



COVID-19-Related School Closures and Caries Risk in Canadian Children

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ABSTRACT

Introduction: The first wave of the COVID-19 pandemic resulted in the closure of schools and workplaces. The potential impact of these closures on the oral health of Canadian schoolchildren has not been fully understood.

Objective: To investigate impact of the COVID-19 pandemic-related school closures on the oral health of Canadian schoolchildren.

Methods: Parents (219) of 243 children completed an online questionnaire that combined demographic information, the World Health Organization's oral health questionnaire (parent-proxy) and sleeping patterns of the child. The Wilcoxon signed-rank test was used to compare parental responses before and after the closures from March to June 2020.

Results: We found a significant increase in the consumption of cariogenic food, especially candy ($p = 0.001$), snacks ($p < 0.001$) and aerated beverages ($p = 0.005$) by children during the pandemic-linked school closures. A significant increase also occurred in irregular sleep habits and delayed bedtimes. The increase in consumption of cariogenic foods was greater in older children ($p < 0.001$) and greater in households with more children ($p = 0.001$).

Conclusion: The results of this study indicate that the COVID-19 pandemic has had an adverse effect on diet and the oral health practices of Canadian children when they were not in school.

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Dental caries is a multifactorial disease that is among the most common chronic diseases of childhood. Dental caries results from the interaction of diet, bacteria, poor oral hygiene and a series of environmental and social determinants of dental health.¹ Although it is difficult to attribute a single causative factor to dental caries, COVID-19-related school closures may have had an impact on the parameters affecting caries risk in Canadian children.

Statistics Canada² reported that approximately 5.7 million children and youth, who attend primary or secondary school, have been impacted academically, mentally, socio-economically and physically by COVID-19-related school closures. Soon after the onset of the COVID-19 pandemic in March 2020, schools across Canada closed and switched to an online learning model (**Table 1**). Schools often allow for the development of consistent routines embedding discipline and structure, including a regular bedtime and diet routine, which is often disrupted by a change in school schedules.⁴

Diet and sleep both affect a child's overall caries risk. An important risk for dental caries is the intake of dietary sugars.⁵ Several studies have shown that consuming foods and drinks high in sugars, such as carbonated drinks, candy, chips and cookies, increases the risk of caries in children.⁶ Oral bacteria, such as *Streptococcus mutans*, metabolize the fermenting carbohydrates and produce organic acids. If enough organic acids are produced, they can penetrate the pores of enamel, eventually demineralizing enamel and dentin producing dentinal caries.⁷ However, a good diet and the consumption of certain food groups have been shown to reduce the risk of caries.⁸ Similarly, dental caries risk is also reduced by the enforcement of oral hygiene practices, such as brushing twice daily and flossing.^{9,10}

Sleep patterns can influence the incidence of dental caries, with studies reporting an increased caries risk in children who sleep less and those who sleep at later hours.¹¹⁻¹⁵ The lack of sleep results in low salivary flow and a low secretion rate of immunoglobins. Low salivary flow limits the antibacterial, lubricating and buffering functions of saliva, ultimately decreasing natural defense mechanisms against dental caries.¹⁶

The effects of school closures on behaviours affecting caries risk in children have not yet been elucidated. The COVID-19 pandemic resulted in extended periods of school closure across all provinces in Canada to varying extents (**Table 1**). In this study, we aimed to evaluate the influence of closures between March and June 2020 on behaviours affecting caries risk, including oral hygiene practices, dietary changes and changes in sleep schedules for Canadian children during the first wave of the COVID-19 pandemic.

Materials and Methods

A questionnaire was developed to assess demographic information, sleeping patterns of the child and oral health status of the child including assessment of cariogenic food intake. Oral health status was assessed via the previously validated World Health Organization (WHO) Oral Health Questionnaire (parent-proxy).¹⁷ The sleep, and oral health (practices and diet) components of the questionnaire recorded 2 sets of responses: 1 for the child's sleep and diet pattern before the school closures and 1 for the pattern during the closures. The survey was distributed once in each Facebook group between June and August 2020. This allowed for at least 4 months of school closures to have elapsed, which is an adequate time for children to acquire new habits representative of behaviours during the pandemic.⁴

Using an effect size of 0.3 for a population of 6 million Canadian children between the ages of 0 and 14 years,¹⁸ the targeted sample size for a power of 0.95 was 300. The actual power for the sample ($n = 244$) with an effect size of 0.3 was 0.942. Between March 2020 and June 2020, only 209 survey responses out of 244 were recorded, giving a post-hoc sample power of 0.921. The questionnaire was digitalized using the Qualtrics online survey platform hosted by Western University (Qualtrics, Prov, Utah, USA) and the form was administered online.

