Severe Dental Caries, Impacts and Determinants Among Children 2–6 Years of Age in Inuvik Region, Northwest Territories, Canada

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ABSTRACT

In 2004–2005, 349 of 541 eligible, mostly preschool, children in the Inuvik Region in the Northwest Territories of Canada were examined clinically, and the parents or caregivers of 315 of these children were interviewed to measure their oral health status, and its impacts and determinants. Dental caries is a highly prevalent health problem among these preschool children in Inuvik Region: we found that 66% (230/349 children) had the disease and had, on average, 4.8 affected teeth, of which 2.4 had untreated decay. Twelve percent (42/349) of the children needed urgent dental care. Among the 315 children whose parents or caregivers were interviewed, 46% (144/315) had severe early childhood tooth decay. Significantly more of the parents of children with severe decay reported that their children had pain and a decreased ability to chew than the parents of children with no or moderate disease. Using logistic regression, we found that protective factors for severe early childhood tooth decay were higher family income (OR = 0.68; 90% CI = 0.54–0.85), community water fluoridation (OR = 0.49; 90% CI = 0.26–0.91), and drinking milk (OR = 0.44; 90% CI = 0.24–0.81) and fruit juices (OR = 0.46; 90% CI = 0.24–0.90) after the child began to walk, whereas significant risks were consuming drinks made from flavour crystals before (OR = 2.4; 90% CI = 1.3–4.6) and after (OR = 2.0; 90% CI = 1.2–3.2) that age. This information should enable the Health and Social Services Authority to plan health promotion and service delivery programs for the children in Inuvik Region.

For citation purposes, the electronic version is the definitive version of this article: www.cda-adc.ca/jcda/vol-74/issue-6/519.html

In 2004–2005, the Inuvik Regional Health and Social Services Authority conducted a census survey of mainly preschool children aged 2–6 years in all 13 communities to obtain information about their oral health status. This information was to be used to assess the need for or revisions to oral health promotion, including service delivery programs.

For younger First Nations children, the incidence of caries has historically been higher than that for southern Canadian populations. For example, mean counts of decayed, extracted or filled teeth (deft) for 3-year-old children ranged from 3.5 to 9.7 teeth and for 5-year-olds, from 4.8 to 13.2 teeth[1–6]; def surface counts were 19.3 decayed surfaces for boys and 24.2 for girls 4–6 years of age in Chisasibi Quebec.[7] More recently, Manitoba investigators reported that the mean deft score for 3-year-olds (mean age 46 months)

in Garden Hill was 13.7 teeth[8]; and 4.4–4.5 in 2 other northern First Nation communities. In contrast, for 5-year-old Ontario schoolchildren, in 1994, the mean deft score was 1.2 teeth.[9]

A major concern in communities with high proportions of aboriginal populations is early childhood tooth decay, a particularly rampant form of dental decay that affects the deciduous teeth of young children. A recent review[10] showed that the condition, usually defined as early childhood caries and measured as the number of def surfaces, has been linked to feeding practices at the time and subsequent to the time when the deciduous teeth emerge. Persistence of infant feeding practices after the child has reached 1 year of age, or around the time the child begins to walk, is an important risk factor for early childhood tooth decay. Because of its high prevalence in remote and aboriginal communities, compared with that in urban populations in Canada, and its impact on children's health and development and on associated treatment costs, the prevalence of early childhood tooth decay and its determinants must be examined to develop policy and preventive and care delivery programs.

The purpose of the survey whose results are reported here was to describe the oral health status and determinants among children 2–6 years of age in the Inuvik Region and to assess the need to develop or refine preventive oral health strategies and programs for preschoolers.

Methods

The survey methods were presented to and approved by the Board of the Inuvik Regional Health and Social Services Authority, on which representatives of Inuvialuit communities, the Gwich'in Tribal Council and the region's communities sit, and by the University of Toronto's Research Ethics Board.

