Comparing Inequalities in Oral and General Health: Findings of the Canadian Health Measures Survey

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ABSTRACT

OBJECTIVE: The aim of this study was to measure and compare the magnitude of income-related inequalities for oral and general health outcomes in Canada.

METHODS: Data for this study were from the 2007/09 Canadian Health Measures Survey (CHMS). The sample size consisted of 3,413 Canadians aged 18-79 (1,601 men and 1,812 women). Oral health indicators were the total number of decayed and missing teeth. General health was measured as obesity and high blood pressure. Socio-economic status was measured as equivalized household income. We used the concentration index (CI) to quantify income-related inequalities in these outcomes. Values for the concentration index range from -1 to +1 with negative (or positive) concentration indices showing that the outcome is more concentrated among the less well off (or among the better off). All statistical analyses were weight-adjusted for the complex survey design and standardized for age.

RESULTS: The concentration indices for oral health outcomes (decayed teeth = -0.25, missing teeth = -0.15) were greater than for general health outcomes (obesity = -0.05, high blood pressure = -0.04). The concentration indices for oral health outcomes, in contrast to general health outcomes, were statistically significant.

CONCLUSION: There were income-related inequalities for oral health outcomes with the disease concentrated more among the poor. Inequalities in oral health were greater than inequalities in general health. The variation in the funding of oral health care and general health care is likely to explain the differences in the magnitude of income-related inequalities for oral and general health.

KEY WORDS: Socioeconomic factors; oral health; income; obesity; blood pressure

Oral health constitutes an important part of general health. The US Surgeon General's report on oral health asserts that oral health is a critical component of health and must be included in the provision of health care.[1] Despite this, there are differences in provision of general and oral health care in many developed countries, including Canada. While Canada has universal health insurance providing for hospital and physician care, this excludes oral health care.[2] There are also social justice challenges in Canada's oral health care system, in that the most socially and economically vulnerable people have the highest level of oral health problems but also the greatest difficulty in accessing oral health care. Two nationally representative surveys of Canadians have reported that a large proportion of the population faces financial barriers to accessing oral health care, and that these limitations are more pronounced among lower income groups.[3,4] Moreover, the limited access to oral health care among the poor is likely to influence the gap in oral health between the poor and the rich. The poor, who avoid seeing dental professionals because of issues such as the affordability and acceptability of care, receive less preventive treatments and postpone curative treatments; therefore, it is arguable that they develop more severe oral health problems and have more untreated disease.

Although the inequality in use of health services is not uncommon in health sectors, the size of inequalities can differ based on the structure of health systems. For example, in Canada, Allin et al.

demonstrated that the inequality in oral health care was the largest when compared to other parts of the health sector (e.g., physician and hospital care).[5] These differences in provision of oral and general health care may accordingly translate into variation in the size of inequalities for oral and general health.

In Canada, and internationally, there has been no comparative study on the magnitude of income-related inequalities in oral and general health. The aim of this study is thus to estimate and compare the magnitude of inequality in oral health, here indicated by the number of decayed and missing teeth, and general health, indicated by obesity and high blood pressure, using a nationally representative sample of Canadian adults.

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METHODS

Sample

Data for this study are from the 2007/09 Canadian Health Measures Survey (CHMS). This survey is the most recent national health survey of the Canadian population, and collected data on oral health indicators. The CHMS is a probabilistic multistage stratified survey of households, excluding institutionalized populations. The CHMS collected data from 5,604 Canadians aged 6-79 years. For the purpose of this study, we analyzed data for Canadian adults aged 18-79 years. The CHMS aimed to provide national estimates by collecting data from several sites covering 97% of the population. The methodology and sampling framework of the CHMS have been described by Statistics Canada elsewhere.[6] Because we investigated the number of decayed teeth in this study, we excluded edentulous adults with no teeth in the upper and lower jaws (n=302). Subjects with missing data were also excluded from analyses (n=351), and of those, the majority were missing data on income (n=326). There was no significant difference with regard to oral and general health between the respondents with missing values on income and those who reported income.

