Dental caries disparities in early childhood: A study of kindergarten children in British Columbia

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ABSTRACT

OBJECTIVE: The objective of this paper was to describe results of a public health-administered, provincial dental survey of children aged 4–6 years old in British Columbia, and assess the changes in rates of dental caries geographically and by neighbourhood socio-economic status between baseline (2006/07) and follow-up data collection (2009/10).

METHOD: The study design involved two retrospective cohorts of kindergarten children who received a public health-administered dental assessment in the years 2006/07 and 2009/10. Neighbourhood socio-economic status was measured by an index created from Canadian Census and Tax Filer data sets. The dental outcomes included previous decay experience, untreated visible decay, and urgent treatment needs.

RESULTS: The analysis comprised dental outcomes for 35,602 kindergarten children in 2006/07 and 35,215 children in 2009/10. There was a modest decrease in dental decay rates between surveys, with rates of decay experience – previous and untreated – of 38.9% and 36.7% respectively. However, there were disparities, with almost 50% of children with dental decay in the most socio-economically disadvantaged neighbourhoods, and approximately 30% with dental decay in the least disadvantaged areas.

CONCLUSION: The kindergarten dental survey had extensive coverage, was at the population level, and enabled analysis of change in early childhood dental decay rates over time and by geography. Although overall rates improved, dental health inequalities persisted in both survey years at both regional and neighbourhood levels.

KEY WORDS: Dental caries; oral health; child; trends; surveillance; British Columbia

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Dental caries (tooth decay) is the most common chronic disease in childhood – five times more common than asthma and seven times more common than hay fever.¹ The etiology of caries in young children is multifactorial, involving a combination of social, behavioural, microbiologic, environmental and clinical factors.¹ The disease occurs worldwide, afflicting predominantly disadvantaged children.² Various cohort studies have shown that children with previous caries experience are at elevated risk for future caries.^{3,4} While dental caries in childhood is common, it is also preventable. Early dental health surveillance programs are an important element of public health service delivery, as they seek to increase the potential for children to remain disease-free. Due to the impact of dental caries on health and the inequities in access to regular preventive and restorative dental care, the prevention of dental diseases is a core function of public health in British Columbia (BC), and dental health is recognized as one of the core programs for public health services across the province.

Despite its significance to public health programming, there is a paucity of information available about the state of oral health for young children at the population level. According to the U.S. National Health and Nutrition Examination Survey (NHANES 2011–12), an estimated 37% of children age 2–8 had experienced dental caries in their primary teeth in 2011–2012. The Canadian Health Measures Survey conducted from 2007 to 2009 revealed

that 57% of 6–11 year olds in the country have or have had a cavity.⁵

Most studies of dental caries in young Canadian children involve smaller, non-representative samples or subpopulations. For instance, one study reported improvements in the dental health of Aboriginal children in BC between 1980 and 1988,⁶ and another study in Northern Manitoba revealed high DEFT scores (decayed, extracted and filled teeth) among First Nations preschoolers.⁷ Other studies have been informative in providing information about dental caries prevalence among samples of 5 year olds in the United Kingdom,^{8–10} but there continues to be

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limited understanding of oral health inequities in Canada and across diverse geographic contexts.

Data from provincial public health surveys of dental caries at the age of school entry have not been extensively used to understand the nature and extent of oral health inequities in young children by geographical location. Population-level dental survey data can contribute contextualized oral health status and trend data that can be useful for informing public health program planning. In public health, evidence-based intervention planning that draws from knowledge of caries risk geographically and from the broader social environment more generally, offers alternatives to individual-level risk factor approaches, which for public health purposes can be impractical and imprecise.¹¹

The kindergarten dental survey in BC is implemented province-wide through 5 regional health authorities, further subdivided into 16 health service delivery areas. Northern health authority, while the largest geographically, provides the lowest population density.¹² This contrasts with Fraser and Vancouver Coastal, which are predominantly urban and ethnically diverse and account for the majority of BC's population.¹² The remaining health authorities (Interior and Vancouver Island) include a mix of urban centres and rural and remote areas.

