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Investigating socioeconomic position in dental caries and traumatic dental injury among children in Quebec

Patricia Da Rosa[1,2], Marie-Claude Rousseau[1,2,3], Anu Edasseri[1], Melanie Henderson[4] and Belinda Nicolau[1,2]

[1]Faculty of Dentistry, McGill University, Montreal, QC, Canada; [2]Epidemiology and Biostatistics Unit, INRS-Institut Armand-Frappier, University of Quebec, Laval, QC, Canada; [3] Department of Social and Preventive Medicine, Université de Montréal, INSPQ, CRCHUM, Montreal, QC, Canada; [4] Department of Pediatrics, Faculty of Medicine, Université de Montréal, Montreal, QC, Canada

Objectives: Socioeconomic position (SEP) is inversely associated with most oral health outcomes, but the patterns of association may vary depending on the specific outcome. We estimated associations between SEP and two oral health outcomes, dental caries and traumatic dental injuries (TDI), in Quebec children. ***Methods:*** We used data from the baseline visit of the QUALITY (QUebec Adipose and Lifestyle Investigation in Youth) Cohort, an ongoing study in Montreal and Quebec, Canada. The analytical sample included 590 children aged 8-10 years. Data on parents' SEP (household income, education) and children's health behaviours and involvement in sports were obtained through questionnaires and interviews. Oral health outcomes (dental caries and TDI in permanent teeth) were assessed by clinical oral exam. Negative binomial regression was used to model dental caries (DMFS index) and number of teeth with TDI adjusting for selected covariates. ***Results:*** The mean (SD) DMFS and number of TDI were 0.61 (1.43) and 0.12 (0.43), respectively. Compared to the upper quartile of income, children in the lower quartile had a DMFS approximately 3 times higher (PRR=2.68, 95% CI: 1.43, 5.04). Adjusting for oral health and nutritional behaviours had no effect. Conversely, children in the highest income quartile had a 3 times higher number of teeth with TDI compared to the lowest quartile (PRR=3.14, 95% CI: 1.22, 8.08). Physical activity did not explain this relationship. Parents' education was not associated with dental caries or TDI. Conclusion: SEP seems to play a different role in the cause of dental caries and TDI.

Key words: *Dental caries; traumatic dental injury; inequality; child; epidemiology; socioeconomic factors, Canada*

Introduction

Social inequalities in health persist in different populations and for several health outcomes (Health Canada, 2010; Mackenbach *et al*., 2008; Marmot, 2005; Marmot *et al*., 1987), and overcoming them is a major challenge worldwide. Remarkably, this evidence is similar for both less and more egalitarian societies (e.g., Nordic countries) where social services are provided and income is redistributed (Guarnizo-Herreño *et al*., 2013; Health Canada, 2010; Mackenbach *et al*., 2008).

However, the pattern of this relationship may differ over time (Dow & Rehkopf, 2010; Marmot *et al*., 1987), across populations (Cubbin & Smith, 2002; Dow & Rehkopf, 2010; Marmot *et al*., 1987), by outcome (Cubbin & Smith, 2002; Marmot *et al*., 1987) and by type of socioeconomic indicator (Cubbin & Smith, 2002; Da Rosa *et al*., 2011; Simpson *et al*., 2005). For instance, coronary heart disease mortality was greater among more advantaged social groups before the 1950's in England and Wales. This scenario dramatically changed over time, and those in the lower social strata became the most affected (Marmot *et al*., 1987). Part of the explanation relates to the discovery of the damaging effects of cigarette smoking, which in the beginning and middle of the 20th century was more common among more advantaged social groups. Interestingly, health intervention programs to tackle this behaviour switched these trends and the consumption of cigarettes became more frequent among those in low socioeconomic position (SEP) (Corsi *et al*., 2014). Indeed, health interventions targeting individual behaviour modification often have less effect among the most disadvantaged, because this subset of the population is characterized by low levels of education attainment, high levels of illiteracy and few economic resources to make healthier choices (Lorenc *et al*., 2013).

