

# Prevalence of Caries among Preschool-Aged Children in a Northern Manitoba Community

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## A b s t r a c t

**Background:** Early childhood caries (ECC) is a devastating form of dental decay affecting many Canadian children, especially those from northern First Nations communities. ECC is multifactorial in origin, and the notion that the principal etiology is inappropriate feeding modalities is no longer tenable.

**Methods:** This study was conducted in the community of Garden Hill First Nation, Manitoba, to assess the prevalence of dental decay in young children, to assess risk factors for ECC and to determine the influence of vitamin D supplementation (a modified form of stostherapy using 100,000 IU vitamin D), both prenatally and at 6 weeks of age, on the oral health of children. The study involved a cross-sectional dental examination of children, an interview with mothers and a maternal chart review.

**Results:** A total of 98 children participated: their mean age was  $46.4 \pm 6.3$  months. The mean number of decayed, extracted and filled teeth (deft) was  $13.7 \pm 3.2$ . Caries rates were significantly greater among children who had had sugar added to the feeding bottle. Behaviours typically associated with ECC and caries activity, such as poor oral hygiene and late weaning from the bottle, were also exhibited among residents. Although 50% of children had enamel hypoplasia, no statistically significant differences in the amount of enamel hypoplasia and caries were found between those who received modified stostherapy and those who did not. Not receiving stostherapy was associated with later eruption time of the first primary tooth (7.2 vs. 5.0 months). Interviews revealed that, during pregnancy, many of the mothers only infrequently consumed foods rich in calcium and vitamin D, elements that are essential to the development of strong bones and teeth.

**Conclusions:** The mean deft for these First Nations preschoolers was high and 50% had enamel defects. Although daily vitamin D supplementation of 400 IU during pregnancy has been known to reduce primary tooth enamel defects, the supplementation previously administered to participants in this study was not found to result in reduced enamel defects or caries. The high caries burden among children from this community reveals the need for effective prevention methods. It is important for pediatricians, family physicians and other health service providers encountering very young children and expectant mothers to be cognizant of ECC and its ramifications, as their education efforts represent the first line of defence.

**MeSH Key Words:** Canada; child, preschool, dental caries/epidemiology; vitamin D

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Dental caries disproportionately affects the North American Aboriginal population, especially children. Several Canadian studies<sup>1-5</sup> have revealed that the prevalence of decay among Aboriginal children and other children living in the north is high compared with the general population. This is generally attributed to the lower socioeconomic status of these groups<sup>3</sup> and their limited

access to dental care.<sup>1,5</sup>

Formerly called “baby bottle tooth decay,” the term “early childhood caries” (ECC) has been adopted to raise awareness of the multiple factors involved in the etiology of this disease, rather than continuing to attribute cause solely to feeding practices. Associations between ECC and improper feeding modalities are not consistent,<sup>6,7</sup> and they are not

longer considered to be the principle etiology. Prevention efforts addressing inappropriate feeding methods have had limited success in reducing ECC. A current definition of ECC, adopted by the American Academy of Pediatric Dentistry (AAPD), is the presence of at least 1 primary tooth affected by caries in children under 6 years of age.<sup>8-10</sup> Others have classified ECC according to 3 specific presentations: isolated decay of primary incisors or molars, decay of primary incisors with or without molar decay, and decay exhibited throughout most of the primary dentition.<sup>11</sup> Whether these 3 patterns are discrete or represent sequential stages of a single disease process remains obscure.

The traditional etiologic triad for the caries process includes susceptibility of the host (tooth enamel), diet (fermentable sugars) and exposure to cariogenic bacteria over time.<sup>12,13</sup> A multitude of other factors have also been associated with ECC, including socioeconomic status,<sup>14-16</sup> psychosocial issues and child-rearing practices.<sup>11,15</sup>

If left untreated, ECC can lead to abscesses, pain and malocclusions. Treatment often includes extraction of the primary maxillary incisors and placement of stainless steel crowns to rehabilitate decayed primary molars, frequently performed under general anesthesia due to the young ages of the patients and the complex nature of care required.

