affected by both our main exposure and outcome, it may still lead to a selection bias due to some unknown factors. Self-selection bias is a common problem in observational studies that involve direct data collection from participants, and in most cases, it is difficult to infer its direction or magnitude because information on the probability of participating in the study from all levels of exposure-outcome combinations in the source population is usually not available.

7.3.1.2 Emigration bias due to loss to follow up and missing values

Among the 413 children whose outcome assessment was available at the baseline, 56 (13.0%) were lost to follow up at visit 2. We compared the baseline characteristics of the participants and non-participants in visit 2 and the latter had a significantly higher mean DMF-S index (Appendix 1, Table 10.1). Similarly, Type 2 had a higher percentage (17.2%) of drop outs than Types 1 (10.6%) and 3 schools (8.5%); however, the difference in proportions were not statistically significant (Appendix 1, Table 10.2). Also, those who dropped out of the study in Type 1 and 2

schools seemed to have a higher baseline caries level than those who attended the follow up; however, this difference was not statistically significant (appendix, Table 10.3).

Finally, we carried out sensitivity analyses to estimate the potential bias that might be attributable to loss to follow up and missing values. There were minimal differences in the estimates for the effect of Type 1 school environments, which was the most successful in reducing dental caries incidence in children. However, the estimates of Type 2 school environments, which also was moderately successful in reducing dental caries incidence in children, moved away from null and remained marginally significant, suggesting that our results might have under estimated the protective effect of this type of school environment.

7.3.2 Information bias

Although information bias may have occurred, we believe that the risk of differential exposure information is minimal because of our quality control procedures. For example, dental caries were recorded by a trained and calibrated dentist in a clinical setting with the participant lying on a dental chair under adequate lighting. All the surfaces were examined for the presence of caries, fillings, and sealants, after drying the surface for about 30 seconds. Hence, the risk of errors in the detection of dental caries was minimised. Also, the dentist and the research assistant who recorded the caries were not aware of the hypothesis or exposure information.

Similarly, the questions we used to assess the school environment were informed by previously validated questionnaires and adapted to the context of Quebec's schools, and validated during a pilot study. Also, all the answers were reviewed carefully after data collection. Despite all the care taken during data collection, there is still a chance that the level of activities in schools may have been over reported (socially desirable responding (135)). Nonetheless, all the schools had an equal probability of over reporting their positive attributes. Hence, this is unlikely to have led to a differential measurement of exposure or information bias. The information on school neighbourhoods was obtained from reliable sources that provided the most accurate and up to date information. Here again, there is no risk of differential exposure information and thus the risk of information bias is minimal.

Another possible source of bias is the misspecification of clusters. As classification into different exposure groups could not have been manually controlled, some mixing of clusters could have occurred. Nonetheless, this mixing would be non-differential with respect to the outcome. Even so, it is not easy to predict the direction of bias. Generally, non-differential misclassification is believed to obscure the real effects and bias the estimates towards null. However, this assumption should be applied with caution (136); assumptions are even more problematic when more than two exposure categories are present. The bias could be towards or away from the null depending on the direction and magnitude of misclassification in the exposure strata (137). Despite these issues, multiple factors were considered to classify the schools and the risk of information bias in the measured variables is minimal. Therefore, we do not expect the proportion of misclassification to be significantly large. Moreover, the categories were named, defined, and described after the classification, further decreasing the chances of erroneous group representation. It may be difficult to repeat the analysis and identify a similar set of clusters using another sample of Quebec schools; however, the analysis serves the purpose of this particular study.

7.3.3 Confounding bias

To reduce confounding bias, we used a causal diagram. All potential confounders and variables that could affect the relationship between school oral health promoting environments and dental caries incidence were entered into a DAG (114, 115). The DAG provides a visual representation of causal relationships and helps to select a minimum set of confounders, rather than including all the potential variables into the model, and thus increases efficiency. Additionally, DAGs facilitate communication among researchers and prevent the unnecessary adjustment of variables, which would in fact induce bias. The DAG was discussed and agreed upon by all the researchers involved in the study. A reliable updated software was used to determine the minimum set of confounders. Thus, all efforts were made to eliminate any bias due to confounding.

7.3.4 External validity

As previously mentioned, the study's selection criteria restricted our source population to 8-10-year-old children of Caucasian origin with both biological parents alive and at least one obese parent. Hence, our study results may not be generalizable to all 8-10-year-old children in Quebec. A comparison of the baseline characteristics of QUALITY cohort participants with those of a representative sample of similar aged Quebec children indicated that children in the QUALITY cohort sample had a relatively high SES and were more likely to live with both parents in an urban area (104, 138). Because our study participants came from a relatively high socio-economic sector of the society, their risk for dental caries may already be low. We can reasonably assume that, if our study had included a more representative sample of children from Montreal with a relatively low SES, the protective effect would have been higher than or at least as strong as the one we observed.

7.4 Public health implications and future directions

We have shown that better oral health promoting environments in schools reduced dental caries incidence in children. Interestingly, general health promotion activities, although not implemented with the exclusive intention of reducing dental caries, and school neighbourhood factors seemed to play a very important role in this respect.

Even though the results do not suggest that dental care programs are unnecessary, they indicate that these programs alone may be incomplete. Complimentary activities (e.g., healthy eating awareness initiatives, participation of parents, teachers and communities in healthy eating and general health promotion activities, training educators about healthy living) are important to reduce dental caries incidence in children. Moreover, if the implementation of dental care programs is not feasible because of cost, diverting the available resources towards a general approach targeting common determinants of oral health, for example promoting a healthy diet, improving the social environment, and implementing policies to reduce unhealthy food intake, can benefit children's oral health.

Moreover, our study adds evidence that the neighborhood environment around the school affects children's oral health. Schools with the most favourable surrounding food environments and located in higher SES areas had an additional effect on the reduction of dental caries incidence. Local government policies targeting such neighbourhood factors may be an important element of oral health promotion. Socio-economic conditions may not be directly modifiable; nonetheless, changes in other factors may in turn buffer some of the disadvantages. It would be wise to restrict poor food choices in the school neighbourhood (e.g., fast food stores, corner stores, where pop, candy and other unhealthful food are sold) and work towards making the default choices to food that are healthy and available at low cost (e.g., healthful stores selling water, fresh fruit and vegetables, dairy). Further studies may be conducted to evaluate impact of these policy changes.