Dental caries, the most common chronic oral disease (COD) of childhood, has substantially declined in the past decades. However, this decline has not been equal among different socioeconomic groups. Data from the latest Canadian oral health survey show that the prevalence and severity of dental caries remain highly skewed towards low SEP groups (Health Canada, 2010). A similar picture is observed in both developing and developed countries (Petersen, 2005) and for other COD (e.g., periodontal disease) (Borrell & Crawford, 2012). Traumatic dental injury (TDI) is an important public health problem due to its prevalence, high treatment cost and occurrence at an early age (Glendor, 2008). The prevalence of TDI varies considerably between and within countries. According to the latest Canadian oral health report (Health Canada, 2010), the prevalence of dental trauma is 6.9% among 6-11 years old Canadian children. However, the prevalence of TDI in Quebec is unknown. Unlike dental caries (Schwendicke *et al*., 2015), the relationship between SEP and TDI,

Correspondence to: Belinda Nicolau, DDS, PhD, Division of Oral Health and Society - Faculty of Dentistry, McGill University, 2001 McGill College, Suite 527, Montréal, QC, Canada, H3A 1G1

an "acute" condition, is less clear (Bendo *et al*., 2009). While a few studies have shown that levels of SEP were positively associated with TDI (Cortes *et al*., 2001; Huang *et al*., 2009), others have reported an inverse (Damé-Teixeira *et al*., 2013; Malikaew *et al*., 2006; Marcenes & Murray, 2001) or no association (Bendo *et al*., 2010; Corrêa-Faria *et al*., 2015; Fakhruddin *et al*., 2008; Nicolau *et al*., 2003).

A better understanding of how the social determinants of oral health, including SEP, may translate into oral diseases and injuries among children is crucial to tackle oral health inequalities. To accomplish this task, one needs to consider that the relationship between indicators of SEP and health does not consistently follow the same pattern, but is subject to the country's context (e.g., social policy) (Dow & Rehkopf, 2010; Lynch & Kaplan, 2000) and may vary over time (Dow & Rehkopf, 2010). Although a systematic review investigating the relationship between SEP and TDI suggested no association (Corrêa-Faria *et al*., 2015), the review included only studies investigating TDI in primary dentition. In addition, the great variability of TDI classifications and measures of SEP among studies makes the comparison of the studies challenging. For instance, most of the studies were performed in Latin America, which may reduce the generalizability of the results to other countries because the socioeconomic environment differs between developing and developed countries (Bendo *et al*., 2009; Corrêa-Faria *et al*., 2015).

Hence, using baseline data from a cohort in Canada, one of the most egalitarian countries in terms of access to healthcare, we investigate the association between SEP and two oral health outcomes, dental caries experience and number of teeth with TDI in children. To our knowledge, only one Canadian study has investigated the relationship between SEP and TDI (Fakhruddin *et al*., 2008) and none in this age group (8- to 10-year-olds). Importantly, all Quebec children up to the age of 10 have free access to dental care. In addition, previous studies did not account for physical activity as a possible risk factor and most of them dichotomized the outcome, reducing the power to investigate the association due to loss of information. Specifically, we estimate the extent to which higher parental SEP is associated with lower prevalence of dental caries after accounting for the effects of oral health and nutritional behaviours; and the extent to which higher parental SEP is associated with higher prevalence of TDI after accounting for the effects of physical activity among 8-10-year-old children.

Methods

Study design and sample

This is a cross-sectional analysis of baseline data from an ongoing longitudinal cohort study, the Quebec Adipose and Lifestyle Investigation in Youth (QUALITY). The methods and data collection procedures of this cohort study, which investigates the natural history of obesity and its metabolic/vascular consequences in Quebec children, have been published previously (Lambert *et al*., 2012). Briefly, this longitudinal study used a school-based sampling strategy and included Caucasian children aged 8-10 years at baseline for whom both parents attended the first study visit. Eligible children were those at risk of obesity, defined as having at least one obese biological parent (i.e., a body mass index (BMI) ≥30 kg/m^2 or abdominal waist circumference ≥88 cm for women or ≥102 cm for men). A total of 634 families were included. Baseline data collection was carried out between 2005 and 2008. The analytical sample included 569 and 590 children from whom information on oral health, SEP and behaviour data were available for dental caries and TDI, respectively.