In 2005, BC's Ministry of Health established a province-wide target for at least 60% of the kindergarten population to have "no visible decay experience." The dental survey is a key information source for monitoring trends between regions and within communities, as well as evaluating outcomes of multiple prevention strategies that aim to decrease the rate of dental caries in young children. The survey was introduced in 1990, but only since 2006 have there been standards for consistent data collection. A *Dental Screening Manual* developed by the BC Dental Public Health Committee in 2006 provides standardized guidelines to conduct the dental survey.¹³ All dental staff conducting kindergarten surveillance in BC are trained according to these guidelines to record through visual inspection teeth/surfaces that have decay and/or previous treatment. These guidelines are consistent with the Association of State & Territorial Dental Directors' (ASTDD) 2011 recommendations for oral health surveillance of school-aged children.¹⁴

As was the case in other jurisdictions using similar visual measures (without radiographs), the Basic Screening Survey (BSS) used in BC counts decay experience if there is obvious visible decay, fillings or teeth missing.¹⁵ Although the BSS does not provide the detail of tooth-and-surface-specific data, it is intended to provide public health programs with standardized data that are simple to collect and interpret, yet informative for program planning and decision-making purposes.^{15,16} The information gathered is at a level consistent with monitoring national health objectives found in the U.S. Public Health Service's Healthy People 2020 publication.¹⁷ Although there is little research on the validity and reliability of the BSS measure, a 1994 study of 632 elementary schoolchildren in Georgia, US found high validity for caries and treatment needs (>90% sensitivity, specificity, and predictive values in a sample having 30% to 40% prevalence).¹⁷ The BSS has been noted to be a quicker and more cost-efficient method of collecting data on dental caries than more formal epidemiological surveys using

the Decayed, Missing, Filled, Teeth or Surfaces (DMFT/DMFS) measures.^{18,19}

The objective of this paper was to describe results of the public health-administered, provincial dental survey of children aged 4–6 years old in BC, with the specific aim of assessing the changes in rates of dental caries geographically and by neighbourhood socio-economic status (SES) between baseline (2006/07) and follow-up data collection (2009/10).

METHOD

The study design involved two retrospective cohorts of kindergarten children who received a public health-administered dental assessment in the years 2006/07 and 2009/10. Prior to conducting the surveys, dental staff (i.e., registered Dental Hygienists and Certified Dental Assistants) developed competencies and consistent technique through observation, practice, calibration and evaluation. Dental staff demonstrated competencies with the clinical objectives by screening a minimum of 40 children at a 95% agreement level with a dental public health supervisor.

Dental staff collected survey data from kindergarten children between the ages of 4 and 6 at school sites and, in a small number of rural areas, at community settings. Through visual inspection of each child's mouth using a small light and tongue depressor, they inspected kindergarten children's mouths for broken enamel, existing restorations, and urgent treatment needs. Diagnostic criteria for assigning a code of visible decay included observations of obvious decay as evidenced by broken enamel (i.e., caries of dentine). Any fractured/broken tooth or broken/lost restoration (including temporary fillings) was considered broken enamel and coded as visible decay. Shadowing without broken enamel was not considered visible decay. Dental staff recorded the presence of: 1) no visible decay or restorations; 2) no visible decay but with existing restorations (e.g., fillings or crowns); or 3) obvious decay or broken enamel. These classifications are mutually exclusive – the sum of children in each category is equal to the number of kindergarten students surveyed.

A fourth classification was used for children in need of immediate dental care (e.g., a child who is in obvious pain at the time of the survey or has obvious visible infection as evidenced by an abscess, gross swelling, or the presence of pus). Students who have had previous treatment, who have visible decay, or who have no visible decay present can also have urgent treatment needs.

Dental decay rates were calculated by aggregating school-level information on outcome codes (i.e., current or previous decay and urgent treatment needs) into 478 neighbourhoods and 5 health regions; 437 neighbourhoods had available data across both survey years, 440 neighbourhoods had data in 2006/07, and 467 neighbourhoods had data in 2009/10.

Each neighbourhood included data for 3.2 schools on average, with a minimum of 1 school and as many as 14 schools per neighbourhood. Neighbourhood boundaries were previously identified²⁰ through a consensus-building process involving Early Child Development Coalitions. These boundaries are demarcated based on natural social and economic divisions; natural or other physical boundaries; local municipal

boundaries; school catchment areas; and neighbourhood association boundaries. Data were incorporated into interactive and static maps where rates were comparable at school, neighbourhood and regional levels.

