Dental Caries Experience in Elementary School Students in Quebec: Surveillance Study Using ICDAS II

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Published July 21, 2020

Abstract

Objectives: The main objective of a 2012–2013 clinical study on the oral health of Quebec elementary school students was to assess the oral health status of Grade 2 and Grade 6 students. We assessed various stages of caries and created caries indicators for primary and permanent dentitions combined.

Methods: Oral health examination of 2875 Grade 2 students and 2788 Grade 6 students, enrolled in public and private, French- and English-language schools, was carried out at schools. The examinations were performed by 16 trained and calibrated dentists using International Caries Detection and Assessment System (ICDAS) II criteria. A 3-level sampling design ensured that the study was representative for the province of Quebec.

Results: Mean indexes for decayed, missing, filled primary teeth (dmft) and secondary teeth (DMFT) or surfaces (dmfs and DMFS) for all stages of caries were as follows. Grade 2 students: dmft 3.96, DMFT 1.88, dmft + DMFT 5.84, dmfs 8.33, DMFS 2.96 and dmfs + DMFS 11.28. Grade 6 students: dmft 1.94, DMFT 4.98, dmft + DMFT 5.98, dmfs 4.04, DMFS 7.86 and dmfs + DMFS 9.96. Most students (90% for Grade 2 and 92% for Grade 6) had a dmfs + DMFS > 0.

Conclusion: Tooth decay remains a public health problem in Quebec. The findings testify to the importance of reinforcing preventive measures to better control dental caries among youth. It is advantageous to use ICDAS II in the context of oral health surveillance at a population level and to present the results as a combination of primary and permanent dentitions.

Introduction

In 2010, the Ministère de la Santé et des Services sociaux in Quebec entrusted the Institut national de santé publique du Québec (INSPQ) with the task of updating oral health surveillance data for elementary school students. The most recent oral health studies dated back to the late 1990s,[1,2] and the lack of more recent clinical data was a barrier to updating Quebec's public dental health program.

In 2012–2013, the INSPQ conducted a province-wide study of the oral health of elementary school students, entitled Étude clinique sur l'état de santé buccodentaire des élèves québécois du primaire (ÉCSBQ 2012–2013).[3,4] This study had 2 distinctive features: its data collection system was different from that used in previous provincial studies, and a caries indicator combining primary and permanent dentitions was developed.

ÉCSBQ 2012–2013 was the first surveillance study in Quebec to generate findings on dental caries that included the first signs of enamel demineralization. In earlier studies, the visual detection threshold for dentin involvement was used in the clinical assessment of dental caries, as recommended by the World Health Organization (WHO).[5] In ÉCSBQ 2012–2013, caries were assessed using the International Caries Detection and Assessment System II (ICDAS II).[6] This made it possible to provide a more complete picture of the level of tooth decay among elementary school students. All stages on the continuum of dental caries, from involvement of the surface layer of enamel to deep lesions, were thus taken into account. In addition, knowledge of the prevalence of dental caries at the early stages of the disease represents a substantial asset in terms of identifying public health preventive measures.

Traditionally, dental caries have been reported separately for each type of dentition, that is, primary and permanent teeth. However, in our opinion, the prevalence of caries in both dentitions combined provides a more comprehensive measure of the burden of dental caries from a surveillance standpoint.

The objective of this article is to provide an overall picture of dental caries in Grade 2 and Grade 6 students in Quebec. More specifically, it aims to compare the prevalence of caries at different stages of the disease in different types of dentition.

Methods

The target population of this cross-sectional descriptive study included all Grade 2 and Grade 6 students enrolled in public and private, French- and English-language elementary schools in Quebec. It excluded students attending schools on Indigenous reserves, specialized schools and schools located in northern regions. Some students were also excluded for logistic or medical reasons. Three levels of sampling — regions, schools and students — ensured that the study would be representative of the province. For the first level, we selected 10 regions among all admissible administrative regions categorized into 3 strata (populous, sparsely populated and other). The second sampling level was aimed at identifying schools in the selected regions according to educational system (public or private schools), the socioeconomic status index of the schools as defined by the Ministère de l'Éducation et de l'Enseignement supérieur of Quebec or the geographic area. At the student level, Grade 2 and Grade 6 students from the chosen schools were selected using a simple, random method without replacement.