Health outcomes

We examined two oral health outcomes: the number of decayed teeth and the number of missing teeth; and two general health outcomes: obesity and high blood pressure. The latter were chosen as, like oral disease, they represent diseases strongly associated with behaviour (e.g., oral hygiene and diet). In the CHMS data, blood pressure was measured by a clinician. Obesity and high blood pressure are not only major public health problems, they are also the leading global risks for mortality in the world according to the World Health Organization.[7] With regard to blood pressure, Statistics Canada has classified participants into six groups (within acceptable range, at high end of acceptable range, above acceptable range, moderately high, high, and very high). For the purpose of this study, we collapsed participants into two groups: No high blood pressure (within acceptable range) versus high blood pressure (at high end of acceptable range, above acceptable range, moderately high, and high). Obesity was ascertained using Body Mass Index (BMI). BMI was calculated as weight (kg)/height (m²). We used the definition of obesity recommended by WHO, in which individuals with BMI ≥30 were considered obese.[8]

Income

We used "total annual household income" as a measure of socio-economic status for a number of reasons. Alternative indicators of socio-economic status such as educational attainment and occupational status tend to be stable or provide little variation among adults, and therefore would mask substantial socio-economic variation in health outcomes. More importantly, the calculation of a relative concentration index requires a ranking socio-economic measure. In the CHMS, total annual household income was originally reported as a 12-level ordinal variable. Participants reported their total annual household income range from zero to more than $100,000. Using this variable, we calculated the "equivalized household income" employing a "modified-OECD scale" approach.[9] This approach takes into account the number of people in the household and their ages. We initially merged the three lower income groups to permit sufficient numbers of observations. The upper boundary for the last category of income variable (more than $100,000) was set at $120,000 to be consistent with the income range in the previous categories of income. This decision was made to calculate the midpoint of income range for those in this income category. We used the formula below to calculate the equivalized household income using the median point of the ranges of the ordinal variable. This method originally defines those aged 0-14 as children and those 15 and older as adults. However, for calculating the equivalized household income, we defined children as those aged 0-15 due to availability of information in the CHMS dataset.

$$\text{Equivalized household income} = \frac{\text{Midpoint of income range}}{1+0.5*(\text{No. of adults}-1)+0.3*(\text{No. of children})}$$

Concentration index

Several standard approaches exist for measuring inequalities in health by income level.[10] We used the "concentration index" to quantify income-related health inequalities. This approach was first developed by Wagstaff et al.[11] and now has become a common measurement tool in the epidemiological and health economics literature to investigate the magnitude of inequality in health. The concentration index is derived from the concentration curve (Figure 1). Values of the concentration index range from -1 to +1 with 0 indicating no inequality, negative values indicating concentration of the outcome among lower income groups, and positive values indicating concentration of the outcome in higher income groups. The greater the absolute value of the concentration index, the greater the degree of concentration in a negative or positive direction. Wagstaff[12] pointed out that when the health outcome is binary, such as obesity and hypertension, and for large samples, the bounds of the concentration index are equal to p-1 and 1-p, respectively, where p is the proportion of outcome variable. In order to permit comparison of the concentration indices of binary outcomes for this study (obesity and high blood pressure) with those of other outcomes (decayed teeth and missing teeth), the concentration index needs to be normalized, because otherwise the bounds are not -1 and +1. For binary outcomes of the study, the normalized concentration index was calculated according to the method by Wagstaff:[12] $C_n = C/(1-p)$.

Statistical analyses

We first examined the distribution of oral and general health outcomes across the quintiles of equivalized household income. We then calculated the concentration index of oral and general health outcomes for both sexes and for the entire population. All data analyses were adjusted for age. Sampling weights suggested by Statistics Canada were used for all stages of the data analyses to adjust for sample design effects in order to produce nationally representative estimates.