Nutritional stress during prenatal development may also affect the integrity of the developing primary tooth enamel, thus limiting the ability of the tooth to resist bacterial invasion and caries.<sup>13,17,18</sup> Enamel hypoplasia has already been identified as an additional risk factor in ECC development.<sup>11,12,19,20</sup> Episodes of malnutrition or deficiencies during enamel formation can predispose teeth to enamel hypoplasia.<sup>18,21,22</sup> Expectant mothers of low socioeconomic status are at a considerable disadvantage as they often cannot afford to meet their increasing nutritional needs. Therefore, investigation of the relation between prenatal nutrition and ECC is worth pursuing. Like ECC, enamel hypoplasia has also been found to be more prevalent among children in populations with lower socioeconomic status.<sup>12,19,23,24</sup>

It is well established that nutritional deficiencies exist among Aboriginal people in Canada.<sup>25</sup> Recent research places the prevalence of prenatal vitamin D deficiency in northern Manitoba at more than 80%.<sup>26</sup> Reasons for nutritional insufficiencies are generally ascribed to a lack of purchasing ability, cost and availability of food and access, along with inadequate dietary education in the community.<sup>25</sup> Recent attempts have been made to draw attention to the cost of milk in northern Manitoba First Nations communities, which hovers around \$12 Canadian for 4 litres<sup>27</sup> compared with \$4 in Winnipeg. Such prices obviously deter many families from purchasing and consuming milk. Widespread vitamin D deficiencies have prompted some northern communities to initiate a modified form of stosstherapy to improve the vitamin D status of their residents and as a rickets prevention strategy. The practice originated in Europe, where some countries have implemented routine administration of 600,000 IU of ergocalciferol

delivered orally 6 times during the first 18 months of life.<sup>28</sup>

Our investigation was conducted to assess the prevalence of caries, to determine potential risk factors for ECC and to study the effects of modified stosstherapy on the primary dentition. Mothers were interviewed regarding infant feeding practices, oral hygiene and dental care of their children, and their health and nutrition during pregnancy.

Cockburn and colleagues<sup>29</sup> showed that maternal vitamin D supplementation of 400 IU a day during pregnancy reduces enamel defects significantly ( $p < 0.01$ ) in the primary teeth, the only known study to report such a finding. A natural opportunity for research in this area was created by a program designed to eliminate rickets in a community where it was endemic. Children born in Garden Hill after 1994 were included in a program where a modified form of stosstherapy was used to reduce concern over hypervitaminosis D and toxicity associated with standard stosstherapy. Mothers were offered 100,000 IU of oral vitamin D (ergocalciferol) at diagnosis of pregnancy and in the third trimester, and their babies could receive the same dose at 6 weeks of age. The hypothesis was that this would also reduce the amount of enamel hypoplasia expressed in the primary teeth, thus potentially reducing the threat of increased caries activity. The introduction of this supplementation has eliminated rickets in Garden Hill (Drs. M. Moffatt and B. Martin, personal communication, March 2004).

## Materials and Methods

Beginning in 1999, a pediatric dental survey was conducted in Garden Hill First Nation, Manitoba. This community, situated on the north shore of Island Lake, is 610 km northeast of Winnipeg, the provincial capital.<sup>30</sup> In 1999, there were 2,241 on-reserve residents.<sup>31</sup>

A cross-sectional and retrospective cohort study design was employed to investigate the oral health of young children. According to band documentation, there were 179 eligible children, i.e., those born in the year before and the year after the introduction of the stosstherapy program. Participant information and consent forms were used in the recruitment of study volunteers. The study was approved and facilitated by the Garden Hill First Nation Band Council and this research was approved by the Health Research Ethics Board, University of Manitoba. Parents or guardians were approached to consent to have their preschool child undergo a thorough dental examination by a pediatric dentist. In addition, mothers were asked to participate in a structured interview conducted by the study coordinator, and chart reviews were performed to determine supplementation status. The dental examiner (CL) was blind to the interview and chart review data.