Questionnaires were distributed by personalized emails sent through parent support groups, as well as Canadian social media parenting groups. To avoid selection bias, we conducted a standardized search of Facebook for parenting groups (**Appendix A**), and all groups that consented to having the questionnaires posted on their page were included. IP addresses were used to verify geographic location, and only responses from within Canada were considered. The questionnaire responses were downloaded to MS Excel (Microsoft Corp., Palo Alto, Calif., USA). The coded variables were analyzed using SPSS v. 25. The independent t-test was used to compare age differences between males and females. The Wilcoxon signed-rank test was used to compare parental perceptions of their child's oral health, sleep and dietary habits before and after the pandemic.

Ethical approval was obtained through the Health Sciences Research Ethics Board of Western University (ID 116207). Informed consent was sought from parents before collection of data.

Results

The sample comprised 219 parents/guardians (203 mothers or female guardians and 16 fathers or male guardians) of 243 children.

Each respondent identified as the primary caregiver of the child. The sample included respondents from 88 towns and cities in 9 provinces across Canada. The respondent filled a separate form for each child. Of 292 online requests that were opened, 243 were submitted for response rate of 83.2%. Parents had the option of not answering a question, and blank responses were not included in the statistical analyses. Of the children, 117 were male and 123 female, 1 was identified as non-binary by the parent and 2 respondents preferred not to disclose the gender of their child. The children were aged 3–14 years (mean 8.24 years, standard deviation [SD] ± 4.9 years). Although boys (mean 8.73 years, SD ± 4.8 years) were slightly older than girls (mean 7.73 years, SD ± 3.9 years), the difference was not statistically significant ($t = 1.762, p = 0.079$).

When children were away from school, more went to bed later and woke up later, although this change was not significant among children < 5 years of age or those > 12 years. For children in the 6–12-year age group, significantly more parents reported an increase in the total number of hours spent in bed (Table 2). Furthermore, a significant increase occurred in the number of children taking naps among both the 6–12-year and the > 12 year age groups, who had not previously done so before the pandemic (Table 2).

Parents perceived a worsening in their children’s tooth health ($p < 0.001$) and gum health ($p < 0.001$). Furthermore, they also noted a significant decrease in the frequency of brushing ($p < 0.001$) (Table 3).

Based on the dietary component of the questionnaire, parents perceived a significant increase in the consumption of cariogenic food during school shutdown compared with before the pandemic. Specifically, there was increased consumption of sweets and candy ($p < 0.005$), biscuits, cakes, cream cakes, sweet pies, buns ($p < 0.001$) and lemonade and other soft drinks ($p < 0.001$) (Table 4).

A regression model was developed with the increase in consumption of cariogenic foods as the dependent variable and the impact of age, gender, number of children in a household and income of the family as factors. No significant association was found between increased consumption of cariogenic foods and either gender ($p = 0.993$) or total family income ($p = 0.576$). However, there was a significant positive association with age ($p < 0.001$), suggesting that increases in cariogenic food consumption during the shutdown were greater in older children than younger children. Households with more children also saw greater increases in the consumption of cariogenic foods ($p = 0.001$) (Table 5).

Table 1: School closures across the regions surveyed in this study.

