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Socio-economic Inequalities and Oral Health in Canada and the United States

ABSTRACT

This paper describes and compares the magnitude of socio-economic inequalities in oral health among adults in Canada and the US over the past 35 years. We analyzed data from nationally representative examination surveys in Canada and the US: Nutrition Canada National Survey (1970-1972, N = 11,546), Canadian Health Measures Survey (2007-2009, N = 3,508), The First National Health and Nutrition Examination Survey (1971-1974, N = 13,131), and National Health and Nutrition Examination Survey (2007-2008, N = 5,707). Oral health outcomes examined were prevalence of edentulism, proportion of individuals having at least 1 untreated decayed tooth, and proportion of individuals having at least 1 filled tooth. Sociodemographic indicators included in our analysis were place of birth, education, and income. Data were age-adjusted, and survey weights were used to account for the complex survey design in making population inferences. Our findings demonstrate that oral health outcomes have improved for adults in both countries. In the 1970s, Canada had a higher prevalence of edentulism and dental decay and lower prevalence of filled teeth. This was also combined with a more pronounced social inequality gradient among place of birth, education, and income groups. Over time, both countries demonstrated a decline in absolute socio-economic inequalities in oral health.

KEY WORDS: public health dentistry, dental health surveys, socio-economic factors, dental caries, edentulous, operative dentistry.

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INTRODUCTION

Previous research has demonstrated fewer social inequalities in health for Canada compared with the United States for diverse health outcomes, including access to medical care (Lasser *et al*., 2006), self-reported health behaviors and health-related quality of life (McGrail *et al.*, 2009), cancer survival (Gorey *et al.*, 2000), and life expectancy (Kunitz and Pesis-Katz, 2005). One potential explanation for fewer inequalities in Canada is its universal medical care insurance system, which guarantees universal access to many types of care. However, Canada's system does not cover oral health care. Dental expenditures in Canada are mainly funded by private insurance, with only 5.8% of expenditures paid through public funds (Baldota and Leake, 2004). Furthermore, almost 32% of Canadians lack any form of dental insurance, and this proportion reaches 50% among those with low income (Canadian Health Measures Survey, 2007-2009, 2010). In the US, nearly 34% of adults do not have dental coverage, and this proportion is 59% among the poor (Manski and Brown, 2007). Oral care is a leading unmet health need in the US (GAO/HEHS, 2000), and inequalities in unmet dental needs are particularly evident in indigenous groups (Niendorff and Jones, 2000) and other racial/ethnic minorities (Mueller *et al.*, 1998).

Little has been published in the Canadian context regarding population-representative estimates of socio-economic inequalities in oral health and unmet dental treatment needs. Moreover, the trends in inequalities over time are poorly characterized, as are comparisons with the US. Given the hypothesized role of health insurance in explaining larger social gradients in health in the US *vs*. Canada, lack of coverage for oral care in Canada presents an interesting opportunity to compare inequalities for health outcomes where the effect of insurance may be similar in the two countries. The objective of our article is to describe and compare the magnitude of socio-economic inequalities in oral health among adults in Canada and the US at two time periods, 35 years apart.

MATERIALS & METHODS

Data Sources

We used two nationally representative surveys from Canada that contain oral examination data. The Nutrition Canada National Survey (NCNS) evaluated the nutritional status of the Canadian population from October 1970 to