Dental decay rates were also studied in relationship to five neighbourhood-level SES classifications: low, moderately low, moderate, moderately high, and high. Neighbourhood-level SES was determined using a SES index, which was created for the purpose of studying area-level SES in relationship to early child development outcomes.²¹ The SES index includes several subcomponents (e.g., Wealth, Education, Unemployment) and is based on data from the 2006 Census and 2004 Tax Filer datasets. Each variable used in the SES index was standardized to have a mean of 0 and standard deviation of 1 (list of variables and components available upon request). The SES index was then constructed by taking the mean of these standardized component scores.

Analysis of Variance (ANOVA) was conducted to determine whether rates of dental decay between health authorities were significantly different from one another. Paired-samples *t*-tests and tests of effect size (Cohen's *d*) were used to assess changes in rates across survey years, with neighbourhoods as the unit of analysis. Ethical approval was obtained from the University of British Columbia's Behavioural Research Ethics Board.

RESULTS

Dental public health staff surveyed 91% of all children enrolled in kindergarten: 35,602 of 38,891 children in 2006/07 and 35,215 of 38,677 children in 2009/10. The average provincial rate of decay dropped between 2006/07 (38.9%) and the follow-up survey in 2009/10 (36.7%) by 2.2 percentage points. The proportion of children with no visible decay, with restorations was slightly higher in 2006/07 (21.6%) than in 2009/10 (19.7%). Rates

of visible decay (17.0%–17.3%) and urgent treatment needs (2.0%–2.1%) remained stable across years. Figure 1 presents the percent of kindergarten students by health authority that fell into each dental outcome category in each survey year.

Results of the ANOVA revealed significant differences in decay rates between health authorities in 2006/07 ($F_{4, 432} = 4.971$; $p < 0.001$) and 2009/10 ($F_{4, 432} = 7.401$; $p < 0.001$). Results of the paired samples *t*-test indicated that the decrease in average decay rates across survey years for the sample of 437 neighbourhoods with survey data in both years was statistically significant ($t = -3.44$, $p = 0.001$). The calculated effect size (Cohen's *d*) was $d = .15$. A series of paired samples *t*-tests were also run for health authorities and health service delivery areas. Two of five health authorities showed statistically significant improvements in oral health: Interior ($t = -3.38$; $p = 0.001$) and Vancouver Coastal ($t = -5.98$; $p < 0.001$). No health service delivery areas showed significant increases in decay rates.

Rates of decay experience in each survey year also varied across neighbourhoods. Overall, 72 neighbourhoods decreased in dental decay and 47 increased between surveys. Ten neighbourhoods experienced a 25% decrease in number of children identified with dental decay; whereas four neighbourhoods experienced a 25% increase. The decay rate in one neighbourhood (East Boundary) in the Interior decreased by more than half between surveys; 52.0% in 2006/07 ($n = 77$) and 24.3% in 2009/10 ($n = 74$). The proportion of neighbourhoods in 2006/07 and 2009/10 that met the provincial target of 60% or more children without visible dental decay is reported in Table 1.

In four of five health authorities, the proportion of neighbourhoods with decay rates at 40% or higher decreased across survey years; one health authority, Fraser, experienced a 7% increase. This is noteworthy because while Fraser covers the smallest area geographically, it has the highest number of

Figure 1. Kindergarten dental survey outcomes for the province and by regional health authority, 2006/07 and 2009/10

Table 1. Neighbourhoods meeting provincial goal of having 60% or more of kindergarten children without visible dental decay

Health authority		Survey year			
		2006/07		2009/10	
		Yes	No	Yes	No
Interior	#	59	37	64	39
	%	61.46	38.54	62.14	37.86
	n	5465		5574	
Fraser	#	103	61	91	72
	%	62.80	37.20	55.83	44.17
	n	14,256		13,660	
Vancouver Coastal	#	34	29	42	21
	%	53.97	46.03	66.67	33.33
	n	7799		7681	
Vancouver Island	#	59	26	66	22
	%	69.41	30.59	75.00	25.00
	n	5313		5320	
Northern	#	11	21	22	28
	%	34.38	65.63	44.00	56.00
	n	2769		2980	
Total (BC)	#	266	174	285	182
	%	60.45	39.55	61.03	38.97
	n	35,602		35,215	

5-year-olds ($n = 17,445$).¹² When analyzed at the neighbourhood level, there were very disparate changes in dental decay rates across survey years, as reflected in Figure 2. In both survey years, the majority of neighbourhoods in Northern reported decay rates of 40% or more. Northern has the smallest 5-year-old population ($n = 3,520$) and highest proportion of Aboriginal peoples.¹² Vancouver Island consistently reported the lowest proportion of neighbourhoods with rates above 40%.