Data analyses were performed using STATA 11.1 and ADePT (4.0). The ADePT is a statistical program developed by the World Bank. In this study, we used the ADePT's Health Module for analyzing health inequality and for estimating the variance of the linear model.

RESULTS

We analyzed the data for 3,413 Canadian adults (1,601 men and 1,812 women). The prevalence of obesity and high blood pressure

Figure 1. Concentration curve
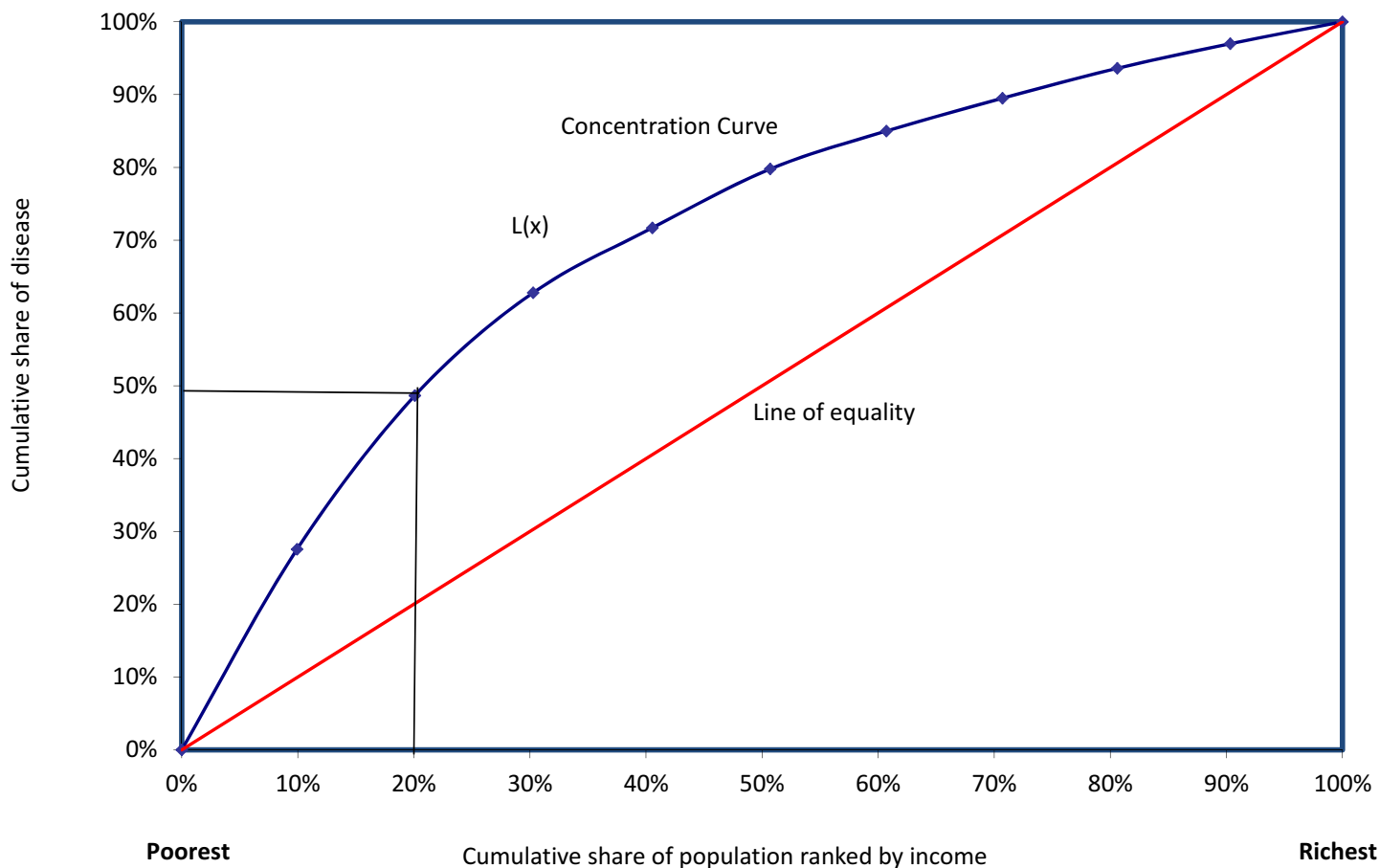
Notes: x axis represents the cumulative proportion of individuals by income, beginning with the lowest and ending with the highest income, and the y axis represents the cumulative total proportion of ill-health. The relative concentration index is defined as twice the area between the concentration curve, L(x), and the line of equality. In the case where there is no income-related inequality, the relative concentration index is zero. The farther the concentration curve lies from the line of equality, the greater the degree of inequality. In this hypothetical graph, 50% of the disease is concentrated among the poorest 20%.