The dental examination was limited to the primary dentition and information was collected relating to dental caries, missing or extracted teeth, enamel hypoplasia and previous restorative treatment following World Health Organization criteria.<sup>32</sup> The half-hour interview consisted of 36 questions focusing on oral hygiene practices and

**Table 1** Mean number ( $\pm$  standard deviation) of decayed (d), extracted (e) and filled (f) teeth and deft in the study population

	All children (n = 98)	3 year olds (n = 10)	4 year olds (n = 62)	5 year olds (n = 26)
d score	6.6 $\pm$ 5.4	9.0 $\pm$ 6.0	6.6 $\pm$ 5.0	5.7 $\pm$ 5.9
e score	3.6 $\pm$ 2.6	2.5 $\pm$ 2.7	4.0 $\pm$ 2.6	3.1 $\pm$ 2.5
f score	3.6 $\pm$ 4.5 (range 0–16)	1.2 $\pm$ 3.2 (range 0–10)	3.4 $\pm$ 4.3 (range 0–13)	4.9 $\pm$ 5.0 (range 0–16)
deft score	13.7 $\pm$ 3.2	12.7 $\pm$ 5.6	13.9 $\pm$ 2.8	13.7 $\pm$ 2.9

previous dental care of the child, early childhood eating habits, maternal health and nutrition and mother and infant exposure to vitamin D. Some questions were structured to assist with recall. Chart reviews were performed to confirm whether women received the modified stostherapy during pregnancy and whether young infants received a high dose of ergocalciferol at 6 weeks of age.

The interview and dental examination results were coded for anonymity, and mother and child components were combined. Study data were analyzed using both SAS version 7 (SAS Institute, Cary, N.C.) and NCSS 6.0 (NCSS Statistical Software, Kaysville, Utah).

## Results

Of the 179 eligible children, 98 (54.8%) participated in this study; others left the community and some parents did not consent to their child's participation. The mean age of participating children was 46.4  $\pm$  6.3 months (about 3.8 years); the mean age of the mothers was 27.1  $\pm$  5.1 years; 57 (58.2%) of the children were male. Mothers' highest level of education completed ranged from grade 3 to 12, with a mean of 9.4  $\pm$  1.9.

The mean deft was 13.7  $\pm$  3.2, and only 1 child had a deft score of 0. According to the AAPD definition, 98.9% of children in this sample had ECC. Mean scores for decayed (d score), extracted (e score) and filled teeth (f score) and overall deft appear in Table 1. Half of the children were observed to have enamel hypoplasia.

Various oral hygiene and preventive practices, such as tooth brushing, use of toothpaste and infant fluoride drops were assessed (Table 2). The mean age for initiating brushing was 2.1  $\pm$  0.9 years.

The interview posed questions related to infant feeding methods and child feeding practices (Table 2). Breastfeeding was common, with 57 respondents (62.0%) reporting that they breastfed their child. The mean age for weaning was 18.6  $\pm$  13.8 months. Eighty women indicated that they gave their child a bottle at some stage during the child's infancy. Women initiated bottle-feeding at 9.1  $\pm$  17.2 months (range 0–30 months, median 2 months) and stopped it at 29.5  $\pm$  17.1 months. In bottle-feeding, many mothers routinely engaged in practices associated with high risk of caries: putting their child to bed with a bottle, giving the bottle on demand and adding sugar to the bottle, all of

which are generally known to promote decay.<sup>33</sup> Bottle contents also varied and included formula, canned milk, whole milk, tea, juice, Kool-Aid and soft drinks. Formula (32.5%), canned milk (25.0%) and whole milk (23.8%) were the most common bottle contents.

The mean age for the eruption of the first tooth was 6.1  $\pm$  3.7 months, the average child's first dental visit occurred at 2.3  $\pm$  1.0 years, and the mean age of the first diagnosis of caries by a dentist or dental therapist was 2.3  $\pm$  0.8 years. Forty per cent of children were diagnosed with caries by 2 years of age (confidence interval [CI] 28.5–51.5%), 41.3% (CI 31.2–51.4%) traveled to Winnipeg for treatment, and 39.1% (CI 28.8–49.4%) required general anesthesia for dental treatment.

Recurrent caries following treatment was also found among those who had prior restorative treatment, extractions or newly decayed teeth. For example, the average child had 3.6  $\pm$  4.5 teeth filled or restored with stainless steel crowns and 3.6  $\pm$  2.6 teeth extracted due to caries, yet had 6.6  $\pm$  5.4 teeth that were affected by active or untreated decay.