Inuvuk Region, the western part of Canada's Northwest Territories, occupies a land mass of 522,000 km and, in 2001, had a total population of about 8,540, 76% of whom were aboriginal. Inuvik and Norman Wells are the only 2 towns; the rest are smaller communities known as hamlets or settlements. At the time of the survey, all but 3 of the 13 communities (Ft. McPherson, Inuvik and Tsiigehitchic) were accessible exclusively by air; only Inuvik provided fluoridated water.

The target population for the survey consisted of all children 2–6 years of age who resided in the 13 communities that make up the region. The number of children eligible for the survey varied by community from 8 to 200; 11 communities had fewer than 50. Local Health and Social Services Authority personnel attempted to increase participation by advance publicity, through radio announcements, posters and advertisement in newspapers, and by door-to-door solicitation of parental consent. The examiner (SJ) trained the interviewer, travelled to each community, further explained the survey to parents and conducted the clinical examinations. He was trained and participated as an examiner in both earlier dental health surveys of Canada's First Nation's children, and used the same methods for this survey as those used in 1990–1991[11] (i.e., natural light, not drying teeth, dull explorer to wipe off the plaque, caries scored as present if the lesion reached into the dentin).

The parental questionnaire consisted of 14 main questions, and the interviewer recorded the parents' responses by circling their answers on the questionnaire. Questions used in the earlier surveys were supplemented with questions about family demographics. Some questions had several embedded questions. For example, the question about identifying the foods consumed by the child the previous day consisted of a list of 16 foods, to which the parent responded yes or no. The completed interview and examination forms were shipped to the University of Toronto where the information was entered into EpiData (EpiData Software 2006, Copenhagen) and processed with SPSSPC version 12.0 (SPSS Inc. 2005, Chicago, Ill.).

Given the young ages of the subjects, the clinical examination was brief. It consisted of recording the status of and treatment needed for each tooth, and assessing whether the child needed urgent, restorative or surgical care.

For analysis, the individual tooth status codes were computed into deft scores for the child. The questionnaire responses were recorded to examine the potential risk factors. For example, use of types of foods was recoded as 2 variables: low- or high-sugar foods. Fresh fruit, diet pop, chips, pretzels, gum without sugar and traditional foods were coded as low-sugar foods. Cereal, cookies, juice, nondiet pop, jam or honey, dry fruit, sugar gum, candy, chocolate bars, flavoured yogourt and ice cream were coded as high-sugar foods.

Since early childhood tooth decay first manifests on the deciduous maxillary anterior teeth, in our previous analysis of the 1990[11] national data, we limited our analysis to those with decay on just the anterior teeth. In the interim, more investigators have written about this subject and, although case definitions still vary, even 1 cavity in children 2–6 years of age is considered evidence of early childhood caries for nonaboriginal populations.[11] However, in a study of Inuvik populations, such a case definition would result in classifying nearly two-thirds of the children as cases, too many to distinguish statistically important risks between cases and noncases. Accordingly, we defined children with severe early childhood tooth decay as those children who had a deft score in the top third for their age group or those who had 2 or more maxillary anterior teeth affected by decay. After examining our data, we found that the top third severity scores were a deft score ≥ 1 at age 2 years, 4 at age 3, 7 at ages 4 and 5, and 10 at age 6. Therefore, we partitioned the children into 3 groups: those with no

Table 1 Percent of participating preschool Inuvik children with caries and mean and total numbers of decayed, extracted, filled deciduous teeth (deft) by community