was 23.4% and 14.2%, respectively. The mean number of decayed teeth and the number of missing teeth was 0.58 (SD=0.007) and 2.07 (SD=0.013), respectively. Figure 2a shows the weighted proportions of obesity and high blood pressure according to equalized household income for the entire population and for both sexes. Figure 2b shows the weighted mean number of decayed and missing teeth across the quintiles of equalized household income for the entire population and for both sexes. Those from higher socio-economic status had a lower prevalence of obesity and high blood pressure and lower mean numbers of decayed and missing teeth. However, the graded shape of the relationship between income and oral health is more consistent than the shape of the relationship between income and general health outcomes.

Table 1 presents the concentration indices for both general and oral health outcomes. This table suggests three things for the entire population: 1) the concentration indices for all general and oral health outcomes were negative, which indicates a higher concentration of general health outcomes and oral health outcomes among the poor; 2) the concentration indices for oral health outcomes suggested statistically significant deviation from equality whereas the concentration indices of general health outcomes did not; and 3) the absolute values for the concentration indices for oral health outcomes were greater than those for the general health

outcomes. We performed additional analyses which confirmed that the differences between the CIs for oral and general health are statistically significant (details of analyses not shown; available upon request from the corresponding author). Sex-stratified calculations of the concentration indices replicated the above findings for both sexes, with the exception of obesity among females, which was statistically significant.

DISCUSSION

This study compared income-related inequalities in Canada between oral and general health outcomes. We found that oral and general health outcomes were concentrated among lower income groups; however, only for oral health outcomes was there a significant deviation from equality. We also found that the magnitude of inequalities was greater for oral health outcomes compared to general health outcomes. Our study not only adds to the existing evidence for oral health inequalities in Canada,[13] but also suggests that inequality in oral health may be a greater problem.

The greater magnitude of inequalities in oral health outcomes compared to general health is in line with dental care being the most unequal aspect of health care in Canada.[5] Access to oral health care is a great challenge for many Canadians, particularly low income groups,[3,4] and financial barriers, in turn, are linked to poor-