Future studies should target a more representative sample including a greater proportion of children from lower socio-economic sectors to confirm our findings. However, the evidence of success we provide may be sufficient to call for the adoption of a comprehensive approach to school-based oral health promotion.

8. Conclusion

Our study aimed to identify distinct types of school environments among a sample of Quebec schools and to estimate the effect of these types of school environments on the reduction of dental caries incidence among 8-10-year-old children over two years. We used a subset of data from the prospective QUALITY cohort study, including children attending schools located in MCMA.

We identified three distinct school environments in MCMA. The first type of schools was located in relatively affluent neighbourhood with a favourable food environment. They had strong healthy eating promotion and weak dental care programs. Type 2 schools were located in neighbourhood with the lowest SES and unfavourable food environment, however they were strong in healthy eating as well as dental care programs. Type 3 schools were located in neighbourhood with average SES and unfavourable food environment. They scored the lowest in healthy eating promotion and average in dental care programs.

We showed that school environments located in favourable neighbourhoods and using a comprehensive approach to promote healthy eating, despite relatively weak dental care programs, were effective in reducing dental caries in children, in comparison to schools located in unfavourable neighbourhoods, with a weaker approach towards healthy eating promotion, and average dental care programs. Schools where dental care programs were complimented by a comprehensive approach to healthy eating promotion were also moderately effective in reducing dental caries incidence, despite unfavourable school neighbourhoods, in comparison to the same reference; however, the effect was only borderline

In conclusion, school-based dental care programs complimented by holistic and participatory approaches targeting common risk factors such as an unhealthy diet could be effective in reducing dental caries incidence in children and may contribute to the reduction of oral health inequalities. A favourable school neighbourhood may add an additional benefit to reducing dental caries incidence. This study adds to the evidence base showing the important role of school environments in oral health promotion and provides direction for considered action to Quebec policy makers.

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10. APPENDIX I: Additional tables

Table 10.1 The baseline DMF-S level of the children who were lost to follow up compared with those attended visit 2

	Total (n=413)	**Those attended visit 2 (n=357)**	**Lost to follow up (n= 56)**	**P value**
Baseline DMF-S Index, Mean (SD)	0.62 (1.66)	0.55 (1.36)	1.05 (2.9)	P = 0.03

Table 10.2 Comparison of the percentage of lost to follow up within each cluster

Cluster membership	**Those attended baseline**	**Lost to follow up**	**P value**
Type 1 (n=189) *	169 (89.4%)	20 (10.6%)	P=0.13
Type 2 (n=145) *	120 (82.8%)	25 (17.2%)	
Type 3 (n=47) *	43 (91.5%)	4 (8.5%)	

*Here total adds up to 381 rather than 413 because of 35 missing values for the variable 'type of schools' and 17 missing values in baseline DMF-S.

Table 10.3 Comparison of baseline DMF-S index between those were lost to follow up and those who were retained, within each school type

	Type 1 schools		**Type 2 schools**		**Type 3 schools**	
	Retained (n=169)	Lost (n=20)	Retained (n=120)	Lost (n=25)	Retained (n=43)	Lost (n=4)
Baseline DMF-S Index Mean (SD)	0.47 (1.15)	1.00 (4.01)	0.65 (1.59)	1.16 (2.17)	0.77 (1.54)	0 (0-0)
P value	P=0.19		P = 0.18		P = 0.33	

11. APPENDIX II : Parental Questionnaire (English)

CHU Sainte-Justine
Le centre hospitalier universitaire mère-enfant

Pour l'amour des enfants

Université de Montréal

UNIVERSITÉ LAVAL

McGill

CHUS

Familial Study on the Prevention of Cardiovascular Disease and Type 2 Diabetes in Children and Adolescents

Parent Questionnaire for Visit 1
Biological Parents Section
(1QB)

Child's PIN: _____

May 2006

Instructions

To be completed by the biological parents of the child participating in the study.

Many of the questions in this questionnaire have several possible answers. Choose the answer best suited to your personal situation.

Answer to the best of your knowledge. There are no right or wrong answers.

Unless otherwise indicated, we ask that you choose only one answer for each question.

Here are a few sample questions and answers to illustrate what we mean:

Example A **Fill in the blank.**

How many people live in the household where the child usually lives?

- ***Include people who may be absent because of studies, travel, in hospital, etc. but who normally live in the household.***

Number of people including the child ..... | | 5 |

Example B **Circle your answer and give details if applicable.**

Where was the child participating in the study born?

A. Québec..... (1)
Other Canadian province..... 2
Outside Canada 3

B. If the child was born outside Canada, please write which country.

_____

If you have difficulty understanding any of the questions, please ask the research assistant for clarification.

Personal Information

1. What is the date of birth of the child participating in the study?
   A. Day _____ (01 to 31)
   B. Month _____ (01 to 12)
   C. Year | 1 | 9 | | |
2. What is the date of birth of his/her biological mother?
   A. Day _____ (01 to 31)
   B. Month _____ (01 to 12)
   C. Year | 1 | 9 | | |
3. What is the date of birth of his/her biological father?
   A. Day _____ (01 to 31)
   B. Month _____ (01 to 12)
   C. Year | 1 | 9 | | |
4. Where was the child participating in the study born?
   A. Québec 1
      Other Canadian province 2
      Outside Canada 3
   B. If the child was born outside of Canada, please write in which country he/she was born.
      _____
5. Where was his/her biological mother born?
   A. Québec 1
      Other Canadian province 2
      Outside Canada 3
   B. If his/her biological mother was born outside of Canada, please write in which country she was born.
      _____
6. Where was his/her biological father born?
   A. Québec 1
      Other Canadian province 2
      Outside Canada 3
   B. If his/her biological father was born outside of Canada, please write in which country he was born.
      _____

7. What language do you use **most often** when speaking with your child at home?

➢ ***Only choose one (1) answer for each parent.***		**1. Biological mother**	**2. Biological father**
A.	French	1	1
	English	2	2
	Italian	3	3
	Greek	4	4
	Spanish	5	5
	Portuguese	6	6
	Other	7	7

B. If you answered «7» (you most often speak with your child in a language not listed here), please specify which language.