Community, no. of children (n = 349)	Children with 1 or more deft (%)	Mean no. of decayed teeth	Mean no. of extracted teeth	Mean no. of filled teeth	Mean (SEM) no. of deft[a]
Aklavik (17)	100	4.1	2.2	1.6	7.9 (1.1)
Colville Lake (not reported for reasons of confidentiality)	83	4.8	0.7	9.8	6.2 (1.3)
Deline (24)	71	2.1	1.8	1.5	5.4 (1.2)
Fort Good Hope (28)	64	1.6	1.5	1.2	4.3 (0.9)
Fort McPherson (29)	86	3.6	2.0	1.4	6.9 (1.1)
Holman (17)	65	3.0	0.9	0.6	4.5 (1.2)
Inuvik (91)	40	1.0	0.5	0.6	2.0 (0.4)
Norman Wells (25)	20	0.4	0.2	0.4	0.9 (0.5)
Paulatuk (15)	80	4.1	1.7	0.5	6.3 (1.3)
Sachs Harbour (not reported for reasons of confidentiality)	100	7.4	3.4	0	10.9 (2.0)
Tsiigehitchic (13)	85	3.2	0.8	0.7	4.6 (0.8)
Tuktoyaktuk (49)	88	3.3	3.0	1.3	7.7 (0.8)
Tulita (22)	82	2.4	2.6	1.2	6.2 (1.2)
Mean (SEM)	**66**	**2.4 (0.2)**	**1.5 (0.2)**	**0.9 (0.1)**	**4.8 (0.3)**

Note: SEM = standard error of the mean.
[a]*May not add due to rounding.*

caries (n = 110); those with severe early childhood tooth decay (n = 144); and the middle group, those who had at least 1 decayed, extracted or filled tooth, but did not meet our criteria for severe disease (n = 61). Our definition of severe early childhood tooth decay is different than that proposed by Drury and others[12] for severe early childhood caries, which follows the convention of counting affected surfaces. However, our definition is appropriate for the resources available for the collection of the field data. Moreover, the results are more than sufficient for the development of health promotion programs and policies for this population.

Findings

The number of children 2–6 years of age who were eligible to participate in the survey ranged from 8 to 200 per community and totalled 541. In all, 349 children had an examination and 315 (58% of all eligible children) had both an examination and a completed parental questionnaire. The ages of these 315 children ranged from 2 to 6 years (mean 4.4 years).

Among the valid responses, 172 (61%) of 282 mothers and 160 (76%) of 211 fathers reported working full- or part-time outside the house. An examination of the records showed that the most common occupation for mothers (86 [34%] of 254 mothers) was administration, financial or clerical services, and for fathers (67 [33%] of 204 fathers), working in the trades, transportation and equipment operator. Close to 20% of both mothers and fathers reported working in a professional category. Of the 208 (66%) of the 315 parents who provided information about income, 51% (106/208 parents) reported annual family incomes of $60,000 or higher, and 14% (29/208 parents) reported family incomes at or below $20,000. Low-income families were more prevalent in Holman (58%), Fort McPherson (41%) and Fort Good Hope (40%).

Table 2 Percent of parents reporting impacts and notification of severe early childhood tooth decay (S-ECTD)

	% severity of caries (no. of respondents)			
Characteristic reported by parent	Caries-free	Moderate	Severe	*p* value for χ^2
Not satisfied with colour	1.8 (110)	9.8 (61)	25.0 (140)	< 0.001
Not satisfied with chewing ability	0.9 (109)	3.3 (61)	14.0 (143)	< 0.001
Not satisfied with speaking ability	3.7 (109)	4.9 (61)	9.2 (142)	0.19[a]
Pain of any kind	3.6 (110)	8.2 (61)	16.7 (144)	0.003
Child's oral health fair to poor	5.5 (109)	21.3 (61)	46.8 (141)	0.001
Not informed of child's S-ECTD	96.1 (108)	98.4 (61)	83.7 (141)	< 0.001

[a]*Not significant.*

Table 1 shows the prevalence and severity of dental caries in the 349 children who had an examination: 66% (230/349 children) of children had at least 1 decayed tooth, and on average, 4.8 of their deciduous teeth were decayed, extracted or filled. One half (2.4 teeth) of the diseased teeth were untreated and of those teeth that were treated, more (1.5 teeth) were extracted than filled (0.9 teeth). Although the prevalence and severity of the disease varied markedly by community, because of the small numbers, not all differences were statistically significant.

According to our case definition, 144 (46%) of the 315 children (for whom we had completed parental questionnaires) had severe early childhood tooth decay, 110 (35%) were caries-free and 61 (19%) were in the middle group. Severe early childhood tooth decay was most prevalent among those living in Sachs Harbour (83%), Aklavik (76%), Tuktoyaktuk (76%) and Paulatuk (71%), and least prevalent in Norman Wells (4%) and Inuvik (21%).