Before oral health examinations were carried out, parents were required to read and sign a consent form and complete a health questionnaire for their child. They were also asked to complete a questionnaire designed to gather sociodemographic information. Afterward, each student was given a summary statement regarding his or her oral health and was referred to a dentist in case of obvious need.

In late October and early November 2012, 16 dentist-examiners received theoretical training followed by practical training to standardize their clinical assessments, in accordance with recommendations of the ICDAS Foundation experts who were consulted. Clinical assessments of 1 of the dental trainers was used as a gold standard for evaluating examiner reliability regarding coding of clinical condition of about a dozen students. This reference dentist had previously been trained by ICDAS Foundation experts who had come to Montréal in spring 2012 for this purpose.

Simple and weighted kappa statistics as well as percentage of agreement were used to determine the reproducibility of the clinical assessments of the gold standard dentist compared with those of the dentist-examiners.[7] Agreement scores were calculated according to data collected under the same conditions as in the field study, as suggested by the founders of ICDAS II.

Two other methods were used to determine the level of interexaminer agreement: (1) approximately 10 of the students examined by each dentist-examiner were seen again by a gold standard dentist about midway through the data collection process; and (2) each dentist-examiner examined 5% of the students twice during the data collection process. Agreement scores for each of the 16 examining dentists as assessed before and during the data collection were satisfactory.

Between November 2012 and June 2013, clinical data were gathered by intraoral examinations conducted without radiographs in elementary schools using portable equipment. Headlamps (Storm 100 lumens; Black Diamond, Utah), disposable dental mirrors (model 1006640; Henry

Schein, New York), and dental probes (model 5009532U0 WHO 23/6; Brasseler, Canada) were used. The ICDAS II system was applied for each tooth surface, although the activity of carious lesions was not assessed.[6] To distinguish between code 1 and 2 carious lesions, the surface of the tooth was dried with an air syringe. Clinical data were entered directly into a computerized data collection tool. SAS 9.3 software was used to create the final database. The results were weighted, so that the final sample would be truly representative of the target population. To account for sampling design, the accuracy of estimates was calculated using the bootstrap weighting technique.

Results are presented according to 3 stages of caries: stage 1–3 caries (non-obvious caries); stage 4–6 caries (obvious dental caries); and stage 1–6 caries. Although various combinations are possible, it was decided to group codes 1–3 and 4–6 to allow comparison of our results with those of previous Quebec studies that assessed the presence of caries at a corresponding ICDAS II code 4 threshold.

The presence of fillings is reported in the F component of the DMFT or DMFS index (upper or lower case for permanent and primary dentition, respectively), as well as the FS component of the ICDAS index, as in the study by Guedes de Amorim et al.[8] The caries experience index, primarily at stages 1–6, underestimates the number of surfaces that are filled because, when this index is calculated, a surface that has both a carious lesion and a filling is considered carious. To estimate the average number of filled surfaces, without taking into account the simultaneous presence of carious lesions, it is more appropriate to use the FS-ICDAS index.

The research protocol for this study was approved by a public health ethics committee. Confirmation of collaboration by the Ministère de l'Éducation, des Loisirs et du Sport, as well as the passive consent of all school boards, their public schools and all the private schools involved in the study was obtained.

Results

The participation rate of schools was approximately 93%, while that of Grade 2 and 6 students was 69% and 64%, respectively. During the data collection phase, the dentist-examiners visited 475 schools and examined 2875 Grade 2 students and 2788 Grade 6 students. A detailed description of the sample is provided in **Table 1**.

Grade 2

Among students in Grade 2, the mean number of primary teeth was 13.06 out of a possible 20, while the mean number of permanent teeth was 10.13 out of a possible 28. When both dentitions were combined, the mean number of teeth observed was 23.19. With regard to primary dentition, students usually had second molars (> 98%) and first

molars (> 95%), as well as canines (> 94%). With regard to permanent dentition, lower central incisors were observed in 98–99% of the students and first molars in > 96%.