1. Biological mother : _____ 2. Biological father :_____

8. What is the highest level of education **completed** by the biological mother and father of the child participating in the study?

➢ ***Only choose one (1) answer for each parent.***	**A. Biological mother**	**B. Biological father**
No formal schooling or did not complete elementary school	1	1
Primary school	2	2
Did not complete high school (grade 7 to 11)	3	3
Graduated from high school (grade 12)	4	4
Graduated from vocational or trade school	5	5
Graduated from college (Cegep)	6	6
Graduated from university	7	7

9. Which parent(s) is completing this questionnaire?

Both the biological mother and the biological father 1

Only the biological mother..... 2

Only the biological father..... 3

Neighbourhood Characteristics

The next questions relate <u>to the neighborhood where the child participating in the study most often lives</u>. We are interested in neighborhood characteristics because the environment may influence lifestyle.

10. Is the neighbourhood in which the child lives …?

Mainly residential 1
Mainly commercial 2
Mixed residential and commercial 3
Rural 4

11. How safe do you feel walking in your neighbourhood?

- ***Please answer for each item.***

	Very safe →				**Not at all safe**
A. During the day	1	2	3	4	5
B. At night	1	2	3	4	5

12. Tell us whether you strongly agree, agree, disagree, or strongly disagree about the following statements when thinking of your neighbours.

   - ***Please answer for each item.***

	Strongly agree	**Agree**	**Disagree**	**Strongly disagree**
A. If there is a problem around here, the neighbours get together to deal with it.	1	2	3	4
B. There are adults in the neighbourhood that can be role models for the children.	1	2	3	4
C. People around here are willing to help their neighbours.	1	2	3	4
D. You can count on adults in this neighbourhood to watch out that children are safe and don't get in trouble.	1	2	3	4
E. When I'm away from home, I know that my neighbours will keep their eyes open for possible trouble.	1	2	3	4

13. How true are each of the following statements in regard to the neighbourhood where the child lives most of the time.

- ***Please answer for each item.***

	Very true →				**Not at all true**
A. There are no sidewalks.	1	2	3	4	5
B. There are lots of hills.	1	2	3	4	5
C. Dogs are well attended.	1	2	3	4	5
D. There is a lack of equipment or facilities to incite children to be active.	1	2	3	4	5
E. There are lots of safe places to be active.	1	2	3	4	5
F. People walk or exercise frequently.	1	2	3	4	5
G. Parents are very involved in watching their children participate in sports.	1	2	3	4	5
H. There are many supervised and organised sports activities for children.	1	2	3	4	5
I. Many people walk to the local grocery store.	1	2	3	4	5
J. The neighbourhood is attractive.	1	2	3	4	5
K. It is a high crime area.	1	2	3	4	5
L. There are few local sports facilities.	1	2	3	4	5
M. Children can play safely outdoors.	1	2	3	4	5
N. Street lights are often burned out.	1	2	3	4	5
O. There is heavy traffic.	1	2	3	4	5

14. On a scale from 1 to 5 (from very convenient to not at all convenient) how conveniently located are the following places/facilities with respect to the child's home?

- ***Please answer for each item.***

	Very convenient →				**Not at all convenient**	**Don't know**
A. Public park or playground	1	2	3	4	5	8
B. Basketball court	1	2	3	4	5	8
C. Bike path or lane	1	2	3	4	5	8
D. Golf course	1	2	3	4	5	8
E. Mini golf	1	2	3	4	5	8
F. Playing field for soccer or football	1	2	3	4	5	8
G. Playing field for baseball	1	2	3	4	5	8
H. Tennis court	1	2	3	4	5	8
I. Sports classes	1	2	3	4	5	8
J. Public recreation center	1	2	3	4	5	8
K. Public indoor swimming pool	1	2	3	4	5	8
L. Public outdoor swimming pool	1	2	3	4	5	8
M. Walking/hiking trails	1	2	3	4	5	8
N. Dance studio/classes	1	2	3	4	5	8
O. Racquetball/squash court	1	2	3	4	5	8
P. Grocery store/shops	1	2	3	4	5	8
Q. Public gym	1	2	3	4	5	8
R. Indoor skating rink/arena	1	2	3	4	5	8
S. Outdoor skating rink	1	2	3	4	5	8
T. Fitness/exercise club	1	2	3	4	5	8

Your Child's Health

15. Does the child participating in the study **curently have or had in the last year** one or more of the following chronic health problems diagnosed or confirmed by a doctor or other health specialist? If yes, please indicate the age (in years) of your child when the diagnosis was first made.

    A chronic health problem is one that has persisted for 6 months or more or that will probably last more than 6 months.

    - ***Please answer for each item.***

	1. No	Yes	2. If yes, age at diagnosis
A. Food allergies	0	1	_____
B. Respiratory problems (asthma or other)	0	1	_____
C. Skin problems	0	1	_____
D. Emotional, psychological or nervous problems	0	1	_____
E. Bone or joint problems	0	1	_____
F. Digestive system problems	0	1	_____
G. Thyroid problems	0	1	_____
H. Liver problems	0	1	_____
I. Kidney problems	0	1	_____
J. Diabetes	0	1	_____
K. Hypertension (high blood pressure)	0	1	_____
L. Cholesterol or lipid problems	0	1	_____
M. Overweight or obesity	0	1	_____

16. Compared to healthy children of the same age, is your child limited in the type or number of activities he/she can do because of a chronic physical or mental health problem?

No ..... 0 ➢ ***Go to question 18.***

Yes 1

17. What is the main health problem that limits your child's activities?

_____

18. In the past 2 months, did your child sustain an injury or trauma that was treated by a physician or nurse?

No 0

Yes 1

19. In the past 2 months, has your child had a serious disease or been very sick, requiring hospitalization for more than one week?

A. No..... 0

Yes 1

B. If yes, specify what

_____

The next questions relate to the pregnancy and birth of the child participating in the study.

20. When pregnant with the child participating in the study, did the biological mother experience any of the following health problems?

➢ ***Please answer for each item.***

	No	Yes	Don't know
A. Hypertension (high blood pressure)	0	1	8
B. Gestational diabetes	0	1	8
C. Was known to have diabetes before the pregnancy	0	1	8

21. Did the child's biological mother smoke during the pregnancy?

A. No..... 0
Yes..... 1 ***if yes*** ➢

During which months of the pregnancy did she smoke?