Figure 2a. Prevalence of general health outcomes according to equivalized household income
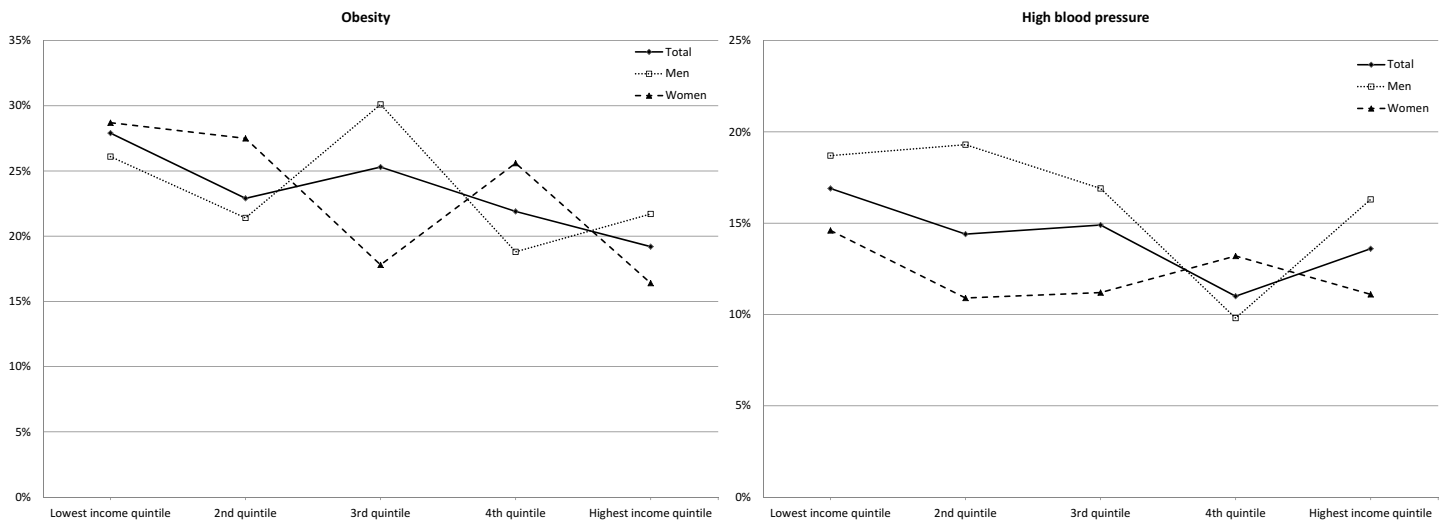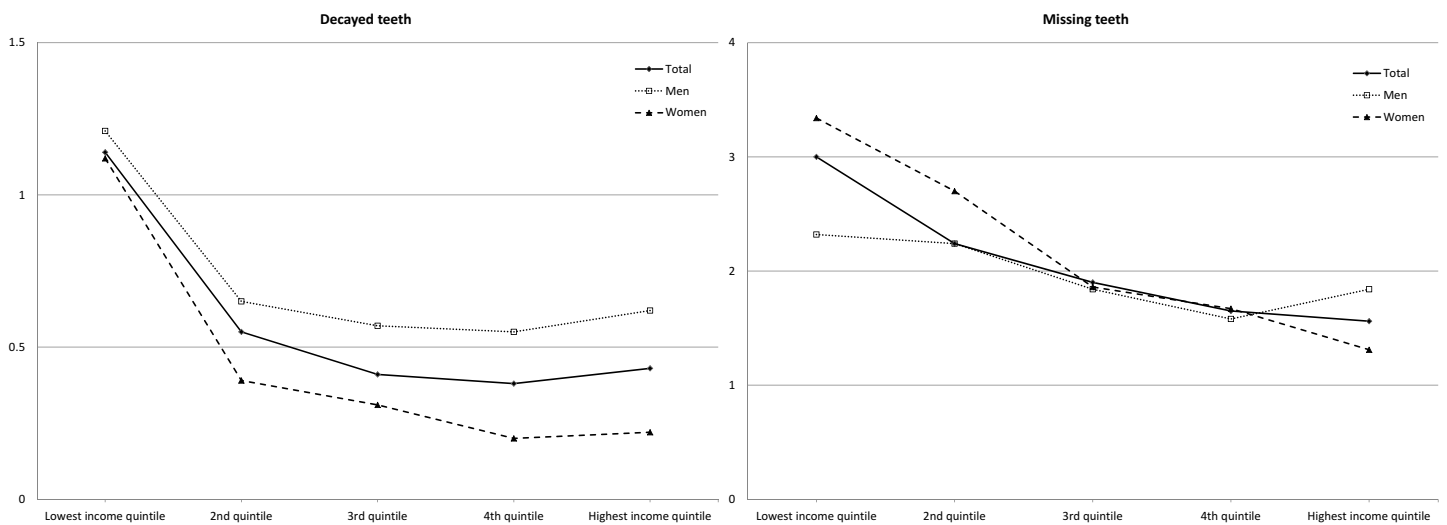