Using the SES index, we found that dental decay rates declined across survey years for all levels of SES; however, dental decay rates varied greatly depending on the SES of the neighbourhood (see Table 2). Approximately half of children from low SES neighbourhoods (49.2%) experienced dental decay in 2006/07 compared to 37.3% of children from moderate-level SES neighbourhoods and 30.5% of children from high SES neighbourhoods.

DISCUSSION

The overall reported prevalence of dental caries varies dramatically depending on case definition, population studied, and research methods employed.¹⁵ The small number of published studies that utilized a similar type of survey measure generally reported higher rates of dental caries than were found in BC. This was to be expected, however, as these previous studies involved sample-based data or vulnerable subpopulations of underserved or untreated children (e.g., Head Start), rather than data for an entire age cohort.^{16,22} Other surveys conducted with smaller samples in the US yielded rates of decay experience and untreated decay that exceeded²³ or were comparable to the rates of BC children.²⁴ Overall, in BC, there was a small decrease (approximately 2%) in the proportion of children with decay experience between 2006/07 and 2009/10, with a similar decrease in the proportion of children with no decay, with restorations. Such decreases may reflect improvements in dental health over time and also a reduced need for restorations,

possibly owing to provincial and regional investments in universal early childhood public health screening programs and early childhood dental health programs, including dental health risk assessments (e.g., 12-month caries risk assessment), preventive counselling and education, and non-invasive management of caries at public health units through fluoride varnish applications for children five and under.

As noted in other studies that utilized the Basic Screening Survey, rates reported in this paper are likely underestimates of caries prevalence, because radiographs were not used and detailed tooth- and surface-specific data were not collected.¹⁶ Caries progression was also not assessed, since indicators such as caries lesion activity data (e.g., active and inactive/arrested caries)²⁵ were not collected. Also, because the diagnostic cut-off used in the dental public health surveys was for dentine caries only, early stages of decay, including initial caries and visible enamel decay, were not captured.²⁶ Another study limitation was that although dental public health staff adhered to a standardized set of provincial guidelines and procedures for calibration and evaluation, involvement of multiple surveyors across different regions may have resulted in inconsistencies in dental caries assessment practices and coding. Notwithstanding these limitations, the coverage in both survey years was extensive; and in BC, these results provided, for the first time, the opportunity to utilize public health data to assess trends in caries rates for 4–6 year olds by geography and neighbourhood SES.

Neighbourhood-level analysis enabled dental public health to identify specific neighbourhoods with stable and changing rates of dental decay – results that would have been masked through regional or provincial analysis alone. Children residing in more socio-economically advantaged areas tended to have lower rates of visible dental decay than those children residing in socio-economically disadvantaged areas. This finding is consistent with the large body of evidence indicating the influence that individual- and neighbourhood-level socio-economic circumstances have on disparate health outcomes across geographic areas.^{27–32} In 2006/07 and 2009/10, the average rate of visible dental decay was highest in the most socio-economically disadvantaged neighbourhoods, with approximately half of the children experiencing visible dental decay; whereas in the moderately high SES neighbourhoods, approximately one third of children experienced visible dental decay. The results indicated that although the highest *rates* of visible dental decay were found in the most socio-economically disadvantaged neighbourhoods, the highest *numbers* of children with dental decay were in the middle SES neighbourhoods. For example, in the 2006/07 dental survey, the highest proportion of children with visible dental decay (50%) was evident in the low SES neighbourhoods; however, in terms of actual numbers of children affected, the total number of children with visible dental decay in the moderate to moderately high SES range ($n = 4,814$) exceeded the total number of children with visible decay experience in the low SES neighbourhoods ($n = 3,661$). Therefore, in BC and other jurisdictions with a similar pattern of disparities in children's dental caries, interventions that solely target 'at risk' individuals or the most socio-economically disadvantaged areas are not sufficient to address the social

Figure 2. Changes in dental decay rates of kindergarten children by neighbourhood in Fraser Health Authority, 2006/07–2009/10

Table 2. Dental decay rates by neighbourhood socio-economic status (SES)