➢ ***Please answer for each item.***

B. During the first trimester

No..... 0
Yes..... 1
Don't know 8

C. During the second trimester

No..... 0
Yes..... 1
Don't know 8

D. During the third trimester

No..... 0
Yes..... 1
Don't know 8

22. How frequently did the child's biological mother drink alcohol during her pregnancy?

Never..... 1
Less than once a month..... 2
Once (1) to three (3) times a month..... 3
Once (1) a week..... 4
Two (2) to three (3) times a week 5
Four (4) to six (6) times a week..... 6
Everyday 7
Don't know 8

23. What was the birth weight of your child?

_____ pounds and _____ ounces **or** _____ kilograms and _____ grams

Don't know 98

24. What was the birth length of your child?

___ inches **or** _____ centimetres

Don't know 98

25. After how many weeks of gestation was your child born? If the child was born at term and you don't know exactly the number of weeks of gestation, write 40 weeks.

_____ weeks

Don't know 98

26. Was this a single birth, twins, or triplets?

Single birth 1

Twins..... 2

Triplets 3

More than triplets 4

27. Did your child receive special medical care following his/her birth?

No 0

Yes..... 1

Don't know 8

28. For how many days did your child remain in the hospital after birth?

_____ days

Not applicable (child was not born in a hospital)..... 996

Don't know 998

29. Compared to other babies in general, would you say that your child's health at birth was…

Excellent..... 1
Very good..... 2
Good 3
Fair..... 4
Poor..... 5

30. Did the mother of the child participating in the study breast-feed him/her even if only for a short time?

A. No..... 0
Yes ..... 1 ***if yes*** ➢

B. For how long?

Less than one (1) week.....1
1-4 weeks.....2
5-8 weeks.....3
9-12 weeks.....4
3-6 months 5
7-9 months 6
10-12 months 7
13-16 months 8
More than 16 months 9

Medicine Taken by Your Child

31. During the past two (2) weeks, did your child take any of the following medications (in pill, syrup, drops form, etc.)?

- ***Please answer for each medication (A to N).***
  If you have any doubts about the type of medication, consult the nurse.

A. Medication to reduce pain or fever

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

B. Medication for a cold or allergies

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

C. Vitamin(s) or mineral(s)

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

D. Antibiotic or anti-infection medication

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

E. Steroids or cortisone by mouth or injection

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify

   _____

F. Asthma medication (such as a pump or inhaler) other than steroids or cortisone by mouth or injection

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

G. Medication to help him/her concentrate better (ex.: ritalin)

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

   _____

H. Medication for digestive problems

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

I. Medication for skin problems

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

J. Medication to lower cholesterol or triglycerides (lipids in blood)

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

K. Medication for hypertension (high blood pressure)

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

L. Medication for diabetes

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

M. Medication for weight loss, or to control appetite

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

N. Any other medication

1. No 0
   Yes 1
   Don't know 8

2. If yes, specify which

_____

Your Child's Dental and Oral Health

32. Has your child ever been to the dentist's clinic, either for treatment, check-up, examination, or just to get used to going?

No ..... 0 ➢ ***Go to question 44.***

Yes 1

33. At what age did your child have his/her first dental visit?

_____ years old

Don't know 98

34. Why did he/she go the first time? Was this because…

➢ ***Please choose only one (1) answer.***

Check-up, examination, or cleaning 1

He/she was having trouble with his/her teeth 2

Recommended by the school's dental hygienist 3

He/she just went to get used to going to the dentist 4

For orthodontic treatments 5

For some other reason 6

Don't know 8

35. Has your child ever had a dental treatment of any kind (e.g. filling, tooth extraction, sealants, fluoride treatment, etc). A check-up is not considered dental treatment.

No ..... 0 ➢ ***Go to question 37.***

Yes 1

36. What kind of dental treatment(s) has your child had over the whole of his/her life so far?

- ***Please answer for each item.***

	No	Yes
A. Tooth filling	0	1
B. Tooth extraction	0	1
C. A general anesthetic to have tooth/teeth taken out	0	1
D. Treatment to stop teeth decaying or going bad	0	1
E. Other reason	0	1

F. If other reason, please specify.

_____

37. When was your child's last visit to the dentist?

In the last six (6) months 1
In the last year..... 2
Not in the last year, but in the last two (2) years 3
Longer than two (2) years 4

38. Why did he/she go to the dentist last time? Was this because…

- ***Please choose only one (1) answer.***

Check-up, examination or cleaning..... 1
He/she was having trouble with his/her teeth..... 2
Recommended by the school dental hygienist..... 3
He/she just went to get used to going to the dentist 4
For orthodontic treatments 5
For some other reason..... 6
Don't know 8

39. Do you have any kind of private insurance (dental plan) which pays for dental care for your child?

No 0

Yes, partial reimbursement 1

Yes, total reimbursement 2

Don't know 8

40. Has your child ever had a fall or some other accident that damaged any of his/her teeth?

No ..... 0 ➢ ***Go to question 44.***

Yes 1

41. What was this damage?

➢ ***Please answer for each item.***

	No	**Yes**
A. Teeth chipped, cracked or broken	0	1
B. Teeth knocked loose	0	1
C. Teeth knocked out	0	1

42. Was this damage to baby (milk) teeth, to second (permanent) teeth, or to both?

Baby teeth 1

Second teeth 2

Both 3

Don't know 8

43. Did your child have to have any teeth taken out at the dentist because of this accident?

No 0

Yes 1

44. Has your child ever received prescription fluoride treatment, such as liquids or gels, **at the dentist office**?

Don't know 8
No 0
Yes 1

} ➢ ***Go to question 46***

45. How often has your child received these treatments?

Every six (6) months 1
Once (1) a year 2
Every two (2) years 3
Less often than every two (2) years 4
Don't know 8

46. Has your child ever received fluoride treatments **through a school program**?

A. Don't know 8
No 0
Yes 1

B. If yes, from what age?
_____ years old

C. Until what age?
_____ years old

47. Has your child ever taken fluoride tablets/drops, or vitamin drops/tablets with fluoride (including multivitamin with fluoride)?