Analysis of variance was performed to determine whether other relations existed between variables in this study. No gender or age differences were apparent with respect to caries rates. Children having dental treatment in Winnipeg had higher deft scores ( $p < 0.05$ ): 14.7  $\pm$  2.6 compared with 13.2  $\pm$  2.8. This is likely due to the fact that the most severe cases of ECC were sent to Winnipeg for treatment. Children who underwent general anesthesia and came to Winnipeg had a significantly greater number of teeth extracted ( $p < 0.001$ ) and filled ( $p < 0.001$ ) than children who did not, but also had less untreated decay than those who underwent treatment in their own community ( $p < 0.001$ ).

Analysis of variance was also performed to assess whether caries experience was associated with behaviours known to be risk factors for ECC, such as night-time bottle use, frequent consumption of fermentable sugars and poor oral hygiene. Mean deft was found to be associated with adding sugar to the child's bottle (14.3  $\pm$  2.8 compared with 13.1  $\pm$  2.5,  $p < 0.06$ ). A higher mean deft score (15.1  $\pm$  2.6 vs. 13.6  $\pm$  2.8,  $p < 0.05$ ) was also associated with households not equipped with refrigerators, perhaps serving as a proxy measure of household socioeconomic status or of milk consumption by household. Multiple regression analysis confirmed that these 2 variables were significantly associ-

**Table 2** Oral hygiene and feeding practices and maternal diet reported during interviews with mothers

	Percentage of respondents	95% CI
<b>Child's oral hygiene and preventive practices</b>		
Brush independently	54.4	44.1–64.7
Brush a few times a week or less	70.3	59.1–81.5
Brush daily	29.6	18.4–40.8
Brush before bed	29.4	16.9–41.9
Use toothpaste	95.4	90.3–100.5
Brush for $\geq 1$ minute	50.8	38.4–63.1
Use fluoride drops	8.1	2.3–13.9
<b>Child feeding practices</b>		
Breastfeed	62.0	52.0–71.9
Bottle-feed	87.9	81.2–94.6
Put child to bed with bottle	86.1	78.5–93.7
Give bottle on demand	67.7	57.4–78.0
Add sugar to bottle	65.4	54.8–76.0
<b>Dietary intake of mothers</b>		
Drink milk daily	34.5	24.5–44.5
Consume milk with cereal a few times a week or more	71.6	62.2–81.0
Consume cheese a few times a week or more	73.9	64.7–83.1
Eat fish a few times a week or more	35.2	25.2–45.2
Eat animal organ meats (e.g., liver) a few times a week or more	13.6	6.4–20.8
Eat soup from animal or fish stock a few times a week or more	40.9	30.6–51.2

**Table 3** Multiple regression analysis of factors potentially affecting mean deft

	Correlation coefficient	95% CI
Add sugar to bottle	-1.37 <sup>a</sup>	$\pm 1.27$
No refrigerator	1.58 <sup>a</sup>	$\pm 1.45$
Vitamin D supplementation	-0.075	$\pm 1.24$
Bottle in bed	0.87	$\pm 1.84$
Breastfeeding	0.88	$\pm 1.24$

CI = confidence interval.

<sup>a</sup> $p < 0.05$ 

ated with caries ( $p < 0.05$ ) (Table 3). No significant associations were found between bottle-feeding and duration of breastfeeding and mean deft.

This study also posed questions to mothers about their health and nutrition. Five (5.8%) respondents were diabetic and 12 (13.2%) reported gestational diabetes. Women's responses with respect to dietary intakes of specific food items appear in Table 2.

As this study also attempted to assess the influence of supplemental ergocalciferol on the primary dentition of the child, analysis of variance was performed to determine whether supplementation was associated with the presence of enamel hypoplasia and caries. Results were negative (Table 4). In addition, vitamin D supplementation was not associated with fewer decayed teeth. No statistically significant differences were found among supplemented and unsupplemented groups in either comparison ( $p > 0.9$  and

$p > 0.5$ , respectively).