Table 2 shows the impact of severe early childhood tooth decay. Compared with parents and caregivers of children who had no caries or children with only moderate severity, parents and caregivers of children with severe early childhood tooth decay reported being less satisfied with the colour of their children's teeth and with their children's ability to chew. A nonsignificant trend toward more speech problems with increasing severity of decay was found. These parents and caregivers also reported a significantly higher prevalence of pain, and far more of them rated their children's health as poor to fair. Eighty-four percent of parents and caregivers with a child who had severe early childhood tooth decay reported that they had not been told that their child had the condition at the time of the survey.

The socioeconomic, behavioural and environmental factors associated with the prevalence of severe early childhood tooth decay are shown in **Table 3**. Although other investigators may have used a fixed amount of disease to define cases, our definition reduced the difference in prevalence by age. Therefore, although the prevalence of severe early childhood tooth decay increased slightly from 3 years of age (40% or 30/75 children) to 5 (46% or 41/90) and 6 (52% or 35/67 children) years of age, the trend was not significant at the 5% level. In these cross-tabulations with χ^2 analysis, community water fluoridation, family income and current brushing behaviour were associated significantly with increasing severity of caries. However, the parents' or caregivers' level of education and previous day consumption of nonsugar or sugar foods, were not.

We used odds ratios (OR) and their 95% confidence intervals (CI) to examine the strength of the relationships of feeding practices on the prevalence of severe early childhood tooth decay. We found that breast-feeding was protective (OR = 0.49; 95% CI = 0.30–0.79). **Table 4** provides the findings on the risks of parent-reported practices before and after the time their children began to walk. Feeding drinks made from flavour crystals and fruit juice to children at the age before they are walking was significantly associated with severe early childhood tooth decay. All 7 children who were fed condensed milk with sugar had severe early childhood tooth decay, but the OR could not be calculated because one of the cells was zero. Drinking from a bottle or a "tippy-cup," namely, the method of providing the drink, at least before the child began to walk, had no effect on the severity of tooth decay.

After the child began to walk (about 1 year of age), having drinks made from crystals was again identified as a risk factor for severe tooth decay, as was drinking baby formula, condensed milk and regular milk with sugar. However, few people practised the latter 2 behaviours. Providing fruit juice after the child began to walk became protective, as did providing regular milk. Not shown in the table were the results of whether feeding by bottle or tippy-cup made a difference. The mode of drinking made no difference for most drinks, except fruit juices and regular milk. Of the 24 children who got their juice in a

Table 3 Social, demographic, environmental and behavioural factors related to risk of severe early childhood tooth decay (S-ECTD)

Current risk (*n*)	Caries-free (%)	Moderate caries (%)	S-ECTD (%)	*p* value for χ^2
All children (315)	35	19	46	
Age of child in years				
2 (7)	71	0	29	0.10
3 (75)	47	13	40	
4 (76)	33	20	47	
5 (90)	31	23	46	
6 (67)	25	22	52	
Community water fluoride				
No (231)	26	20	54	< 0.001
Yes (84)	61	18	21	
Parents with high school education				
No report for both (27)	15	37	64	
One no, other no report (61)	13	23	57	
Both no (56)	25	18	33	< 0.001
One yes, other no report (21)	29	38	54	
One yes, other no (57)	37	9	24	
Both yes (93)	61	15	48	
Family income				
Not reported (109)	21	20	58	
< $20K–$39K (76)	14	22	59	< 0.001
$40K–$79K (56)	39	18	42	
> $80K (74)	69	16	15	
Previous day consumption of low-sugar foods				
No (23)	22	26	52	0.36
Yes (292)	36	19	45	
Previous day consumption of high-sugar foods				
No (20)	20	30	50	0.26
Yes (292)	36	19	45	
Brushes at least once per day				
No (42)	14	26	60	0.01
Yes (272)	38	18	43	

bottle, 14 (58%) had severe early childhood tooth decay, compared with 100 (42%) of the 238 children who drank juice from a tippy-cup. Of the 27 children drinking milk from the bottle, 13 (48%) had severe early childhood tooth decay, compared with 94 (42%) of 223 children drinking milk from a tippy cup. The use of a tippy cup was protective in both cases.