A. Don't know 8
No..... 0
Yes 1

B. If yes, from what age? (If less than one (1) year old, write 0)
_____ year old

C. Until what age? (If less than one (1) year old, write 0)
_____year old

Your Child and School

48. What type of school does your child attend now (or attended during the shool year that just ended)?

Public school 1

Private school..... 2

Other 3

49. What is the name of the school that your child attends now (or attended during the school year that just ended)?

_____

50. What is the postal code of the school that your child attends now (or attended during the school year that just ended)?

51. In the last two (2) years, has your child failed a grade or was he/she held back one year in school (including kindergarten)?

No 0

Yes 1

52. In the last two (2) years, has your child received specialized services because of difficulties experienced in school (learning disability, behavioural problems, etc.)?

No 0

Yes 1

Don't know 8

53. Other than the progression through the school system in your area, has your child changed schools?

No ..... 0 ➢ ***Go to question 56.***

Yes 1

54. In the last two (2) years, how many times has your child changed schools?

_____ times

55. For the most recent change in schools, what was the reason for changing?

- ***Please choose only one (1) answer.***

Family or child moved 1
Child not progressing well 2
Child not getting along well with others 3
Concerns about standards and quality of teaching at the school 4
Wanted a specific program 5
Other 6

56. With regard to how your child feels about school, how often does he/she look forward to going to school?

Almost never 1
Rarely 2
Sometimes 3
Often 4
Almost always 5

Your Child's Friends, Feelings and Behaviours

The next questions relate to your child's relationships with his/her friends, family, and other people.

57. About how many days a week does your child do things with friends?

Never..... 1
One (1) day a week..... 2
Two (2) or three (3) days a week 3
Four (4) or five (5) days a week 4
Six (6) or seven (7) days a week..... 5

58. About how many close friends does your child have?

None..... 1
One (1)..... 2
Two (2) or three (3) 3
Four (4) or five (5) 4
Six (6) or more 5

59. When it comes to meeting new children and making new friends, is your child…

Somewhat shy..... 1
About average..... 2
Very outgoing – makes friends easily 3

60. During the past six (6) months, how well did your child get along **with other kids, such as friends or classmates (excluding brothers or sisters)**?

Very well, no problems..... 1
Quite well, hardly any problems..... 2
Pretty well, occasional problems..... 3
Not too well, frequent problems 4
Not well at all, constant problems 5

61. During the past six (6) months, how well did your child get along **with his/her teacher(s) at school**?

Very well, no problems 1
Quite well, hardly any problems 2
Pretty well, occasional problems 3
Not too well, frequent problems 4
Not well at all, constant problems 5

62. During the past six (6) months, how well did your child get along **with his/her parent(s)**?

Very well, no problems 1
Quite well, hardly any problems 2
Pretty well, occasional problems 3
Not too well, frequent problems 4
Not well at all, constant problems 5

63. During the past six (6) months, how well did your child get along **with his/her brother(s)/sister(s)**?

Very well, no problems 1
Quite well, hardly any problems 2
Pretty well, occasional problems 3
Not too well, frequent problems 4
Not well at all, constant problems 5
Does not have brother(s) or sister(s) 6

Now we would like to ask you questions about how your child seems to feel or act.

64. Using one of the three (3) following answers: "never or not true, sometimes or somewhat true, or often or very true", how often would you say that your child…

- ***Please answer for each item.***

	Never or not true	Sometimes or somewhat true	Often or very true
A. Shows sympathy to someone who has made a mistake?	1	2	3
B. Can't sit still, is restless or hyperactive?	1	2	3
C. Will try to help someone who has been hurt?	1	2	3
D. Is defiant?	1	2	3
E. Seems to be unhappy, sad, or depressed?	1	2	3
F. Gets into many fights?	1	2	3
G. Is easily distracted, has trouble sticking to any activity?	1	2	3
H. Doesn't seem to feel guilty after misbehaving?	1	2	3
I. Is not as happy as other children?	1	2	3
J. Fidgets?	1	2	3
K. Can't concentrate, can't pay attention for long?	1	2	3
L. Is too fearful or nervous?	1	2	3
M. Punishment doesn't change his/her behaviour?	1	2	3
N. Is impulsive, acts without thinking?	1	2	3
O. Has temper tantrums or a hot temper?	1	2	3
P. Offers to help other children (friend, brother or sister) who are having difficulty with a task?	1	2	3
Q. Is worried?	1	2	3
R. Has difficulty waiting for his/her turn in games or groups?	1	2	3

	Never or not true	Sometimes or somewhat true	Often or very true
S. When somebody accidentally hurts him/her, he/she reacts with anger and starts a fight?	1	2	3
T. Has angry moods?	1	2	3
U. Comforts a child (friend, brother or sister) who is crying or upset?	1	2	3
V. Cries a lot?	1	2	3
W. Clings to adults or is too dependent?	1	2	3
X. Gives up easily?	1	2	3
Y. Cannot settle down to do anything for more than a few moments?	1	2	3
Z. Constantly seeks help?	1	2	3
AA. Is nervous, high strung or tense?	1	2	3
BB. Kicks, bites, hits other children?	1	2	3
CC. Doesn't want to sleep alone?	1	2	3
DD. Is inattentive?	1	2	3
EE. Has trouble enjoying him/herself?	1	2	3
FF. Helps other children (friends, brother or sister) who are feeling sick?	1	2	3
GG. Gets too upset when separated from parents?	1	2	3
HH. Helps those who do not do as well as he/she does?	1	2	3

65. Has your child ever experienced any event or situation that has caused him/her a great amount of worry or unhappiness?

A. No..... 0
Yes..... 1

B. If yes, what was this (these) event(s) or situation(s)?

- ***Please answer for each item.***

	No	Yes
1. Death in family (other than parents)	0	1
2. Divorce/separation of parents	0	1
3. Move	0	1
4. Stay in hospital	0	1
5. Stay in foster home	0	1
6. Other separation from parents	0	1
7. Illness/injury of child	0	1
8. Illness/injury of a family member	0	1
9. Abuse/fear of abuse	0	1
10. Change in household members	0	1
11. Alcoholism or mental health disorder in family	0	1
12. Conflict between parents	0	1
13. Parent loss of employment	0	1
14. Change in the family financial situation	0	1
15. Birth of another child	0	1
16. Other	0	1

Sibling Health

The next questions relate to the biological brothers and sisters and biological half-brothers and half-sisters of the child participating in the study.