Although analysis of variance did not demonstrate a significant relation between prenatal modified stoss therapy and hypoplasia or caries, it did show an association with time of eruption of the child's first tooth. Mothers who did not receive this prenatal supplementation reported later eruption times than mothers who received supplementation ( $p < 0.15$ ) (Table 5). When the "unsure" category was removed from this analysis, the difference in eruption times between supplemented and unsupplemented groups became statistically significant ( $p < 0.05$ ).

## Discussion

Little published epidemiologic data for ECC exist in Canada, especially for children in Manitoba. This study provides much-needed information on the oral health status of children residing in a northern First Nations community in the province and highlights the need to improve their oral health status.

Caries experience was high for the population under investigation. The mean deft of  $13.7 \pm 3.2$  is far larger than deft scores observed in other regions of Canada's North,<sup>34–36</sup> and only 1 child in the cohort did not have ECC. Deft scores for 3–5 year olds from the Keewatin and Churchill, Manitoba, assessed in the early 1990s were  $8.12 \pm 5.49$  and approximately 2.0, respectively.<sup>34,35,37</sup> Recent unpublished data on the oral health status of 4- and 5-year-old treaty status Aboriginal children from Churchill show a mean deft of  $1.60 \pm 3.58$  teeth (Drs. R. Schroth and D. Brothwell,

**Table 4** Influence of stostherapy on enamel hypoplasia and deft

	Stostherapy			<i>p</i>
	Yes ( <i>n</i> = 41)	No ( <i>n</i> = 30)	Unknown ( <i>n</i> = 27)	
Mean number of teeth with enamel hypoplasia	1.7 ± 2.5 (range 0–11)	1.6 ± 2.2 (range 0–6)	1.7 ± 2.0 (range 0–6)	> 0.9
Mean deft	14.1 ± 2.3	13.3 ± 3.5	13.7 ± 3.9	> 0.5

**Table 5** Influence of stostherapy on primary tooth eruption

Maternal vitamin D supplementation (stostherapy)	<i>n</i>	Eruption age (months ± SD) <sup>a</sup>
Yes	23	5.0 ± 2.2
No	18	7.2 ± 4.6
Unsure	18	6.4 ± 4.1

*SD* = standard deviation.

<sup>a</sup>Eruption times between the yes and no categories of supplementation were significantly different (*p* < 0.05).

personal communication May 24, 2002).

The mean d, e, and f scores of the pediatric population under study in Garden Hill reveal a great deal of active decay: d = 6.6 ± 5.4 teeth. We must be cautious in interpreting the e score, as this was likely enlarged due to the practice among pediatric dentists of extracting decayed primary maxillary incisors rather than restoring these teeth. Although many children did receive dental treatment in the north, they had far more decayed teeth than children who underwent treatment in Winnipeg under general anesthesia (*p* < 0.001). This perhaps indicates the need for additional treatment opportunities or modalities if treatment is to continue to be provided in this isolated community.

Forty-one per cent of the children underwent dental treatment in Winnipeg. As expected, these children had a significantly higher deft score than children who did not undergo such treatment. Analysis of variance also revealed that higher deft was associated with adding sugar to bottles. Higher deft scores were observed in children from households that did not have a refrigerator. The presence of a refrigerator may serve as a proxy measure of socioeconomic status, or it might more realistically indicate that those homes purchased milk because they had the capacity to store it.

Most mothers stated that they bottle-fed their child (87.9%) at some point and stopped at 29.5 ± 17.1 months. This is more than twice the AAPD-recommended bottle weaning age of 12–14 months.<sup>9</sup> Also, 86.1% of mothers admitted that they put their child to bed with the bottle, which is contrary to expert advice.<sup>9</sup> A large segment of the children were brushing independently, but 70.3% of mothers indicated that their children were brushing a few times a week or less and only 29.4% were doing so before bed. The mean age at which tooth brushing commenced was also late, at 2.1

± 0.9 years of age, and reinforces the need for better parental education surrounding oral hygiene for young children.

An objective of this study was to determine whether modified stostherapy during pregnancy or infancy could reduce ECC and enamel hypoplasia in the primary dentition. However, the participant children were beyond the desirable ages to assess enamel hypoplasia and ECC in the primary maxillary incisors. This precluded a proper assessment of prevalence. We intended to examine children at age 3, but logistical problems, including difficulty in securing and retaining a local coordinator, delayed the study. Level of intake of ergocalciferol also varied among the study population.