Table 1: *Description of the study population, including the characteristics of Grade 2 and Grade 6 students and their parents.*

Characteristics	Grade 2 (*n* = 2875)		Grade 6 (*n* = 2788)	
	No.	%	No.	%
Age, years				
7	1600	55.7		
8	916	31.9		
9	39	1.4		
10			12	0.4
11			1497	53.7
12			952	34.1
13			72	2.6
Partial nonresponse rate[a]	320	11.1	255	9.1
Mean age	7.4 years		11.4 years	
Sex				
Female	1480	51.5	1416	50.8
Male	1395	48.5	1372	49.2
Language(s) spoken most often at home[b]				
At least French	2466	85.8	2394	85.9
At least English, but not French	225	7.8	227	8.1
Neither French nor English	150	5.2	130	4.7
Partial non-response rate[a]	34	1.2	37	1.3
Number of children at home				
1	391	13.6	453	16.2
2	1432	49.8	1327	47.6
3	727	25.3	659	23.6
≥ 4	270	9.4	289	10.4
Partial non-response rate[a]	55	1.9	60	2.2
Highest level of education of the mother				
No secondary school diploma	201	7.0	227	8.1
Secondary school diploma	352	12.2	422	15.1
Post-secondary school diploma	2247	78.2	2039	73.1
Partial non-response rate[a]	75	2.6	100	3.6
Highest level of education among the parents				
No secondary school diploma	123	4.3	141	5.1
Secondary school diploma	274	9.5	348	12.5
Post-secondary school diploma	2428	84.5	2234	80.1
Partial nonresponse rate[a]	50	1.7	65	2.3

[a] The partial non-response rate is defined as the ratio of the number of weighted non-respondents for the variable over the weighted number of eligible students. The higher this rate, the greater the risk of bias caused by partial non-response. A partial non-response of less than 5% has a negligible impact, in general, on the national estimates.
[b] 'One' or 'more than one language' could be provided as an answer. However, the data were subsequently recoded as described in Table 1 to facilitate interpretation.

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J Can Dent Assoc 2020;86:k3
July 21, 2020

Table 2 shows the caries experience of Grade 2 students by tooth or surface, index components and dentition. At the tooth level, the mean caries experience for Grade 2 students was 3.96 d_{1-6}mft and 1.88 D_{1-6}MFT or 5.84 for primary and secondary dentitions combined. At the surface level, the mean caries experience of the same children was about 8.33 for d_{1-6}mfs, 2.96 for D_{1-6}MFS and 11.28 combined. For dmfs + DMFS, nearly 7 surfaces (6.57) had a carious lesion, with lesions on 5.79 of those surfaces at stage 1–3 and lesions on 0.77 at stage 4–6; few surfaces were missing (0.31) and 4.40 surfaces were filled. However, irrespective of the presence or absence of carious lesions, the mean number of filled surfaces (fs-icdas + FS-ICDAS) was 4.92.

Table 2: *Mean number of decayed, missing or filled (dmf and DMF) teeth and surfaces with caries in Grade 2 students (n = 2875), according to stage of caries and dentition.[a]*

Caries experience by stage	Teeth		Surfaces	
	Mean no.	95% CI	Mean no.	95% CI
Primary dentition				
d_{1-6}mf	3.96	3.80–4.15	8.33	7.80–8.88
d_{1-6}	2.53	2.38–2.68	3.86	3.54–4.22
d_{1-3}	2.15	2.03–2.28	3.14	2.88–3.45
d_{4-6}	0.38	0.33–0.43	0.72	0.61–0.85
m	0.06[†]	0.04–0.09	0.31[†]	0.21–0.43
f	1.38	1.28–1.47	4.16	3.83–4.49
fs-icdas			4.66	4.30–4.99
Permanent dentition				
D_{1-6}MF	1.88	1.76–2.04	2.96	2.67–3.33
D_{1-6}	1.77	1.65–1.93	2.72	2.43–3.10
D_{1-3}	1.73	1.61–1.89	2.67	2.38–3.05
D_{4-6}	0.04	0.03–0.05	0.05[†]	0.04–0.07
M	0.00[‡]	0.00–0.00	0.00[‡]	0.00–0.00
F	0.11	0.09–0.14	0.24	0.19–0.29
FS-ICDAS			0.26	0.23–0.31
Primary and permanent dentition combined				
d_{1-6}mf + D_{1-6}MF	5.84	5.57–6.14	11.28	10.52–12.11
d_{1-6} + D_{1-6}	4.29	4.05–4.59	6.57	6.00–7.27
d_{1-3} + D_{1-3}	3.87	3.66–4.15	5.79	5.28–6.44
d_{4-6} + D_{4-6}	0.42	0.37–0.47	0.77	0.66–0.91
m + M	0.06[†]	0.04–0.09	0.31[†]	0.21–0.43
f + F	1.49	1.38–1.59	4.40	4.06–4.74
fs-icdas + FS-ICDAS			4.92	4.56–5.26