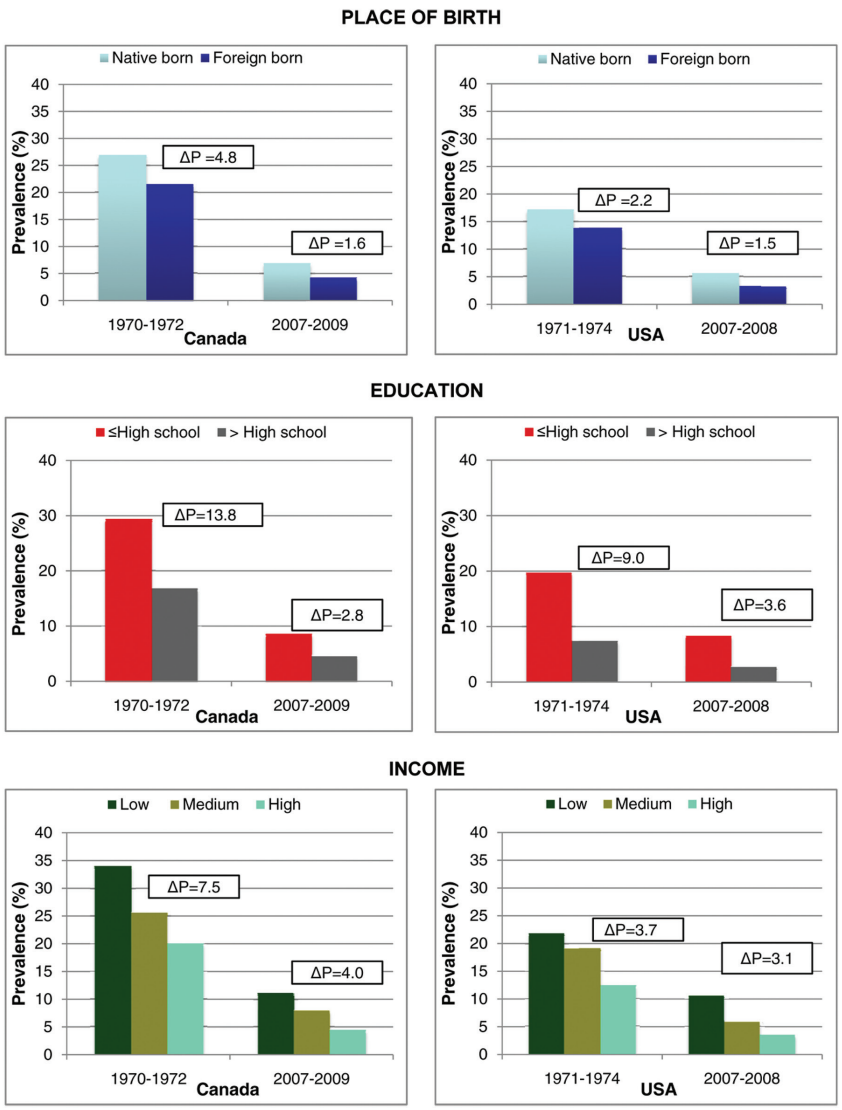

Figure 1. Prevalence of edentulism by place of birth, education, and income.

September 1972, surveying 19,590 individuals from newborn to ages over 100 yrs (Department of National Health and Welfare, 1977). The Canadian Health Measures Survey (CHMS) included an oral examination module, conducted between March 2007 and February 2009, with 5,586 people aged 6 to 79 yrs (Canadian Health Measures Survey 2007-2009, 2010). Full-time members of the armed forces and individuals living on First Nations reserve, Crown lands, remote regions, or institutions were all excluded from the CHMS. Both the NCNS and CHMS used multi-stage stratified sample designs and have detailed sociodemographic information and covariate data on factors relevant to oral health, such as nutrition, smoking, medical history, and current health status (Department of National Health and Welfare, 1977; Giroux, 2007).

For comparison with the United States, we utilized data from the US National Health and Nutrition Examination Surveys (NHANES; Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey). The NHANES surveys are stratified multistage probability samples of the civilian non-institutionalized population of the US that were conducted three times from 1971 to 1994 and annually beginning in 1999. For direct comparison with the NCNS, we utilized data from the first NHANES survey conducted between April 1971 and June 1974. The NHANES I survey contains data on 20,749 individuals aged 1 to 75 yrs who underwent an oral examination. For comparison with the CHMS 2007-2009 module, we used the later NHANES, conducted between January 2007 and December 2008, with the oral health examination of 8,311 individuals aged 5 to 80 yrs. Both NHANES surveys contain detailed demographic data, including measures of racial/ethnic background and socio-economic position, detailed measures of tobacco and alcohol consumption, nutrition, and health conditions.

Variables

We used place of birth, education, and income as indicators of social position. We categorized those variables based on information from the 4 surveys, to be able to make the comparison on a common scale. We dichotomized place of birth into native or foreign-born. Education was measured differently in the 4 surveys. In the early surveys (NHANES I and NCNS), education was measured on a continuous scale based on years of education completed, and in the later surveys (NHANES and CHMS), it was reported as categories of certification. To facilitate comparisons across time and country, we categorized education into high school graduation and less than or greater than a high school degree. Last, income was recorded as different categories in the 4 surveys. We adjusted the income categories for inflation to year 2000 US dollars and re-coded it, based on each survey distribution, as low, medium, or high.