66. Does your child have any biological brothers, sisters, half-brothers or half-sisters?

No ..... 0 ➢ ***Go to question 71.***

Yes 1

67. How many living biological brothers, sisters, half-brothers or half-sisters does your child have?

➢ ***Please answer for each item A, B, C, and D. Write "0" if the answer is none.***

A. Number of brothers .....
B. Number of sisters .....
C. Number of half-brothers .....
D. Number of half-sisters .....

68. How old are the biological brothers/sisters/half-brothers/half-sisters of the child participating in the study? If a child is less than 1 year old, write 0.

A. Age of child 1 (other than the child participating in the study) : _____ years old
B. Age of child 2 (other than the child participating in the study) : _____ years old
C. Age of child 3 (other than the child participating in the study) : _____ years old
D. Age of child 4 (other than the child participating in the study) : _____ years old
E. Age of child 5 (other than the child participating in the study) : _____ years old

69. Did any of your child's biological brothers or sisters or half-brothers or sisters die after birth?

No 0

Yes 1

70. Do any of your child's biological brothers or sisters or half-brothers or half-sisters actually have any of the following chronic health problems that have been diagnosed or confirmed by a doctor or other health specialist?

A chronic health problem is one that has persisted for 6 months or more or that will probably last more than 6 months.

➢ ***Please answer for each item.***

	No	**Yes**	**Don't know**
A. Diabetes	0	1	8
B. Hypertension (high blood pressure)	0	1	8
C. Overweight or obesity	0	1	8
D. Elevated blood cholesterol or triglycerides (lipids in blood)	0	1	8

Your Child's Home

The next questions relate to the family with whom the participating child <u>usually lives</u>.

71. Does your child currently live with both of his/her biological parents?

No 0

Yes ..... 1 ➢ ***Please, go to question 74.***

72. If the child does not currently live with both of his/her biological parents, indicate how long he/she has not been living with both. Write 0 if for less than a year.

Number of complete years ..... | | |

Never lived with both his/her parents 97

73. With which parent does the child **usually** live?

A. With his/her mother only 1

With his/her father only 2

Most of the time with his/her mother 3

Most of the time with his/her father 4

Equal time with mother and father 5

Other 6

B. If you answered that the child usually lives with a person other than his biological mother or father, please specify who this (these) person(s) is (are).

_____

74. How many people live in the household where the child usually lives?

➢ ***Include people who may be absent because of studies, travel, in hospital, etc., but who normally live in the household.***

Number of people including the child ..... | | |

75. How many bedrooms are there in the household where the child usually lives?

Number of bedrooms ..... | | |

76. What type of home does your child usually live in?

- ***Please choose only one (1) answer.***

Single detached house..... 1
Semi-detached or double (side-by-side) house 2
Town house or row house..... 3
Duplex (one above the other)..... 4
Low-rise apartment (less than five (5) stories)..... 5
High-rise apartment (5 or more stories) 6
Mobile home..... 7
Other 8

Again, the next questions relate to the family with whom the participating child usually lives.

77. At the present time, which of the following best describes your main occupational status and that of your spouse/partner?

- ***INDICATE ONLY ONE (1) FOR EACH PERSON AND CHOOSE ONLY TWO (2) PERSONS. Therefore, if your child currently lives with his/her two (2) biological parents, answer for the biological mother and biological father; if your child lives most often with his/her biological mother, answer for the biological mother and her partner (if applicable); if your child lives most often with the biological father, answer for the biological father and his partner (if applicable).***

	1. Biological mother	2. Biological father	3. Partner of biological mother	4. Partner of biological father
Full-time job (30 hrs. or more a week)	1	1	1	1
Part-time job (less than 30 hrs. a week)	2	2	2	2
Going to school	3	3	3	3
Homemaker	4	4	4	4
Not working for health reasons	5	5	5	5
Maternity or paternity leave	6	6	6	6
Unemployed	7	7	7	7
On welfare (social assistance)	8	8	8	8
On strike or locked out	9	9	9	9
Other (retired, sabbatical, etc.)	10	10	10	10
No partner			97	97

78. If you or your spouse/partner have a paid job, when do you work?

- ***INDICATE ONLY ONE (1) FOR EACH PERSON AND CHOOSE ONLY TWO (2) PERSONS. Therefore, if your child currently lives with his/her two (2) biological parents, answer for the biological mother and biological father; if your child lives most often with his/her biological mother, answer for the biological mother and her partner (if applicable); if your child lives most often with the biological father, answer for the biological father and his partner (if applicable).***

A. During the week

	1. Biological mother	2. Biological father	3. Partner of biological mother	4. Partner of biological father
Days	1	1	1	1
Evenings or nights	2	2	2	2
Alternating days and evenings/nights (shift work)	3	3	3	3
Don't work during the week	4	4	4	4
No partner			97	97

B. Weekend

	1. Biological mother	2. Biological father	3. Partner of biological mother	4. Partner of biological father
Days	1	1	1	1
Evenings or nights	2	2	2	2
Alternating days and evenings/nights (shift work)	3	3	3	3
Don't work during the weekend	4	4	4	4
No partner			97	97

Although many health expenses are covered by the provincial health insurance plan, there is still a relationship between health and income. We would appreciate that you answer the following question to help us study this relationship.

As with all the other information you have provided in this questionnaire, your response will remain completely CONFIDENTIAL.

79. What was your total household income for the last completed fiscal year, before taxes and deductions (i.e total income of everyone living in the same residence where your child usually lives, and who share expenses)?

Less than 10 000$	01
10 000$ - 14 999$	02
15 000$ - 19 999$	03
20 000$ - 29 999$	04
30 000$ - 39 999$	05
40 000$ - 49 999$	06
50 000$ - 59 999$	07
60 000$ - 79 999$	08
80 000$ - 99 999$	09
100 000$ - 119 999$	10
120 000$ - 139 999$	11
140 000$ and more	12

Today's date

				2	0	0	
Day		Month			Year		

This is the end of the first part of the parents' questionnaire. The next section should be filled out by each biological parent separately. Thank you for your collaboration and patience.