Note: CI = confidence interval, ICDAS = International Caries Detection and Assessment System.
[a] *For each dentition, these indicators were calculated using a sample of students with at least 1 tooth present in their mouth or at least 1 missing tooth due to caries. The results were inferred to the population as a whole by weighting the data. The results for stage 1–6 caries may vary slightly in the full report3 given the different sample.*
[†] *Coefficient of variation > 15% and ≤ 25%. The value of the mean must, therefore, be viewed with caution.*
[‡] *Coefficient of variation > 25%. The value of the mean is provided for information purposes only.*

Table 3 reveals that about 80% of Grade 2 students had stage 1–6 caries in their primary dentition, while 69% had stage 1–6 caries in their permanent dentition. For combined dentitions, almost all students (90%) had stage 1–6 caries. In addition, the proportion of students with non-obvious carious lesions in their combined dentitions (d_{1-3}s + D_{1-3}S > 0) was high (85%), while the proportion of students with obvious carious lesions in both dentitions (d_{4-6}s + D_{4-6}S > 0) was lower (20%).

Table 3: *Proportion of Grade 2 and Grade 6 students with at least 1 decayed, missing or filled (dmfs and DMFS) surface, according to stage of caries and dentition.[a]*

Caries experience by stage	Grade			
	Grade 2, % (n = 2875)	95% CI	Grade 6, % (n = 2788)	95% CI
Primary dentition				
d_{1-6}mfs > 0	79.6	77.6–81.7	69.6	66.3–73.8
d_{1-6}s > 0	71.4	68.9–73.8	58.4	54.8–63.3
d_{1-3}s > 0	69.8	67.2–72.3	55.4	51.9–60.2
d_{4-6}s > 0	18.4	16.2–20.5	12.8	10.7–15.7
Permanent dentition				
D_{1-6}MFS > 0	68.7	66.4–71.7	88.4	86.6–90.3
D_{1-6}S > 0	65.9	63.5–69.1	86.2	84.4–88.2
D_{1-3}S > 0	65.7	63.3–68.8	86.1	84.3–88.0
D_{4-6}S > 0	2.9	2.2–3.7	8.1	6.7–9.5
Primary and permanent dentitions combined				
d_{1-6}mfs + D_{1-6}MFS > 0	89.7	88.0–91.3	91.8	90.3–93.6
d_{1-6}s + D_{1-6}S > 0	85.3	83.4–87.3	89.1	87.5–91.0
d_{1-3}s + D_{1-3}S > 0	84.6	82.6–86.7	88.8	87.1–90.7
d_{4-6}s + D_{4-6}S > 0	19.8	17.7–22.0	13.7	12.1–15.7

Note: CI = confidence interval, ICDAS = International Caries Detection and Assessment System.
[a] *The results for stage 1–6 caries may vary slightly in the full report[3] given the different sample.*

Grade 6

For Grade 6 students, several primary teeth had already been replaced by permanent teeth. On average, only about 2.56 primary teeth were present, compared with 23.19 permanent teeth out of a possible 28. For combined dentitions, the mean number of teeth was 25.75. Of all the teeth normally present, the students most frequently had permanent first molars (all students) and permanent lateral and central incisors (almost all students).

At the tooth level, Grade 6 students had, on average, a d_{1-6}mft of 1.94, a D_{1-6}MFT of 4.98 and a d_{1-6}mft + D_{1-6}MFT of 5.98 (**Table 4**). At the surface level, the mean caries experience was 4.04 for d_{1-6}mfs, 7.86 for D_{1-6}MFS and 9.96 for d_{1-6}mfs + D_{1-6}MFS. Close to 8 surfaces (7.88) had a carious lesion: 7.49 surfaces had stage 1–3 caries and 0.39 surfaces had stage 4–6 caries. There were almost no missing surfaces (0.06) and 2.01 filled surfaces. The fs-icdas + FS-ICDAS index revealed 2.48 filled surfaces.