The study was approved by the Research Ethics Committees of all participating institutions and an informed consent was provided by all children and their parents.

Study variables

Data were collected at the clinical research unit at Sainte-Justine Hospital in Montreal and Laval Hospital in Quebec City. Children were clinically examined and face-to-face interviews collected information on lifestyle and health-related behaviours (e.g., frequency of tooth brushing, participation in sports). Telephone interviews with both children and parents assessed children's dietary behaviour. Parents also completed a self-administered questionnaire, which covered information on indicators of SEP and their children's oral health behaviour.

Indicators of SEP

Information on SEP, based on two indicators, household income and education level, was provided by both parents. Parents reported the annual household income before taxes by choosing one of the 12 categories ranging from CAN$ <10,000 to 140,000 or more. This information was transformed into a new variable to account for the number of people living in the house. The midpoint of each household income category was divided by the square root of the number of people living in the house. For the lowest and highest categories, CAN$ 5,000 and CAN$ 150,000 was assumed as the midpoint, respectively. This variable was then categorized using quartiles of the overall distribution: CAN$: (i) < $ 28,000, (ii) $ 28,000-$ 41,000, (iii) $ 41,001-$ 55,000 (iv) > $ 55,000.

Information on parental education level was assessed through a 7-category question further recoded into a 3-category variable: (i) Both parents with high school degree or less, (ii) 1 or both parents with at most a technical, vocational/trade school degree and (iii) 1 or both parents with a university degree.

Child's oral health outcomes

All children were clinically examined by a licensed, trained and calibrated dental research team using a dental chair, plane mouth mirror and artificial light without radiography, fiber-optic trans illumination, or compressed air. We used the UK Children Dental Health Survey diagnostic criteria to measure dental caries (Pendry *et al*., 2004). These criteria included enamel and non-cavitated lesions assessed visually. The dental caries experience was computed as the total number of decayed (D), missing (M) and filled (F) surfaces (DMF-S index).

The clinical assessment of TDI included only upper and lower permanent incisors. Using the UK Children

Dental Health Survey diagnostic criteria (Pendry *et al*., 2004), fractures, discolorations, missing teeth due to TDI, as well as treated and untreated injuries were considered to determine the presence or absence of TDI. The total number of teeth with TDI was calculated by counting the number of permanent incisors with any TDI.

Child's oral health behaviour and physical activity

Children's oral health behaviour was assessed by a questionnaire and included information regarding oral hygiene (frequency of tooth brushing), use of dental care services (time since last visit to the dentist) and nutritional behaviour (daily number of snacks and amount of sugary drinks consumed).

Self-reported frequency of tooth brushing was recorded in 4 categories. However, since fewer than 5% of the children reported brushing less than once per day, a 3-category variable was created: once or less a day; twice a day; and three times a day or more. The time since last visit to the dentist, reported by both parents, was recorded in 4 categories but collapsed into 3: less than 6 months; more than 6 months but less than a year and more than a year. Nutritional behaviour was assessed through three 24-h dietary recalls conducted over the telephone by a dietician, first with the child, then confirmed with the parent who prepared the meals to measure the daily amount (in ml) of sugary drinks and number of snacks consumed. Both variables were grouped into tertiles based on their distributions: daily amount of high-sugar drinks (low- 0 ml; medium- 0.1-134 ml; and high- ≥134 ml), and number of snacks per day (low- 0-3 snacks; medium- 4-5 snacks; and high- 6 or more).

Physical activity was measured as participation in sports in the previous year. The total number of sports teams that the child belonged to or took lessons, both at school and outside were counted. The variable "participation in sports activities" was grouped into 4 categories: no participation in any sports teams; one sports team inside or outside the school; two sports teams inside or outside the school; three or more sports teams inside or outside the school.