Province*	Nº. responses (n = 243)	Start of school closure	End of lockdown
British Columbia	37	17 Mar. 2020	On 1 June, schools in B.C. reopened in some way. Children in all grades returned to class on a part-time, voluntary basis.
Alberta	72	15 Mar. 2020	Online learning until end of school year (June).
Manitoba	3	23 Mar. 2020	Online learning until end of school year (June) for some children. Limited use of school facilities started on 1 June 2020 with restoring safe services: phase 2. Teachers and some students were back in schools, for specific programing, planning and student assessment purposes, while practising physical distancing.
Saskatchewan	11	20 Mar. 2020	Online learning until end of school year (June).
Ontario	76	14 Mar. 2020	Online learning until end of school year (June).
Quebec	26	16 Mar. 2020	Elementary schools outside the greater Montréal area opened on 11 May 2020. Montréal schools remained closed for the rest of the school year.
Nova Scotia	2	23 Mar. 2020	Online learning until end of school year (June).
New Brunswick	15	16 Mar. 2020	Online learning until end of school year (June).
Newfoundland	0	16 Mar. 2020	Online learning until end of school year (June).
Prince Edward Island	1	23 Mar. 2020	Partial reopening on 11 May 2020 for some students who receive individualized support from educational assistants and youth service workers.

Source: CBCKids News.³

*The study received no responses from the territories.

Table 2: Impact of school closures on sleep patterns.

Age cohort	Sleep characteristic	N°. responses (n = 243)			p*
		More before COVID	No change	More during the school shutdown	
0–5 years	Total hours of sleep	21	61	17	0.127
	Irregular sleeping/naps	3	82	21	0.175
6–12 years	Total hours of sleep	16	44	36	< 0.001†
	Irregular sleeping/naps	0	10	85	< 0.001†
> 12 years	Total hours of sleep	16	8	11	0.546
	Irregular sleeping/naps	0	7	28	< 0.001†

*Calculated using the Wilcoxon signed-rank test.
†Difference significant.

Table 3: Parental perception of their children’s oral health.

Perception of Oral Health	N°. responses (n = 243)			p*
	Better before COVID	No change	Better during the school shutdown	
Health of your child’s teeth	38	137	4	< 0.001†
Frequency of child’s brushing	38	134	11	< 0.001†
Health of your child’s gum	23	151	2	< 0.001†
Frequency of toothaches or discomfort	14	143	19	0.627
No. dental visits in the past year	97	36	28	< 0.001†

*Calculated using the Wilcoxon signed-rank test.
†Difference significant.

Table 4: Pattern of consumption of various foods and drink before and during the school shutdown.

Food type	N°. responses (n = 243)			p*
	More before COVID	No change	More during the school shutdown	
Fresh fruit	18	138	24	0.249
Biscuits, cakes, cream cakes, sweet pies, buns, etc.	18	29	133	< 0.001†
Lemonade, Coca Cola, other soft drinks	12	134	34	0.001†
Jam/honey	16	143	20	0.812
Chewing gum containing sugar	10	161	9	0.608
Sweets/candy	20	117	42	0.005†
Milk with sugar	11	157	12	0.353
Tea with sugar	5	172	3	0.429
Coffee with sugar	3	169	3	0.708

*Calculated using the Wilcoxon signed-rank test.
†Difference significant.

Table 5: Impact of age, gender, number of children in the home and income on increased frequency of consumption of cariogenic foods ($n = 243$).

Model		Unstandardized coefficients		Standardized coefficients	<i>f</i>	<i>p</i> *
		<i>B</i>	<i>SE</i>	Beta		
1	(Constant)	47.903	1.699		28.196	0.000
	Gender	-0.005	0.603	-0.001	0.008	0.993
	Age	0.507	0.075	0.449	-6.730	< 0.001*
	Number of children in the house	1.355	0.416	0.219	-3.260	0.001*
	Combined household income	-0.119	0.213	0.036	-0.561	0.576

Note: SE = standard error of B.
*Significant impact.

Discussion

This study examined the impact of pandemic-related school closures on certain factors affecting caries risk and oral health, namely diet, sleep and oral hygiene practices. The goal was to ascertain whether there had been a shift in the patterns of these 3 parameters during the period when children were not physically in school. Several self-reporting tools have been used to assess self- or parent-reported oral hygiene and diet practices, but our decision to use the WHO Oral Health Questionnaire (parent-proxy)¹⁷ was based on the fact that the tool has been used historically to provide a reliable baseline for oral health care programs around the world.