To establish the independent effect of the various risk and protective factors, we conducted a logistic regression of the factors related to severe early childhood tooth decay (compared with moderate and no caries). Given the relatively few numbers and the need to consider factors that might lend themselves to a health promotion program or to policy development, we examined the probability of the relationship being a chance finding at the 90% CI of the OR. The statistically significant factors from **Tables 2** and **3** were entered into the model and were examined by backward step-wise analysis. Complete data on all variables were available for 283 of the 315 subjects. On the fifth iteration, the first model had eliminated 4 variables, the use of baby formula after the child began to walk, the combined education of the parents or caregivers, current brushing frequency and the drinking fruit juice before the child began to walk.

The results for a second model with these factors removed are shown in **Table 5**. Two risk factors were iden-

Table 4 Reported feeding practices and related risks of severe early childhood tooth decay (S-ECTD)

	Before walking			After walking		
Risk/Preventive factor	**Exposure (*n*)**	**Prevalence of S-ECTD (%)**	**OR (95% CI)**	**Exposure (*n*)**	**Prevalence of S-ECTD (%)**	**OR (95%CI)**
Drinks made from drink crystals	No (242) Yes (54)	40 70	3.50 (1.80–6.60)	No (145) Yes (150)	33 59	2.00 (1.80–4.60)
Baby formula	No (109) Yes (186)	47 46	0.96 (0.57–1.50)	No (248) Yes (47)	43 62	2.10 (1.10–4.00)
Condensed milk	No (250) Yes (23)	45 49	1.20 (0.61–2.20)	No (289) Yes (6)	46 67	2.40 (0.43–13.20)
Condensed milk with sugar	No (128) Yes (7)	45 100	Can't calculate	No (134) Yes (2)	46 100	Can't calculate
Fruit juice	No (111) Yes (184)	38 50	1.70 (1.04–2.70)	No (39) Yes (256)	61 44	0.49 (0.24–0.97)
Regular milk	Not asked			No (46) Yes (246)	63 43	0.44 (0.23–0.84)
Regular milk with sugar	Not asked			No (288) Yes (7)	46 71	3.0 (0.57–15.70)

Note: OR = odds ratio; CI = confidence interval.

Table 5 Results of logistic regression analysis on the determinants of severe early childhood tooth decay[a]

Determinant	Odds ratio	90% CI (*p* value)
Drinks made from crystals before walking (No = ref)	2.40	1.30–4.60 (0.02)
Drinks made from crystals after walking (No = ref)	2.00	1.20–3.20 (0.02)
Income: (> $80K/$40K–$79K/< $20K–$39K; No report = ref)	0.68	0.54–0.85 (0.005)
Breast fed (No = ref)	0.60	0.37–0.96 (0.08)
Community water fluoridation (No = ref)	0.49	0.26–0.91 (0.06)
Fruit juices after walking (No= ref)	0.46	0.24–0.90 (0.03)
Regular milk after walking (No = ref)	0.44	0.24–0.81 (0.03)

Note: 90% CI = 90% confidence interval of odds ratio; ref = reference category for analysis.
[a]Sensitivity = 0.70; Specificity = 0.72; Cox & Snell R^2 = 0.22; Hosmer & Lemshow Goodness of Fit Statistic, p = 0.8.

tified as significant: the use of drink crystals before and after the child began to walk. Five characteristics were identified as protective: drinking regular milk after the child began to walk, drinking fruit juices after the child began to walk, community water fluoridation, breast-feeding and increasingly higher income categories. All of these factors, except community water fluoridation and breast-feeding, were also significant at the conventional level of significance (i.e., $p < 0.05$). Increasing family income had the highest level of significance ($p = 0.005$) and, given its 4 levels, had the strongest relationship to the development of severe early childhood tooth decay.