Statistical analysis

As a preliminary step, descriptive and bivariate analyses were performed. Because income and education are usually highly correlated, that correlation was investigated using Spearman's rank order correlation coefficient (Munro, 2004). The distributions of DMFS and TDI were highly skewed (with a high number of zeros) and over dispersed. In addition, each carious lesion or trauma in a child were dependent of each other. Consequently, a negative binomial (rather than Poisson) regression was used to model DMFS and TDI (Solinas *et al*., 2009).

To reflect our research questions, we built our models in steps as shown in Figure 1. First, we included the variables representing indicators of SEP. Subsequently, we wanted to test the change in effect of indicators of SEP when accounting for behaviour variables (e.g., brushing, snacking, visiting dentists for dental caries models and sport participation for the TDI). Our choices of covariates were based on prior knowledge. Model 1 was similar for both dental caries experience and number of teeth with TDI outcomes. It included household income and parental education adjusted for the child's demographic characteristics (age, sex).

For the association between SEP and dental caries experience, Model 2, we included all variables from Model 1 and oral health behaviour variables (frequency of tooth brushing, time since last visit to the dentist). Similarly, Model 3 included all variables from Model 2 and the nutritional behaviour variables (daily amount of sugary drinks and number of snacks). For the association between SEP and number of teeth with TDI, Model 2, apart from all the variables from Model 1, included participation in sports activities. Effect modification between SEP variables and sex was tested because sports requiring expensive equipment may differ by sex, they may carry different levels of risk, and thus present differing associations by sex. Data were analysed with Stata/SE version 12 (Stata Corp LP, College Station, Texas, USA).