Obesity

High blood pressure

Figure 2b. Mean number of oral health outcomes according to equivalized household income

Decayed teeth

Missing teeth

er oral health.[3] We suggest that the variation in the provision of medical and dental care in Canada is among the factors that are responsible for the greater magnitude of oral health inequality. While Canada has nationalized hospital and physician care through its universal health insurance program, oral health care is almost wholly privately financed, with approximately 60% of dental care paid through employment-based insurance, and 35% through out-of-pocket expenditures.[14] This strongly links the utilization of and access to dental care with the ability to pay.

More equitable access to health care plays an important role in reducing inequalities in health.[15,16] The differences in the provision of medical care in Canada (universal health insurance) and the US (mostly privately funded) have provided a platform for comparing the effects of health care on health inequalities. A number of studies suggest that health inequalities are more pronounced in the US than in Canada[17-19] due to cross-national differences in social policies, particularly in universal health insurance.

In the dental literature, there has been recent interest in evaluating the role of oral health care in reducing oral health inequali-

ties, and the existing evidence has yielded inconsistent findings.[20-23] Most notably, Wamala et al. found that approximately 60% of inequalities in oral health are due to "refraining from seeking dental treatment".[20] Similarly, it is suggested that dental attendance can partly explain oral health inequalities with regard to the number of sound teeth.[22] In contrast, other studies did not suggest a major effect on oral health care of reducing health inequalities.[21,23] These studies looked at different characteristics of oral health care (dental visits, patterns of dental service use, etc.) in various settings, which might explain the contradictory findings. Our study, however, did not examine to what extent social policies and the characteristics of health care are responsible for inequalities in oral and general health. One great advantage of the concentration index approach, which we used in this study, is that the concentration index is a "decomposable" index.[24] This enables quantifying the extent to which potential factors contribute to health inequalities. We advise that future studies employ the analysis of "decomposition of the concentration index" to evaluate what factors are responsible – and to what extent – for inequalities in oral and gen-

Table 1. Concentration Index for General Health Outcomes and Oral Health Outcomes by Sex

Health Outcome		Total Population			Men			Women		
		Concentration Index	SE	(95% CI)	Concentration Index	SE	(95% CI)	Concentration Index	SE	(95% CI)
General health	Obesity†	-0.05	0.027	(-0.1, 0)	-0.02	0.041	(-0.1, 0.06)	-0.08*	0.036	(-0.15, -0.01)
	High blood pressure†	-0.04	0.039	(-0.11, 0.04)	-0.05	0.056	(-0.16, 0.06)	-0.04	0.053	(-0.15, 0.06)
Oral health	Decayed teeth	-0.25*	0.047	(-0.34, -0.16)	-0.20*	0.064	(-0.33, -0.08)	-0.34*	0.053	(-0.45, -0.24)
	Missing teeth	-0.15*	0.021	(-0.19, -0.11)	-0.08*	0.032	(-0.14, -0.02)	-0.20*	0.026	(-0.25, -0.15)

* Statistically significant; $p<0.05$.
† Concentration indices for binary outcomes (obesity and high blood pressure) are normalized according to Wagstaff, 2005.[12]

eral health and how these factors differ between oral and general health inequalities.

For high blood pressure and obesity, there appear to be no statistically significant income-related inequalities. The absence of significant income-related inequalities for these two general health outcomes in Canada is partially in keeping with the existing literature. A study of elderly Canadians did not find income-related inequalities for high blood pressure,[25] and other Canadian studies have documented the absence of significant inequalities for major health outcomes such as mortality[17] and quality of life.[18] Yet with regard to obesity, studies of Canadian populations have yielded mixed findings concerning the relationship between socioeconomic status and obesity.[26-28] There are a number of explanations for the inconsistency between our findings and those of previous studies in Canada. First, the relationship between socio-economic status and obesity is complex and varies extensively according to sex and the measurement of socio-economic status.[29] Second, previous studies looked at obesity by analyzing BMI scores whereas our study classified individuals into two groups, i.e., obese and non-obese. Third, it is possible that the status of inequalities has varied over time.