A significant number of parents and caregivers reported an increase in consumption of cariogenic food and a reduction in good oral practices, such as brushing, since the beginning of the school closures (Table 3). This is a matter of concern, as diet and oral hygiene are perhaps the most significant factors contributing to good oral health among children.¹⁰⁻¹² The significantly positive association between age and consumption of cariogenic foods suggests that the order of routine imposed by school timings has a greater impact on older children. The findings of the study also seem to suggest that these increases were greater in larger households. This is in keeping with previous studies that show that parental supervision of eating habits is less likely in larger families.^{8,11}

Parents also reported that they perceived their children's oral health as worse during the pandemic-related shutdown. However, it is important to remember that increased parental awareness of oral health problems need not mean an increase in oral disease, but

instead that parents had more time to reflect on their children's oral health. Although self-reports play a vital role in health services research, the importance of parent-proxy reports cannot be underestimated in pediatric studies.¹⁹ Research has shown that parents accurately report foods and beverages that their children have consumed.²⁰

Another factor of interest was the report of irregular sleep patterns, delayed bedtimes and "nap" habits, especially among older children. Adolescents who stay up late and develop irregular sleep patterns tend to develop higher risk for dental caries.^{13,16} Although the findings of the current study include limitations of parental reporting, this finding should be of concern as a risk factor for dental caries.¹¹⁻¹⁴

The results of our study are in keeping with recent behavioural science literature that has shown significant increases in negative behaviour among children experiencing school closures and lockdowns.^{21,22} However, some parents also reported improvement or no changes in dietary and oral health outcomes since the beginning of the lockdown. Behaviours need time to develop; at the time of distribution of this survey, schools had been closed 4 months, which is adequate time for children to acquire new habits representative of behaviours during the pandemic.⁴

In terms of limitations, our study was not able to obtain a significant sample from Atlantic Canada. This is important, as Atlantic Canada has had a different COVID-19 pattern, compared with the rest of Canada. Furthermore, because of the lockdown, the study could only be conducted virtually, limiting questionnaire distribution to social media and email. Not all Canadian households have Internet or are

active on social media; active social media users may overrepresent socio-economic, race or geographic clusters. The study also focused on the first wave of the pandemic; since then, schools have reopened and closed to varying degrees in different provinces across Canada.

Another important limitation is that the results are based on parental perceptions of changes rather than direct measures. In addition, although most schooling in the first wave of shutdowns was asynchronous, during the second wave, schooling in many provinces moved to a synchronous model with regular online school hours. The effect of this schedule change on children's oral health behaviours was beyond the scope of the current study, but could be the topic of future research.

Finally, social isolation, employment instability and stress related to the pandemic have affected families worldwide. People have reported changes in their mental health along with increased stressors and emotions. Some have even reported changes in their interactions with children during the pandemic. Pandemic-related

changes in parenting styles may have played a role in changes in their children's oral hygiene and dietary behaviours.²³ However, considering all these variables was beyond the scope of our study.

Future work could also involve comparing the results from this study with future clinical findings. If the habitual changes during the pandemic were meaningful, clinicians should see an increase in caries in the near future. This can be useful in adding and refining guidelines to the anticipatory guidance and managing of oral health care in children should pandemic lockdowns occur again.

Conclusion

Despite the limitations, the results of this study suggest that the COVID-19 pandemic has had an adverse effect on diet and the oral health practices of Canadian children when they are not physically in school.

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Appendix A: Facebook Groups Contacted

Mom Life
The Mom Squad
Working Moms Supports Group
Simple Families
Mommies and Nannies Canada
Toronto Parents group
Ontario Families for public Education
Nova Scotia Families for Public Education
Alberta Parent Network
Coronavirus Parents: Parenting in a Pandemic
Parents Empowering Parents Society
Parents Of Canada
Nova Scotia Mom's Community
Connecting with Kids these Days
Parenting Under Quarantine
Albertans for Special Supports....
Moms & Dads of Richmond Hill
Peel Parents Resource — Brampton, Mississauga, Caledon — Activities, Events
Parenting Under Quarantine
Parents of London ON (POLO)
Etobicoke Moms
Mothers Village YJK
Greenwood Park Mommies
Kingston, ON Parents
VancouverMom.ca — Community of Vancouver Parents
Toronto Moms
Moms Connect Surrey
Parents of Global Community Canada
Mom 2 Mom Parenting Advice Canada
Moms of Windermere
Strathcona County Moms Community
Edmonton Moms Community Group
Parenting under Quarantine
Moms in Canada