Discussion

We set out to measure the prevalence and severity of dental caries and to examine its impact on and determinants for a census of preschool children in Inuvik Region. To maximize validity, we used standard definitions of caries, questions consistent with those of earlier surveys and an examiner who had conducted examinations for the 2 previous surveys. However, studies such as this one are inherently subject to errors or bias in parents' or caregivers' recall or reporting of risk behaviours. These factors, along with our 58% participation, somewhat reduces the certainty of our findings.

Because the prevalence and severity of caries in our study population were so high, we adopted a relatively restrictive definition of severe early childhood tooth decay: we considered children with the highest third of the deft scores for their age, plus those with 2 or more maxillary anterior teeth decayed, extracted or filled, to have severe early childhood tooth decay. The determin-

ants of severe early childhood tooth decay that we identified explained only 22% of the variation in the findings. As Peressini[10] has shown, standard epidemiologic quantitative methods have limits that can best be overcome by the parallel use of qualitative methods, which were not available for this study.

We found that dental caries affected 66% of children and, on average, they had 4.8 decayed, extracted or filled primary teeth. Forty-six percent of the children met our case definition for severe early childhood tooth decay, which is consistent with the findings of others. They have reported the prevalence of early childhood caries and severe early childhood caries as ranging variously from 50%,[13] 52%,[14] 56%–59%[15] and 59%[16] to 73%,[6] in contrast with that of more southern urban sites like Toronto, where prevalence estimates based on less restrictive definitions vary from 6% (parent-reported for children from birth to 6 years of age)[17] to 11% (by examination of 5-year-olds).[18]

We found that parents of children with severe early childhood tooth decay reported a significantly greater impact on their children, namely, more pain and a decreased ability to chew, than parents of children with more moderate or no caries. Four determinants of oral health were protective factors: higher family incomes, community water fluoridation, and drinking milk and drinking fruit juices after the child began to walk. Consuming drinks made from flavour crystals, both before and after the age that the child began to walk, were identified as significant risk behaviours (OR = 2.0 and 2.4, respectively). However, none of our determinants was particularly strong (ORs varying from 0.4 to 2.4), except for drinking condensed milk with added sugar (in all 7 instances, the child had severe early childhood tooth decay).

Our findings are consistent with general knowledge about the determinants of oral diseases, namely, that higher incomes, and access to fluorides and healthy diets (e.g., milk and fruit juices) are consistent with better oral health, whereas unhealthy diets (e.g., drinks made with flavour crystals or sugar added to condensed milk) are risks for severe disease.[19] Our finding that family income was an important determinant of early childhood caries is consistent with the findings of Smith and Moffat's[20] review. Despite our study's design and potential for recall errors, this consistency of our findings with what is known from other studies adds credibility to our results.

Although current data for southern preschoolers across Canada are lacking, comparisons with the children in the United States is possible. In 1999–2000, among U.S. children 2–5 years of age, 27.9% had 1 or more cavities, with a mean 1.06 decayed or filled teeth and 0.62 decayed teeth.[21] The equivalent numbers for the Inuvik population are 66%, with 3.3 decayed or filled teeth and 2.4 decayed teeth — more than 2 to 4 times worse. In comparing these findings with those of the earlier national study,[11] both the prevalence and severity of caries and the number of decayed teeth were lower in 2004–2005 than in 1990–1991. However, much or all of this difference could be the result of the children in the current study being about 2 years younger. The proportions of deciduous maxillary anterior teeth filled and extracted remained much the same over the 15 years.

Our findings should provide Health and Social Service Authority planners with information for the development of health promotion and service delivery programs for the children in Inuvik Region.

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***Acknowledgments:** The authors would like to acknowledge M. Clarke, MSc, for the data entry and cleaning.*

The study was funded by the Inuvik Regional Health and Social Services Authority through the Primary Health Care Transition Fund.

The authors have no declared financial interests.

This article has been peer reviewed.

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