Modified stostherapy was associated with eruption time of the child's first primary tooth. Children whose mothers did not receive 100,000 IU ergocalciferol had eruption times significantly later than children of supplemented mothers (*p* < 0.05). This finding is consistent with other reports of effects of malnutrition, premature birth and neonatal nutrition on primary tooth eruption.<sup>38–40</sup> The association supports the hypothesis that vitamin D can influence the development of the primary dentition.

This investigation yielded several interesting findings with respect to maternal nutrition and prenatal health, oral hygiene practices of children and dental caries. In general, mothers reported infrequent intake of foods known to contain high levels of calcium and vitamin D and were unlikely to have received the recommended daily amounts during pregnancy. For example, level of daily milk consumption among mothers was low and consumption of fish was infrequent. The diet of First Nations people has changed considerably over recent decades. Unfortunately, some types of nutritional deficiencies have increased significantly over this same time.

A limitation of this study was participation rate (55%). We do not know the direction of the potential bias, but it is possible that parents whose children were known to have dental problems were more likely to participate, accounting for the extraordinarily high mean deft. However, even if we make the unlikely assumption, that all non-participants were caries free, the mean deft for the entire population would still be 7.5, close to the highest rate reported elsewhere. There can be no doubt that ECC is a problem in Garden Hill.

Another limitation was the retrospective design of the interview. Many of the mothers indicated that they had

difficulty recalling specific information. They also had difficulty recalling when they first noticed their child had caries and the time of the first dental visit. This may have also influenced their ability to recall the exact eruption time of their child's first tooth.

We should have examined children at an earlier age. To assess the effect of vitamin D supplementation on the presence of enamel hypoplasia, subjects should have been identified and assessed as soon as their primary teeth erupted, starting at 6–9 months of age. As many of the children enrolled into this study had caries and had already undergone dental treatment, it was not possible to fully evaluate hypoplasia status. Several children also had missing primary maxillary incisors, which led the investigators to believe that they had been affected by caries. Had infants been examined as the primary maxillary incisors were erupting, then followed prospectively, the hypothesized effects of stostherapy on the primary dentition may have been observed. One other limitation included variation in the frequency and timing of supplementation in the supplemented group while amelogenesis was occurring, as well as small numbers for statistical analysis (supplementation: 41 yes, 30 no).

The AAPD recently published oral health policies with respect to ECC.<sup>9</sup> In this document, reference is made to the need for women to receive proper nutrition during the period when primary teeth are forming in the fetus, as it is known that hypoplasia of primary teeth is related to ECC.<sup>9</sup> In addition, the AAPD recommends that children at high risk for ECC be screened at early ages, within months of eruption of the first tooth.<sup>9</sup>

New front-line prevention efforts need to be targeted at expectant mothers to ensure that their nutritional intake is sufficient during the stage when primary tooth enamel is forming.<sup>12</sup> Future epidemiologic studies in prenatal nutrition, ECC and enamel hypoplasia are needed, especially those that are prospective in design. Evidence exists to encourage the intake of 400 IU of vitamin D daily during pregnancy,<sup>29</sup> but research is needed to determine the effective dosage and schedules for intermittent supplementation for the prenatal population not receiving 400 IU daily.

## Conclusions

The mean deft score was  $13.7 \pm 3.2$ . High-risk behaviours for ECC, such as poor oral hygiene and bottle-feeding practices, were routine within this cohort, while maternal intake of foods rich in vitamin D and calcium were infrequent. Higher caries rates were observed among children who had sugar added to their bottles. Modified stostherapy was not associated with a reduction in dental caries or the presence of enamel hypoplasia, but was associated with eruption time of the first primary tooth (those not receiving it had a later eruption time). The high caries burden among children from this community reveals the need for effective prevention methods.

First Nations children and those of low socioeconomic

status are at particular risk for ECC. Thus, both medical providers and those working with pregnant women and the very young must play an integral role in the prevention and early detection of ECC. It is important for pediatricians, family physicians and other health service providers encountering expectant mothers and very young children to be cognizant of ECC and its ramifications, as they represent the first line of defence. ♦

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