Table 4: *Mean number of decayed, missing or filled (dmf and DMF) teeth and surfaces in Grade 6 students (n = 2788), according to stage of caries and dentition.*[a]

Caries experience by stage	Teeth		Surfaces	
	Mean no.	95% CI	Mean no.	95% CI
Primary dentition				
$d_{1-6}mf$	1.94	1.81–2.12	4.04	3.71–4.46
d_{1-6}	1.29	1.19–1.43	2.01	1.83–2.24
d_{1-3}	1.10	1.00–1.23	1.63	1.48–1.82
d_{4-6}	0.19	0.16–0.24	0.39	0.30–0.50
m	0.01[†]	0.00–0.02	0.05[‡]	0.01–0.10
f	0.64	0.56–0.74	1.98	1.75–2.25
fs-icdas			2.37	2.18–2.58
Permanent dentition				
$D_{1-6}MF$	4.98	4.73–5.30	7.86	7.36–8.47
D_{1-6}	4.63	4.37–4.96	6.84	6.37–7.41
D_{1-3}	4.49	4.24–4.81	6.65	6.21–7.21
D_{4-6}	0.14	0.11–0.17	0.19	0.15–0.24
M	0.01[‡]	0.00–0.02	0.04[‡]	0.00–0.09
F	0.34	0.29–0.38	0.98	0.87–1.09
FS-ICDAS			1.26	1.15–1.37
Primary and permanent dentitions combined				
$d_{1-6}mf + D_{1-6}MF$	5.98	5.71–6.33	9.96	9.38–10.65
$d_{1-6} + D_{1-6}$	5.30	5.02–5.65	7.88	7.39–8.49
$d_{1-3} + D_{1-3}$	5.06	4.80–5.41	7.49	7.03–8.08
$d_{4-6} + D_{4-6}$	0.24	0.20–0.28	0.39	0.32–0.47
m + M	0.01[‡]	0.00–0.02	0.06[‡]	0.02–0.12
f + F	0.67	0.61–0.74	2.01	1.82–2.21
fs-icdas + FS-ICDAS			2.48	2.34–2.64

Note: CI = confidence interval, ICDAS = International Caries Detection and Assessment System.

[a] *For each dentition, these indicators were calculated using the sample of students with at least 1 tooth present in their mouth or at least 1 missing tooth due to caries. The results were inferred to the population as a whole by weighting the data from the sample. The results for stage 1–6 caries may vary slightly in the full report[3] given the different sample.*

[†] *Coefficient of variation > 15% and ≤ 25%. The mean must, therefore, be viewed with caution.*

[‡] *Coefficient of variation > 25%. The mean is provided for information purposes only.*

As shown in **Table 3**, about 70% of Grade 6 students had stage 1–6 caries on their primary teeth, while close to 90% had such caries on their permanent teeth. When both dentitions were combined, almost 92% of students were affected. As for Grade 2 students, a large proportion of those in Grade 6 (89%) had non-obvious caries in combined dentitions ($d_{1-3}S + D_{1-3}S > 0$). Again, the proportion was lower (14%) for obvious caries ($d_{4-6}S + D_{4-6}S > 0$).

Discussion

In ÉSCBQ 2012–2013, every precaution was taken to ensure the quality of the data and minimize bias. The large sample size allowed more precise estimates and the procedures for making inferences regarding the target population took into account the complexity of the sampling design. In addition,

the training and clinical assessment standardization procedures put in place ensured reliable interpretation, comprehension and application of the criteria and codes.

On the other hand, certain limits must be mentioned. First, a selection bias may be present as parents who agree to allow their child to participate in oral health surveys may be more educated than those who refuse permission. They may also come from a more privileged background. As such, all results presented in this article have been weighted to minimize this type of bias. Second, observer bias, mainly related to the measurement of caries experience, can interfere in a clinical study. The training and the various procedures used to standardize the clinical judgement of the dentist-examiners before and during data collection limited this type of bias. The cross-sectional design of the study depicts a measure of caries among Grade 2 and 6 students in Quebec at a specific moment in time. Although this is unavoidable in such a study, a higher prevalence of caries might have been found if the examinations had taken place a few months earlier, given that the students were at an age of primary tooth exfoliation. However, for the purpose of comparison, we maintained the same data collection period as in previous studies conducted in Quebec. Finally, the decision not to use radiographs was based on ethical considerations, as the examinations were conducted for surveillance purposes and in school settings. In similar surveillance studies carried out on large populations and for international comparison between studies, radiographs have not been used. Thus, an underestimation of true caries prevalence is expected in all surveillance studies.