To have consistent sets of oral health outcomes that could be compared across the 4 surveys, we restricted our outcome variables to (1) prevalence of edentulism, (2) proportion of individuals having at least 1 untreated decayed tooth, and (3) proportion of individuals having at least 1 filled tooth. All outcomes were based on 32 teeth except for the CHMS (28 teeth), which excluded third molars from the dental examination.

Analysis

We limited our analysis to individuals aged 20 yrs and older who underwent the oral examination. For estimating differences by education, we limited the sample to ages 25 yrs and over, to

allow time for individuals to complete their education. We initially estimated inequalities separately by gender but found little evidence for heterogeneity of prevalence differences. When estimating the adjusted absolute prevalence differences by place of birth, we adjusted for gender and household size. When estimating differences by income, we additionally adjusted for education, and when estimating education differences, we adjusted for gender, household size, and place of birth. In addition, all analyses were age-adjusted to the average age distribution of the 4 combined surveys.

We used Stata's suite of commands for survey data to incorporate sample weights for each survey and account for the complex survey designs in making population inferences (Stata, 2009). We also used Stata's post-estimation-margins options following the logistic regression models to obtain adjusted absolute differences for the various proportions and their 95% confidence intervals (CI).

This study received ethical approval from the Institutional Review Board (IRB) of the McGill University Faculty of Medicine.

RESULTS

Canada and the US had nearly similar distributions of demographic characteristics (Table). Gender, age, and place of birth distributions remained stable over time, with increasing proportions of respondents in higher education and income categories between the early (NHANES I and NCNS) and the recent surveys (NHANES and CHMS).

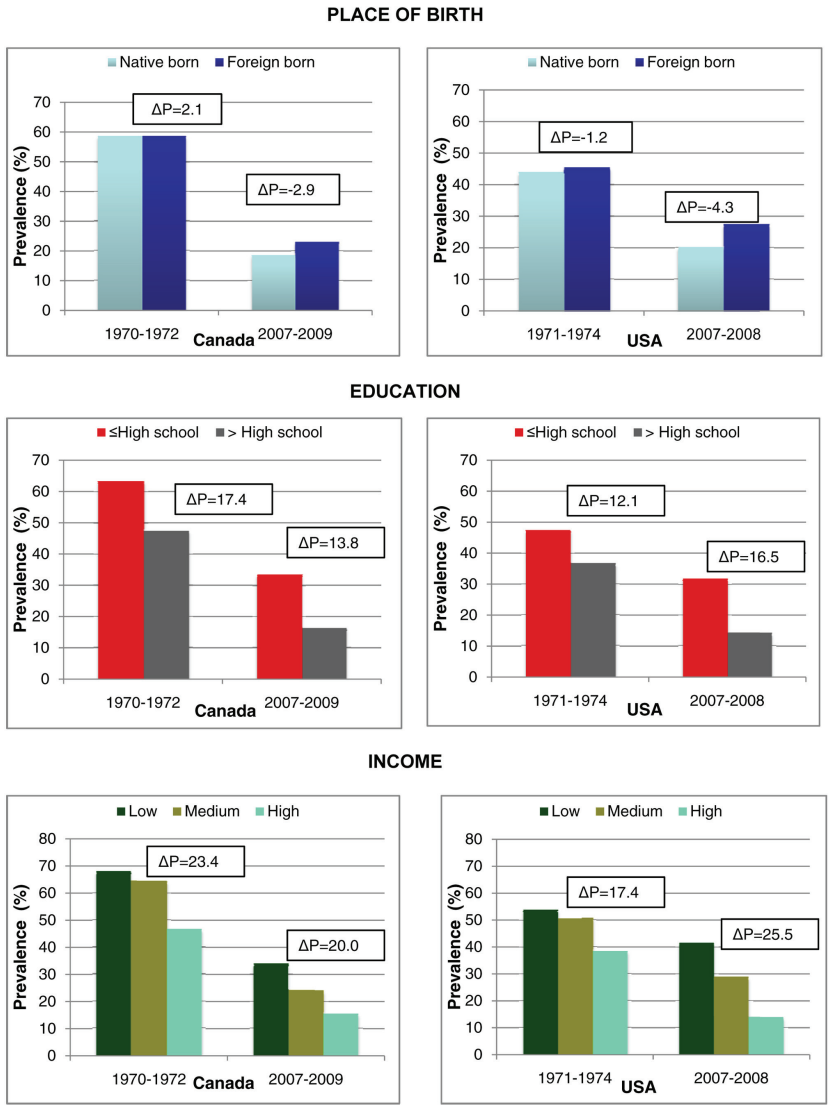

Figure 2. Prevalence of untreated decayed teeth by place of birth, education, and income.