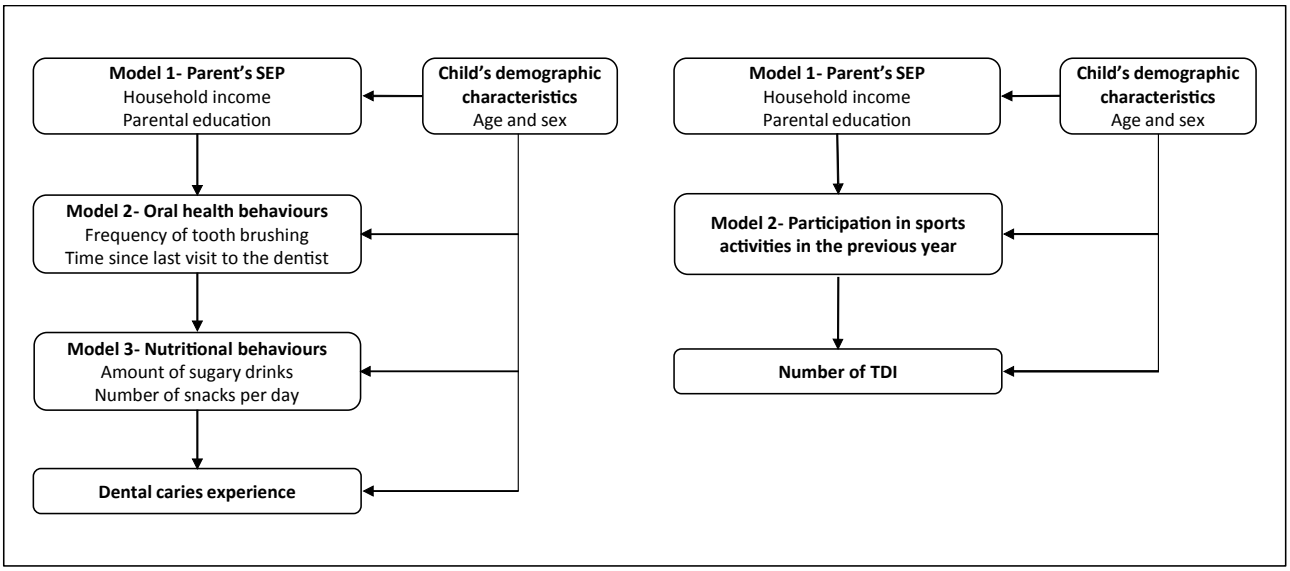

Figure 1. *Analysis model used in the study.*

Results

Among 630 families recruited for the baseline of the QUALITY Cohort, oral health data were available for 94.8% (597 children). Seven children were further excluded from the analysis: 1 child had an unexpectedly high number of cavities and parents' SEP was not available for 6 children. Moreover, we excluded a further 21 participants (3.5% of the sample) because missing values were present in some of the covariates. Thus, our final sample included 569 and 590 participants for the analyses related to dental caries experience and number of teeth with TDI, respectively.

Parents' SEP and children's health behaviours and individual characteristics for the 322 boys and 268 girls included in the analyses are shown in Table 1. The mean age was 9 years. The distribution of household income reflects the categorization by quartile, 54% of the families included at least one parent with a university degree. More than 50% reported good compliance with preventive oral health behaviour. Nutritional behaviour differed by sex; girls ate more snacks per day ($p < 0.01$) than boys.

Table 1. Frequency distribution of individual and familial characteristics among QUALITY study participants at baseline visit in 2005-2008 (N=590)

	Total n (%)
Age, Mean (SD)	9.11 (0.9)
Gender, boys	322 (54.6)
Household income	
< $ 28,000	148 (25.1)
$ 28,000 - $ 41,000	154 (26.1)
$ 41,001 - $ 55,000	154 (26.1)
> $ 55,000	134 (22.7)
Parental education	
Both parents with high school degree or less	48 (8.1)
1 or both parents with technical, vocational/ trade school degree	226 (38.3)
1 or both parents with university degree	316 (53.6)
Frequency of tooth brushing	
Once or less a day	142 (24.1)
Twice a day	333 (56.5)
Three times a day or more	114 (19.4)
Missing	1
Time since last visit to the dentist	
Less than 6 months	457 (77.7)
More than 6 months but less than a year	109 (18.5)
More than a year	22 (3.7)
Missing	2
Amount of sugary drinks (ml)/day	
Low (0 ml)	201 (35.1)
Medium (0.1 to 133 ml)	182 (31.8)
High (134 ml or more)	189 (33.0)
Missing	18
Number of snacks per day	
Low (0 to 3 snacks)	155 (27.1)
Medium (4 to 5 snacks)	203 (35.5)
High (6 or more)	214 (37.4)
Missing	18
Participation in sports activities in the previous year	
No participation	61 (10.3)
One team inside or outside school	163 (27.6)
Two teams inside or outside school	181 (30.7)
Three or more teams	185 (31.4)

At baseline, 24% of children had at least one carious lesion on permanent teeth and 8.8% had at least one TDI on permanent incisors. The mean (SD) of DMFS and TDI were 0.61 (1.43) and 0.12 (0.43) respectively. Both outcomes were higher among boys ($p=0.004$ and $p=0.40$, respectively), although not statistically significant at the 5% level in the case of TDI. The most common type of injury was enamel fracture (63.5%); forty-two percent of the TDI were caused by sports, physical activity, falls and collision.

Prevalence rate ratios (PRR) and 95% confidence intervals (CI) from negative binomial regression models of the associations between SEP and dental caries experience are presented in Table 2. Household income and parental education were moderately correlated ($r = 0.40$), and thus these variables were both included in the models as the likelihood of multicollinearity was low (Pagano & Gauvreau, 2000). In all three models, household income was associated with dental caries experience. Greater caries prevalence was observed in lower income levels. The prevalence was highest among children in the lowest quartile of household income (PRR=2.68, 95% CI: 1.43, 5.04) compared to those in the highest income category, after adjusting for sex and age. A gradient with an increasing prevalence from the highest to lowest quartile of household income was also observed. Although a tendency was also seen with parental education level, no statistically significant association was observed. Adding oral health and nutritional behaviours to the regression models had little effect on the PRRs for SEP variables.