A caries experience indicator involving primary and permanent dentitions combined and incorporating all stages in the development of caries was created for surveillance purposes. In our view, this indicator provides a better measure of the burden of the disease than an indicator of only later-stage caries in a single dentition.

First, using the combined dentitions is a more meaningful and comprehensive approach to describing caries experience because the latter is reported for all teeth present in the mouth rather than for primary and permanent dentitions separately. In fact, the results clearly demonstrate the usefulness of this indicator, particularly for Grade 2 students who have, on average, almost as many primary teeth (13.06) as permanent ones (10.13). The caries experience increased from an average of 3.96 primary teeth and 1.88 permanent teeth affected by stage 1–6 caries to 5.84 teeth affected by such caries for the combined dentition. However, this indicator is not as useful for students in Grade 6, given that they have, on average, only 2.56 primary teeth compared with 23.19 permanent teeth. Nonetheless, their $d_{1-6}mft + D_{1-6}MFT$ (5.98) index showed, on average, 1 more affected tooth than the $D_{1-6}MFT$ (4.98). Although primary and permanent dentitions each have specific morphological characteristics, the combined dentition can be a choice

indicator, especially within the context of surveillance where the number of indicators designed to monitor oral health is limited.

Second, this indicator includes the first stages of demineralization as well as the later stages of caries disease, thus taking into account all levels of the disease. It should be noted that the decayed component of $d_{1-6}mft + D_{1-6}MFT$ represents a large proportion of the total caries experience at stage 1–6 (79%) among Grade 6 students. Of these decayed surfaces, 7.49 out of 7.88 had stage 1–3 lesions, while 0.39 had stage 4–6 lesions. In other words, when early stages of caries and combined dentition were taken into account, the caries experience increased considerably. Similarly, ÉCSBQ 2012–2013 revealed that almost all students in Grades 2 and 6 had non-obvious carious lesions. Even though such lesions can become more serious, they can also be reversed.[9-11] Effective preventive measures exist for reducing the risk that such lesions will get worse. These measures will also prevent the appearance or development of new, non-obvious carious lesions.

For the purposes of comparison with other countries, ÉCSBQ 2012–2013 documented primary, permanent and combined dentitions, although few surveillance studies have used primary and permanent dentitions combined for the prevalence of stage 1–6 caries. A study involving Grade 6 students conducted in Iceland in 2004–2005 revealed that the mean experience of stage 1–6 caries was lower than in Quebec, even though ÉCSBQ 2012–2013 is more recent.[12] The Icelandic study indicated that for 12-year-old students, the $D_{1-6}MFT$ was 3.93 and the $D_{1-6}MFS$ 6.64. Comparable figures for Grade 6 students in Quebec were 4.98 and 7.86. In addition, the proportion of students with no experience of stage 1–6 caries was higher in Iceland than in Quebec (22% versus 12%). Another study in Spain in 2010 also seems to indicate that the mean experience of stage 1–6 caries in that country was lower than in Quebec.[13] Indeed, 12-year-old Spanish students had a $D_{1-6}MFT$ of 3.46 and a $D_{1-6}MFS$ of 4.45. The proportion of students with no caries experience also seemed to be higher in Spain: 23% of the students involved in the Spanish study had no experience of stage 1–6 caries in their permanent teeth compared with 12% of Quebec students.

In conclusion, this study shows that dental caries continues to be a public health problem in Quebec. The findings thus testify to the importance of enhancing prevention in the area of oral health. Over the past 3 decades, efforts have been made by both the public and private sectors to improve the oral health of youth. To preserve the gains achieved and continue to make progress in oral health, a strategy aimed at using effective interventions appears to be appropriate.

NOTE: The detailed results presented in this report and its appendices are available on the website of the Institut national de santé publique du Québec.

Summary (in English):

https://www.inspq.qc.ca/sites/default/files/publications/2144_study_oral_health_quebec_elementarys_students.pdf

National report (in French):

https://www.inspq.qc.ca/sites/default/files/publications/2034_sante_buccodentaire_primaire.pdf

Appendices (in French):

https://www.inspq.qc.ca/sites/default/files/publications/2034_sante_buccodentaire_primaire_annexes.pdf

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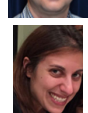
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This article has been peer reviewed.

The authors declare that they have no conflicts of interest.

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