Fig. 1 presents the prevalence of edentulism by place of birth, education, and income for individuals aged 20 yrs and older. In the early 1970s, the prevalence of edentulism was high for both Canada and the US. However, the proportion of edentulism was higher in Canada, with a larger absolute difference between 'place of birth' groups (adjusted absolute prevalence difference ΔP = 4.8, 95%CI 0.5, 9.1), education (ΔP = 13.8, 95%CI 8.8, 18.7), and income (ΔP = 7.5, 95%CI 1.6, 13.4). Over time, there was a decline in the prevalence of edentulism and in absolute socio-economic inequalities in Canada and the US (detailed results available in the Appendix Table).

The proportion of individuals with 1 or more untreated decayed teeth (Fig. 2) was also high in the 1970s for both countries, with Canada showing higher prevalence among place of birth (ΔP = 2.1, 95%CI -7.6, 11.9), education (ΔP = 17.4, 95%CI 10.7, 24.1), and income (ΔP = 23.4, 95%CI 13.9, 33.0). The recent NHANES and the CHMS demonstrated an improvement in the prevalence of untreated decayed teeth as well as a decrease in the inequality between socio-economic groups. However, the CHMS indicated that Canada had showed better progress in narrowing the absolute inequality among place of birth (ΔP = -2.9, 95%CI -7.8, 2.0), education (ΔP = 13.8, 95%CI 8.5, 19.2), and income (ΔP = 20.0, 95%CI 9.6, 30.3).

Fig. 3 displays the prevalence of individuals with at least 1 filled tooth in Canada and the US. In Canada there was an increase in the proportion of people with filled teeth between the NCNS and the CHMS. In the US, the increase in prevalence in the later NHANES was mainly for disadvantaged socio-economic groups. There was also a decrease in absolute inequality by place of birth, education, and income groups between the early surveys