SES Index	% Visible dental decay in 2006/07				% Visible dental decay in 2009/10			
	M	SD	Students surveyed	Students with decay	M	SD	Students surveyed	Students with decay
SES Index categories								
Low SES*	49.2	10.8	7411	3647	47.1	10.9	7114	3352
Moderate-low SES	42.1	10.1	6329	2664	41.1	10.6	6258	2573
Moderate SES	37.3	10.7	6532	2435	34.9	10.1	6661	2325
Moderate-high SES	34.7	9.0	6918	2404	32.9	10.1	6883	2264
High SES†	30.5	8.6	6483	1975	28.9	9.9	6378	1845
Total	38.8	11.8	33,673	13,125	37.0	12.4	33,294	12,359

Note: SES Index categories are grouped into $n = 87$ neighbourhoods ($n = 88$ neighbourhoods in the Moderate SES category) across both survey years. The sample includes neighbourhoods that were surveyed in both years minus one neighbourhood with missing data on SES ($n = 436$).

* Low SES = bottom 20th percentile of neighbourhoods in BC in terms of SES.

† High SES = top 20th percentile of neighbourhoods in BC in terms of SES.

gradient in dental health.^{33,34} A combination of universal and targeted approaches are needed.

Interactive and static maps provided graphic displays of rates by school and neighbourhood across regions and also served as tools to support public health in further contextualizing the complex

interplay of factors influencing children's oral health (e.g., community supports and barriers). The significance of these results stems from their capacity to be used by public health to tailor and develop population-level and geographically-based interventions at a level and intensity proportionate to the needs

of its residents. Geographic targeting, for instance, enables an entire population (e.g., in schools and communities) within specific geographic boundaries to be eligible for treatments or services.¹¹ Contextualization is critical given that regions vary greatly with respect to their population size, density, geographic area, socio-economic deprivation, and ethnic and cultural diversity.

Surveillance that involved dental public health staff's consistent measurement of dental decay across geographies and over time was critical in developing an initial basis for understanding oral health trends for this population. Survey results serve as an important resource that informs public health program planning and allocation of resources to those areas with identified needs. While there was modest improvement in overall caries rates across survey years, dental health inequities are a persistent public health concern. A more precise, in-depth understanding of these disparities, within and across communities, can inform our understanding of how dental health interventions have differential impacts on a population.

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RÉSUMÉ

OBJECTIF : Décrire les résultats d'une enquête dentaire provinciale de santé publique menée auprès des enfants de 4 à 6 ans en Colombie-Britannique, et évaluer les changements dans les taux de carie dentaire sur le plan géographique et selon le statut socioéconomique du quartier entre la base de référence (2006-2007) et la collecte des données de suivi (2009-2010).

METHOD : Le protocole d'étude comportait deux cohortes rétrospectives d'enfants de la maternelle ayant reçu un examen dentaire administré par la santé publique en 2006-2007 et en 2009-2010. Le statut socioéconomique du quartier a été mesuré selon un indice créé à partir du Recensement canadien et des jeux de données des déclarants de l'impôt. Les résultats dentaires étaient l'expérience préalable des caries, les caries visibles non traitées et les besoins urgents de traitement.

RÉSULTATS : L'analyse a porté sur les résultats dentaires de 35 602 enfants de la maternelle en 2006-2007 et de 35 215 enfants en 2009-2010. Il y a eu une baisse modeste des taux de carie dentaire entre les deux enquêtes,

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avec des taux d'expérience des caries – antérieures et non traitées – de 38,9 % et de 36,7 %, respectivement. Toutefois, il y a eu des disparités : près de 50 % des enfants avaient des caries dentaires dans les quartiers les plus défavorisés sur le plan socioéconomique, contre environ 30 % dans les quartiers les moins défavorisés.

CONCLUSION : L'enquête dentaire auprès des enfants de la maternelle avait une vaste couverture, elle a été menée à l'échelle de la population, et

elle a permis d'analyser les changements spatiotemporels dans les taux de carie dentaire des jeunes enfants. Bien que les taux globaux se soient améliorés, les inégalités sur le plan de la santé dentaire ont subsisté au cours des deux années de l'enquête, tant à l'échelle régionale qu'à celle des quartiers.

MOTS CLÉS : caries dentaires; santé buccodentaire; enfant; tendances; surveillance; Colombie-Britannique