Associations between SEP and number of teeth with TDI are presented in Table 3. The first model included both SEP variables, age, and sex, while participation in sports activities was added in the second model. A pattern of increasing TDI risk with increasing household income was observed in both models. Children in the highest quartile were likely to have about 3 times more teeth with TDI (PRR=3.14, 95% CI: 1.22, 8.08) than the lowest quartile of household income. Parental education level was not associated with the number of teeth with TDI. Adjusting for participation in sports activities had little effect on the PRRs for SEP variables.

A comparison between binary regression and negative binomial regression was carried out. Although the results were similar, we chose count over binary data to avoid loss of information and consequently loss of power to detect a possible association between both oral health outcomes and SEP. Effect measure modification (EMM) between SEP variables and sex was tested by including interaction terms. However, no significant EMM were found on a multiplicative scale for both DMFS and TDI outcomes.

Discussion

Using baseline data from a cohort study in Quebec, Canada, we observed an association between household income and children's oral health. However, while the prevalence of dental caries was significantly higher among children from low income families, children from high income families were more likely to experience TDI than those from low income families. Interestingly, none of the outcomes were associated with parental education level. Moreover, our modelling strategy shows that the effect of SEP on the oral health outcomes does not seem to be affected by behavioural factors.

Table 2. Associations between parents' SEP and dental caries experience in Quebec children participating in the QUALITY Cohort study at baseline visit in 2005-2008 (N=569)

	DMFS[1] *Mean(SD)*	*Model 1 PRR 95% CI*	*Model 2 PRR 95% CI*	*Model 3 PRR 95% CI*
Household income				
< $ 28,000	0.99 (1.87)	2.68 (1.43-5.04)	2.63 (1.39-4.97)	2.89 (1.52-5.48)
$ 28,000 - $ 41,000	0.55 (1.15)	1.65 (0.89-3.09)	1.54 (0.82-2.89)	1.58 (0.84-2.98)
$ 41,001 - $ 55,000	0.45 (1.21)	1.55 (0.83-2.89)	1.45 (0.78-2.71)	1.44 (0.77-2.69)
> $ 55,000	0.32 (0.82)	1.00	1.00	1.00
Parental education				
Both with high school degree or less	0.90 (1.50)	1.40 (0.62-3.18)	1.39 (0.62-3.13)	1.37 (0.61-3.09)
1 or both with technical, vocational/ trade school degree	0.69 (1.49)	1.18 (0.75-1.86)	1.27 (0.79-2.02)	1.31 (0.81-2.11)
1 or both with a university degree	0.46 (1.19)	1.00	1.00	1.00
Frequency of tooth brushing				
Once or less a day	0.78 (1.56)		2.15 (1.09-4.22)	1.92 (0.97-3.82)
Twice a day	0.59 (1.34)		2.23 (1.21-4.11)	2.05 (1.11-3.79)
Three times a day or more	0.31 (0.94)		1.00	1.00
Time since last visit to the dentist				
Less than 6 months	0.54 (1.25)		1.00	1.00
Less than 1 year	0.77 (1.70)		1.16 (0.68-1.98)	1.10 (0.64-1.89)
More than 1 year	0.59 (1.14)		0.85 (0.30-2.45)	0.89 (0.31-2.56)
Amount of sugary drinks (ml)/day				
Low (0 ml)	0.55 (1.35)			1.00
Medium (0.1 to 133 ml)	0.55 (1.24)			0.85 (0.50-1.43)
High (134 ml or more)	0.64 (1.42)			0.99 (0.59-1.66)
Number of snacks per day				
Low (0 to 3 snacks)	0.55 (1.47)			1.00
Medium (4 to 5 snacks)	0.50 (1.09)			1.22 (0.70-2.11)
High (6 or more)	0.68 (1.45)			1.66 (0.96-2.88)

*All models adjusted for sex and age. Model 1-Parents' SEP; Model 2-model 1+oral health behaviours; Model 3-model 2+ nutritional behaviours. [1]Decayed Missing Filled Surfaces index.