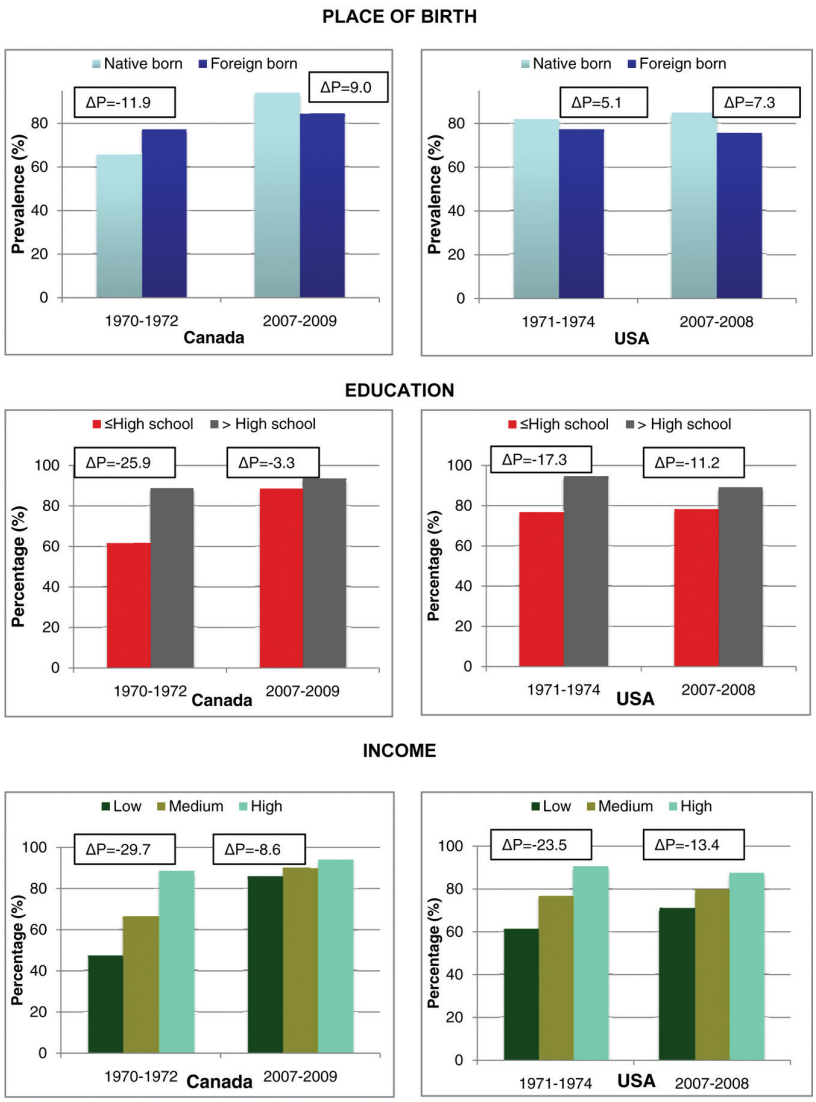

Figure 3. Prevalence of filled teeth by place of birth, education, and income.

and the later surveys for both countries, but this decline in the absolute inequalities was much more pronounced in Canada (place of birth ΔP = 9, 95%CI 4.9, 13.1; education ΔP = -3.3, 95%CI -6.3, -0.3; and income ΔP = -8.6, 95%CI -16.3, -1.0).

DISCUSSION

To our knowledge, this is the first study to use nationally representative data from Canada and the US for comprehensive examination and comparison of time trends and social gradients in population oral health. Our results demonstrate that oral health outcomes have improved for adults in both Canada and the US. In the 1970s, Canada had a higher prevalence of edentulism and dental decay and a lower prevalence of filled teeth. This was also combined with a more pronounced social inequality gradient among place of birth, education, and income groups. Over time, both countries demonstrated an improvement in the prevalence of these oral health outcomes, with a decline in absolute socio-economic inequalities. However, Canada appears to have made somewhat better progress in improving oral health among disadvantaged populations. In the recent period, Canada and the US demonstrated similar disparity gradient patterns.

Socio-economic inequality in oral health has been demonstrated in several countries by various oral health indicators. Australian researchers, using self-reported tooth loss data, demonstrated an inverse income gradient in edentulism among adults (Sanders and Spencer, 2004). In the United Kingdom, socio-economic inequalities in decayed teeth and edentulism were evident among children and adults (Watt and Sheiham, 1999). Moreover, evidence of persistence social gradient was also demonstrated for edentulism among adults (Marmot and Bell, 2011) and older adults in the United Kingdom (Tsakos *et al.*, 2011). Similarly, income inequality in DMFT (decayed, missed, filled teeth) scores and in filled teeth was reported based on survey data from 18 rich countries between 1995-2005, including Canada and the US (Bernabe *et al.*, 2009).

Very few studies have assessed oral health inequalities in Canada. There is some evidence of a higher prevalence of decayed teeth and greater need for dental treatment among foreign-born compared with Canadian-born adolescents (Locker *et al.*, 1998). Also, older adults from more advantaged income and education groups tended to have 20 or more teeth (Joaquim *et al.*, 2010). In Ontario, a telephone interview survey found that lower-income older adults were less likely to be edentulous (Locker and Ford, 1994). In Quebec, inequalities in income and education were demonstrated for missing teeth, and decayed and filled coronal surfaces (Brodeur *et al.*, 2000). However, none of these studies used national representative data, which limits their generalizability.

In the US, socio-economic inequalities among adults have been documented for several oral health outcomes. The prevalence of periodontitis has been shown to differ by race/ethnicity, income, and education (Borrell and Crawford, 2008). Worse perceived oral health was reported by individuals with low education and low income (Sabbah *et al.*, 2007). Our findings, which indicate a decline in the prevalence of edentulism and untreated decayed teeth in the US between 1970s and the recent NHANES with persistent social gradient, are in agreement with those of previous studies that used NHANES data. Improvements in the prevalence of edentulism and coronal caries were reported in a

Table. Demographic Characteristics of the Four Surveys, "Weighted Proportions"