12. APPENDIX III : School environment questionnaire (French)

Étude QUALITY, volet diagnostic environnemental des écoles

Nom de l'école : _____ NIFS : Date (JJ/MM/AA) :

HEURE DÉBUT ENTREVUE (HH:MM): _____

MERCI POUR VOTRE TEMPS. J'AIMERAIS D'ABORD VOUS ASSURER QUE TOUTES VOS RÉPONSES SERONT CONFIDENTIELLES; ET QU'AUCUNE INFORMATION NOMINALE NE SERA DÉCRITE.

1- Quelle est votre fonction actuelle?

□ Directeur. ----> **Avez-vous été enseignant d'éducation physique?** □Oui ou □Non

□ Enseignant en éducation physique

□ Autre (décrire) : _____

2- Depuis combien d'années occupez-vous ce poste à cette école? _____années

3- Depuis combien d'années l'école est-elle située dans ce bâtiment? _____années

4- Quels cycles ou années accueillez-vous?

□Pré-maternelle □maternelle □cycle I □cycle II □cycle III

5- Est-ce que votre école a une vocation particulière? (Ex: alternative, internationale, musique…)

□ Oui ou □ Non **Si OUI, laquelle? _____**

6- Quel est le nombre total d'élèves inscrits dans votre école? _____ élèves

7- Quel est le nombre total de groupes? _____ groupes

8- Une journée normale d'école débute à (HH:MM) **_____ et se termine à** (HH:MM) **_____**

9- Quelle est la durée de la période de dîner? _____ minutes

10- Combien y a-t-il de récréations par jour? (sans inclure la période du dîner) **_____** récréations

11-Quelle est la <u>durée totale</u> de toutes les récréations pour une journée normale? (sans inclure la période du dîner) **_____** minutes

12-Combien d'élèves voyagent aller-retour par autobus scolaire? (Inscrire nombre et/ou %)

No: **_____** élèves et/ou **_____**%

13-Combien d'élèves marchent pour aller ou revenir de l'école? (Inscrire nombre et/ou %)

No: **_____** élèves et/ou **_____**%

14- Est-ce qu'il y a un service de garde…. (SI AUCUN SERVICE DE GARDE ----> Q 18)

a) Le matin? □ Oui ou □ Non

b) Le midi? □ Oui ou □ Non

c) Après les cours? □ Oui ou □ Non

15- Combien d'élèves sont inscrits au service de garde? (Inscrire nombre et/ou %)

No: **_____** élèves et/ou **_____** %

16- Qui a la responsabilité du service de garde?

□ École □ Autre ? ---->Qui? _____

17- Est-ce que le service de garde est offert ici à l'école, ou ailleurs?

□ École □ Ailleurs ---->Où? _____

1

Maintenant je vais vous poser quelques questions sur les opportunités qui s'offrent aux enfants pour participer à des activités physiques dans votre école.

18- Combien de minutes d'éducation physique sont offertes aux cycles 1,2 et 3 par semaine de 5 jours? _____ minutes/semaine (OU _____min/cycle de _____ jours)

19- Est-ce qu' il y a des activités physiques gratuites organisées (donc <u>avec animateur</u>), pendant les récréations? □Oui ou □Non

- **Si OUI combien de fois par semaine pour un élève donné?** _____ fois/semaine
- **ET combien d'élèves participent? (Nombre et/ou %)** No: _____ élèves ou _____ %
- **Obligatoire ?** □Oui ou □Non

20- Dans le contexte du service de garde, est-ce qu'il y a des activités physiques gratuites organisées (donc <u>avec animateur)</u>, PENDANT LA PÉRIODE DU DÎNER? □Oui ou □Non

- **Si OUI combien de fois par semaine pour un élève donné?** _____ fois/semaine
- **ET combien d'élèves participent? (Nombre et/ou %)** No: _____ élèves ou _____ %
- **Obligatoire ?** □Oui ou □Non

21- Dans le contexte du service de garde, est-ce qu'il y a des activités physiques gratuites organisées (donc <u>avec animateur)</u> AVANT OU APRÈS L'ÉCOLE (encercler)**?** □Oui ou □Non

- **Si OUI combien de fois par semaine pour un élève donné?** _____ fois/semaine
- **ET combien d'élèves participent? (Nombre et/ou %)** No: _____ élèves ou _____ %
- **Obligatoire ?** □Oui ou □Non

22- Y a-t-il des activités physiques parascolaires, incluant des activités individuelles, des activités en groupe, et des cours, auxquelles les élèves peuvent participer? □Oui ou □Non
Si OUI, quelles sont ces activités? *(Inscrire les activités) Demander pour chacune <u>la fréquence par semaine</u> (1 X 60 minutes, 3 X 45 minutes, etc.) <u>la durée</u> (nb de semaines) et le <u>nombre d'élèves inscrits</u>.*

	<u>Durée</u>	<u>Fréquence par semaine</u>	<u># d'élèves inscrits</u>
_____		_____	
_____		_____	
_____		_____	
_____		_____	
_____		_____	
_____		_____	

23- Est-ce qu'il y a des <u>équipes de sport</u> dans votre l'école? Une équipe de sport a un entraîneur et participe à des compétitions extra-murales, i.e. contre d'autres écoles. □Oui ou □Non
Si OUI, lesquelles? Est-ce que tous les élèves peuvent y participer? □Oui ou □Non ->Si non pourquoi
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

24- AUTRE que le cours d'éducation physique, des activités physiques dans le contexte du service de garde, et des activités physiques parascolaires, est-ce qu'il y a des évènements ponctuels spéciaux visant l'activité physique auxquels tous les élèves peuvent participer, comme des tournois, des olympiades, des experts invités, des sorties? □Oui ou □Non
Si OUI, pouvez-vous me les nommer et les décrire très brièvement?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

25- Je vais lire une série d'énoncés. Pour chacun, SVP dites-moi si vous êtes <u>TOUT À FAIT DACCORD, ASSEZ D'ACCORD, PLUS OU MOINS D'ACCORD, OU PAS D'ACCORD</u>. SVP répondez d'abord pour la saine alimentation, et ensuite pour l'activité physique. Alors, êtes-vous tout à fait d'accord, assez d'accord, plus ou moins d'accord, ou pas d'accord qu'....