Table 3. Associations between parents' SEP and number of teeth with TDI in Quebec children participating in the QUALITY Cohort study at baseline visit in 2005-2008 (N=590)

	TDI Mean (SD)	*Model 1 PRR 95% CI*	*Model 2 PRR 95% CI*
Household income			
< $ 28,000	0.07 (0.31)	1.00	1.00
$ 28,000 - $ 41,000	0.05 (0.25)	0.69 (0.24-1.99)	0.70 (0.24-2.02)
$ 41,001 - $ 55,000	0.18 (0.56)	2.39 (0.97-5.88)	2.49 (1.00-6.18)
> $ 55,000	0.20 (0.52)	3.14 (1.22-8.08)	3.28 (1.26-8.51)
Parental education			
Both parents held a high school degree or less	0.06 (0.24)	1.00	1.00
1 or both with technical, vocational/trade school degree	0.12 (0.45)	1.80 (0.43-7.54)	1.80 (0.43-7.60)
1 or both held a university degree	0.13 (0.44)	1.25 (0.29-5.33)	1.28 (0.30-5.50)
Participation in sports activities in the previous year			
No participation in any teams	0.13 (0.43)		1.00
One team inside or outside school	0.13 (0.47)		1.16 (0.40-3.36)
Two teams inside or outside school	0.12 (0.40)		1.14 (0.39-3.31)
Three or more teams inside or outside school	0.11 (0.43)		0.88 (0.30-2.57)

*All models adjusted for sex and age. Model 1-Parents' SEP; Model 2-model 1+ Participation in sports activities

Our findings support the argument that the relationship between SEP and oral health differs according to both the outcome being analyzed and the indicator of SEP being used, raising the question of how income may impact the occurrence of each outcome. The different directions of association observed between income and two oral health outcomes, as well as the absence of association between parental education and both outcomes, suggest that dental caries and TDI are differentially related to these two dimensions of SEP. While both outcomes are influenced by exposures over the individual's life span (Nicolau *et al*., 2007), dental caries is a chronic disease and thus its development is influenced by genetics, biological, and environmental factors, whereas TDI is an acute condition resulting mostly from social and physical exposures.

Although the enduring association between SEP and health is widely recognized (Fakhruddin *et al*., 2008; Guarnizo-Herreño *et al*., 2013; Marmot, 2005), the reasons for this relationship are unclear. Health behaviours could provide an explanation, as compromising or enhancing behaviours

may damage or protect an individual's health (Black *et al*., 1982). However, in our study, including oral health and nutritional behaviours in the model did not change the magnitude of association between income and dental caries experience. Thus, in agreement with previous studies (Polk *et al*., 2010; Sanders *et al*., 2006), our findings do not support the behavioural explanation of the social differences in oral health. As a chronic disease, the aetiology of dental caries involves several contributing factors (e.g., lifestyle factors, psychological, social, and behavioural). SEP is a complex construct that encompasses several of these underlying factors. Although SEP is consistently associated with several chronic diseases including dental caries, disentangling these associations is complex. Arguably, associations between SEP and dental caries may reflect a combination of a complex set of demographic, social and lifestyle factors along the children's life course. For example, early life experiences/exposures (e.g., nutrition, stress), which are linked to SEP, may affect the susceptibility to chronic disease later. Therefore, the associations between SEP and dental caries observed in our study may not be strongly related to behaviour.

A higher education level has previously been associated with better health (Da Rosa *et al*., 2011; Mackenbach *et al*., 2008; Polk *et al*., 2010). The absence of an association between parents' education and children's oral health in our study may reflect the fact that most families were highly educated. Thus, educational differences were limited, which highlights the importance of considering more than one measure of SEP.