	Canada		US	
	Nutrition 1970-1972	CHMS 2007-2009	NHANES 1971-1974	NHANES 2007-2008
	N = 11,546	N = 3,508	N = 13,131	N = 5,707
Variables	N (%)*	(%)*	N (%)*	N (%)*
Gender				
Male	4,882 (46.6)	(49.5)	5,001 (47.3)	2,797 (48.2)
Female	6,664 (53.4)	(50.5)	8,130 (52.7)	2,910 (51.8)
Language				
English	8,200 (70.0)	(64.7)	11,469 (89.7)	4,574 (88.0)
Other	3,327 (30.0)	(35.3)	1,536 (10.3)	1,131 (12.1)
Language				
English	8,200 (70.0)	(64.7)	11,469 (89.7)	4,362 (86.2)
French/Spanish[1]	2,141 (20.2)	(23.3)	618 (3.9)	1,140 (9.1)
Other	1,186 (9.8)	(12.0)	918 (6.4)	203 (4.7)
Place of birth				
Native-born	9,016 (75.3)	(75.7)	12,148 (93.4)	4,296 (83.8)
Foreign-born	2,532 (24.7)	(24.3)	889 (6.6)	1,409 (16.2)
Race[2]				
White		(86.4)	10,690 (89.0)	2,670 (69.4)
Non-white	_	(13.6)	2,441 (11.0)	3,037 (30.6)
Education				
≤ High school	7,974 (78.5)	(31.7)	8,932 (73.2)	2,934 (45.6)
>High school	1,611 (21.5)	(68.3)	2,340 (26.8)	2,321(54.4)
Mean age (yrs)	43.6 ± 16.1	45.5±15.3	42.8 ± 15.4	46.8± 14.7
Mean household size	3.4 ± 1.8	2.8±1.4	3.4 ± 1.9	2.8 ± 1.4
Income[3]				
Low (~$0-15K)	3,926 (30.2)	(7.1)	3,117 (15.8)	946 (12.1)
Medium (~$15-40K)	5,047 (47.1)	(36.0)	5,037 (38.1)	2,278 (34.8)
High (~>$40K)	1,932 (22.8)	(56.9)	4,474 (46.1)	2,237 (53.1)

N.B.: All numbers are based on individuals aged 20 yrs and older except for education, which is based on individuals aged 25 yrs and older.
[1]French pertains to Canadian surveys and Spanish to US surveys.
[2]Race variable was not measured in the Nutrition survey.
[3]Inflation-adjusted (US $, Year 2000)
*Weighted proportions.

comparison of trends in social gradient with NHANES 1988-1994 and 1999-2004 (Dye *et al*., 2007). Moreover, declines in the prevalence of edentulism between 1972 and 2001 were demonstrated, but mostly for advantaged groups (Cunha-Cruz *et al.*, 2007).

Several limitations need to be considered when findings from this study are interpreted. Although we used nationally representative surveys from Canada and the US, the examination was not conducted in the same year. In addition, the CHMS oral examination data were based on 28 teeth, which might have exaggerated the progress in Canada. Another limitation related to our analysis was the crude categorization of socio-economic measures. This may be an inevitable trade-off, given that these 4 surveys were not necessarily designed to be comparable. Nevertheless, the patterns of inequalities we found using more crude categorizations of socio-economic position were consistent with previous research. Finally, unlike most previous investigations that used the DMFT index as an indicator for oral health, we were forced to rely on the prevalence of edentulism, untreated decayed teeth, and filled teeth as our oral health outcomes. Our choice was limited by the availability of comparable data across the 4 surveys; mainly due to lack of tooth-specific measures in the later NHANES. Despite these limitations, this study demonstrated the time trend and social inequalities in oral health in Canada and the US using large, nationally representative datasets from both countries. In addition, in this analysis we used appropriate survey procedures with suitable statistical methods to report representative adjusted prevalence estimates as well as valid confidence intervals. Another strength of this study is the use of 3 different social indicators to assess the absolute measures of inequality, rather than relative measures, which has the advantage of an attributable prevalence interpretation.

In conclusion, this article compares oral health inequalities in Canada and the US. Our findings demonstrate an improvement in the absolute prevalence of edentulism, untreated decayed teeth, and filled teeth in both countries, with a decrease in the

socio-economic inequalities with a persistent gradient over time. Despite improvements over time in both countries in all measures of population oral health, analysis of the most recent data showed limited evidence that differences in population oral health by place of birth and socio-economic position are fewer in Canada compared with the United States. For prevalence of edentulism, the magnitude of inequality in place of birth and income remained wider in Canada compared with the US. In contrast, this magnitude was smaller in Canada for prevalence of untreated decayed teeth. Finally, the magnitude of inequality for prevalence of filled teeth differed between Canada and the US: It was smaller in the US for place of birth, but for income and education, it was smaller in Canada.

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