	La saine alimentation				L'activité physique?			
	Tout a fait d'accord	Assez d'accord	Plus ou moins d'accord	Pas d'accord	Tout a fait d'accord	Assez d'accord	Plus ou moins d'accord	Pas d'accord
a) Il y une volonté de la part de la DIRECTION pour promouvoir la saine alimentation auprès des élèves...et l'activité physique auprès des élèves.								
b) Il y une volonté de la part des ENSEIGNANTS pour promouvoir la saine alimentation auprès des élèves....et l'activité physique auprès des élèves								
c) Il y une volonté de la part des PARENTS pour promouvoir la saine alimentation auprès des élèves....et l'activité physique auprès des élèves								
d) Il y une volonté de la part des RESPONSABLES DU SERVICE DE GARDE pour promouvoir la saine alimentation auprès des élèves....et l'activité physique auprès des élèves								
f) Il y une volonté de la part de vos PARTENAIRES COMMUNAUTAIRES (centres communautaires, la ville, responsables des loisirs) pour promouvoir la saine alimentation auprès des élèves....et l'activité physique auprès des élèves								

26- Une série d'orientations ont été proposées par le Ministère de l'Éducation des Loisirs et du Sport (MELS) pour améliorer l'environnement scolaire en lien avec la saine alimentation et l'activité physique auprès des élèves. SVP dites-moi si les énoncés suivants sont pour vous TOUT À FAIT VRAI, PLUS OU MOINS VRAI, PLUS OU MOINS FAUX, OU TOUT À FAIT FAUX

	Tout a fait VRAI	Plus ou moins VRAI	Plus ou moins FAUX	Tout a fait FAUX	NSP	N/A
L'école vend des aliments et boissons conformes aux principes d'une saine alimentation à l'occasion des campagnes de financement.						
L'école offre des aliments et boissons conformes aux principes d'une saine alimentation à l'occasion d'évènements spéciaux, de voyages, de sorties éducatives, etc.						
Le menu du service de traiteur doit être approuvé par une nutritionniste.						
L'école augmente les occasions d'être actif physiquement en formant et soutenant des jeunes leaders.						
L'école augmente les occasions d'être actif physiquement en formant et soutenant le personnel du service de garde.						
L'école prévoit des activités répondant de façon particulière aux intérêts des filles.						
L'école met à la disposition des jeunes du matériel en bon état, sécuritaire et en quantité suffisante.						
L'école sensibilise l'ensemble des éducateurs à l'importance de promouvoir les saines habitudes de vie.						
L'école informe périodiquement les parents des différentes actions mises en places afin qu'ils soutiennent les efforts du milieu scolaire.						
L'école a des ententes avec la communauté pour augmenter les occasions d'être actif physiquement						
L'école a des ententes avec la communauté pour favoriser la saine alimentation des élèves.						
L'école établit avec la municipalité des corridors sécuritaires vers l'école (signalisation adéquate, accès sécuritaires, réglementation routière, etc.)						
L'école fait place à beaucoup de bénévoles venants des familles.						

27- Est-ce qu'il y a dans votre école des initiatives ou des projets formels visant la saine alimentation? ***(On peut considérer 'formel' toute initiative qui a été incluse dans le projet éducatif ou le plan de réussite, ou qui le sera prochainement).*** □Oui ou □Non

Si OUI, SVP les nommer et me donner une très brève description, en donnant par exemple l'objectif ou l'action principale, et m'indiquer depuis combien d'années ce projet est en place.

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28- Est-ce qu'il y a dans votre école des initiatives ou des projets formels visant le transport actif, c'est-à dire marcher à l'école, ou le temps passé devant les écrans, c'est-à-dire télévision et ordinateur ? □Oui ou □Non
Si OUI, SVP les nommer et me donner une très brève description, en donnant par exemple l'objectif ou l'action principale, et m'indiquer depuis combien d'années ce projet est en place.

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29- On a beaucoup parlé d'occasions pour faire de l'activité physique ; est-ce qu'il y aurait d'autres initiatives ou projets formels en activité physique que vous n'avez pas encore mentionnés (Ex : École en forme et en santé) □Oui ou □Non
Si OUI, SVP les nommer et donner une très brève description.

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Enfin, voici quelques questions concernant d'autres programmes de santé offerts aux élèves de votre école.

30- a) Faites-vous des activités <u>pédagogiques</u> liées au contrôle du tabac? □Oui ou □Non
(Si oui lesquelles)

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b) Faites-vous des activités spéciales <u>en dehors des heures de cours</u> liées au contrôle du tabac?
□Oui ou □Non **(Si oui lesquelles)**

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c) Si non, avez- vous <u>l'intention</u> de mettre en place des activités liées au contrôle du tabac?
□Oui ou □Non **(Si oui, lesquelles)**

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31- a) Votre école a t-elle un programme en santé dentaire? □Oui ou □Non
Si oui, Quels professionnels visitent l'école? (Cochez les réponses qui s'appliquent)

□Dentiste

□Hygiéniste dentaire

□Autre (spécifier) _____

b) Les élèves reçoivent-ils de l'éducation en hygiène dentaire? □Oui ou □Non
Si oui, combien de fois par année? _____

c) Les élèves reçoivent ils d'autres services en hygiène dentaire? □Oui ou □Non
Si oui, lesquels?

_____
_____
_____
Combien de fois par année? _____

32- Combien d'incidences de blessures découlant de bagarres entre élèves ont été rapportés l'année dernière à votre école?

Encercler un choix : aucun □, 1 seul □, 2 □ ,3 □,4 □, 5 □, plus que 5 □.

En ce qui concerne les espaces réservés à la pratique de l'activité physique :

En plus du gymnase et de la cour d'école, est-ce qu'il y a d'autres espaces réservés prioritairement pour les élèves où ils peuvent pratiquer de l'activité physique, par exemple comme une palestre ou un parc-école? (*Cocher les espaces disponibles*). Est-ce qu'il y a eu des rénovations ou des améliorations importantes apportées récemment au gymnase, à la cour, et aux autres espaces s'il y a lieu? Est-ce que il y en a de planifiées?

	Présent ? (cocher si oui)	**Rénovations récentes ?**	**Rénovations planifiées ?**
Gymnase :			
Palestre :			
Cours d'école :			
Parc-école :			
Parc adjacent :			
Prêt d'équipement:**			
Autre :			

**Si prêt d'équipement, indiquer lesquels :

Nom	Nb	Condition

Courriel : _____

HEURE FIN ENTREVUE (HH:MM): _____