The positive association between household income and number of teeth with TDI found in our study may reflect the distal effect of social and physical factors on dental injury. Controlling for physical activity, measured by increased participation in sports, did not significantly affect this association. This adjustment for measures of physical activity is a strength of our study. Although we did not have data on the use of protective sports equipment, intensity or type of sports performed by the child (e.g., soccer, basketball), we could not identify many studies that took this variable into consideration in their analysis.

Our results may reflect the role of income in terms of material resources and buying power. Children from wealthier families may have more opportunities to practice hazardous recreational or outdoor activities that require expensive fees or ownership of sports equipment (e.g., hockey). This may contribute to a greater risk for TDI among children from wealthier families. Participation in sports has been shown to be low among socioeconomically disadvantaged children (Johnston *et al*., 2007), and children from high SES families report greater participation in sports lessons or classes than low SES students (Sallis *et al*., 1996). Moreover, our results concur with other studies (Cortes *et al*., 2001; Huang *et al*., 2009). Canadian adolescents from higher SEP families were more likely to experience non-fatal injuries related to sports, while injuries related to violence and fights were more common among the poor (Simpson *et al*., 2005). Similarly, a review concluded that serious and fatal injuries were more likely to occur among those in low SEP, while non-fatal injuries were more likely to occur among high SEP individuals, suggesting that such injuries may reflect a greater exposure to recreational activities (Cubbin & Smith, 2002). Hence, as injuries are caused by external factors, both physical and social environments, including SEP, need to be considered in relation to TDI risk. Thus, as a complex and multifactorial relationship, the lack of better measures of SEP may explain the conflicting results on the association between SEP and TDI reported in the literature (Bendo *et al*., 2009; Damé-Teixeira *et al*., 2013).

From a methodological point of view, our results should be interpreted with caution. This cross-sectional analysis can only explore associations, not infer causality. Another limitation is the lack of assessment of intra- and inter-rater agreement. Although examiners received training and followed a clinical protocol, the dentists did not examine the same children, preventing calculation of the reliability of oral health outcomes during the main study. However, all examiners were trained and calibrated before data collection. Intra- and inter-rater reliability measures were performed and overall agreement for dental caries and dental trauma were above 85%. Moreover, our sample comes from a specific population (children at risk of obesity), is mainly from a higher SEP (more aware of health), and has free access to dental care. Although this may represent a limitation in terms of generalizability, it does not affect the validity of associations observed in the study. Indeed, the main concern in cohort studies is the internal validity, that is, the ability to make inferences regarding cause-effect. Compared to the results from the latest Canadian dental survey (Health Canada, 2010), dental caries experience was lower among our sample (24% vs 56.8%) and TDI prevalence was also slightly lower (6.9% vs 8.8%). Despite these low disease levels, it was still possible to identify a significant association between income and two outcomes that are very different from an etiological point of view. Hence, although our study may not be generalizable to the population at large, the findings may suggest hypotheses on how income may impact the occurrence of each outcome (dental caries and TDI). Alternative approaches, such as studying life course and intergenerational effects in oral health may help us to better understand the mechanisms underlying the social differences in oral health (Nicolau & Marcenes, 2012; Nicolau *et al*., 2007). Furthermore, as this study was observational, confounding could be present due to other unmeasured variables. For instance, group level variables such as neighborhood characteristics may have an independent effect on individual oral health, in addition to individual level risk factors. It has been shown that individuals living in neighborhoods with poor access to healthy foods are more likely to have dental caries (Tellez, 2006), whereas individuals from deprived and overcrowded areas had a much higher prevalence of TDI than those living in the area overall (Marcenes & Murray, 2001). Therefore, future research including environmental factors such as neighborhood characteristics could be conducted to comprehensively assess the role of SEP in oral disease and injuries.

Conclusion

Our study makes a unique scientific contribution to the body of evidence on the relationship between SEP and two oral health outcomes with very different aetiology, as it evaluated dental caries and TDI in permanent dentition of 8-10-year-old children from a developed country with free access to dental care. Although this study uses a unique population from a relatively egalitarian society, social inequalities in oral health were still observed. Thus, there is a need for more in-depth investigation of the mechanisms that could explain this association.

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