This study benefitted from the concentration index approach, which is an innovative method in health inequality research.[24] Using the concentration index gives us a more comprehensive picture of the health inequalities across the population. Traditionally, regression analyses have been used to investigate the association between socio-economic status and health outcomes. Accordingly, odds ratios or beta coefficients are reported to indicate the magnitude and direction of association. This approach, despite being common, is somewhat limited in that regression-based analyses do not allow measuring inequalities across the whole range of the socio-economic hierarchy. Comparing inequality across studies or over time using traditional regression analysis is also difficult because studies employ different categories of socio-economic status. The concentration index is limited in that it can only be applied if a strict ranking socio-economic variable is present. In this survey, a large portion of the sample had missing values for the actual values of income. Thus, to minimize the bias due to missing values, we opted to use ordinal rather than actual values of income.

Comparative analysis is an important tool for understanding health inequalities. Although much is known about inequalities in both oral and general health, no comparative research has investigated differences in the magnitude of these inequalities. Previous comparative study of inequalities in oral and general health are limited in that they only investigated the absence or presence of inequalities.[30] Our study is the first, to our knowledge, to compare the magnitude of these inequalities. One limitation associated with comparing general and oral health outcomes is that the investigated outcomes do not represent all domains of general and oral

health. Therefore, caution should be taken with regard to extrapolating the findings of this study to other general and oral health outcomes. This study also had some other limitations. Due to the cross-sectional nature of the survey, we are unable to establish causal relationships between income and health. Further, the CHMS excluded those Canadians living in institutions, on crown land or Indian reserves, or in remote regions, as well as full-time members of the Canadian Forces. Sample size was designed to obtain estimates of the prevalence of health conditions in the Canadian population as a whole and so when analyses are performed using variables with multiple categories, the power of the analyses is reduced. We also collapsed the blood pressure and obesity variables to dichotomous, which may have reduced the power of the study. Excluding the edentulous individuals may have influenced the calculation of equivalized income.

It is no longer sufficient to look at the presence or absence of inequalities. Attention should be paid to the magnitude of inequalities in order to identify priority areas for intervention when tackling health inequalities. Inequalities in oral health have decreased in Canada over the past decades.[31] Despite this, our findings suggest that inequalities in oral health may represent a greater challenge in comparison with inequalities in general health. The variation in the funding of oral health care and general health care, in this regard, is of interest. The funding of oral health care in Canada has received attention in recent years with dental professionals demanding more strategic involvement from governments,[32] and the public supporting its incorporation into Canada's national system of health insurance yet concurrently not ranking dental care as a first priority for government funding. Given this, and that implementing universal health care is suggested as an effective approach to reduce inequalities in oral health,[33] policy makers may need to consider shifting towards some level of universal oral health care.

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RÉSUMÉ

OBJECTIF : Mesurer et comparer l'ampleur des inégalités liées au revenu pour ce qui est des résultats de santé buccodentaire et de santé générale au Canada.

MÉTHODE : Les données de l'étude proviennent de l'Enquête canadienne sur les mesures de la santé (ECMS) de 2007-2009. L'échantillon englobait 3 413 Canadiens de 18 à 79 ans (1 601 hommes et 1 812 femmes). Les indicateurs de la santé buccodentaire étaient le nombre total de dents cariées et manquantes. La santé générale a été mesurée selon l'obésité et l'hypertension artérielle. Le statut socioéconomique a été mesuré selon le revenu équivalent des ménages. Nous avons utilisé l'indice de concentration (IC) pour chiffrer les inégalités liées au revenu dans les résultats obtenus. La valeur de l'indice de concentration variait de -1 à +1, les indices négatifs (ou positifs) montrant que le résultat était plus concentré dans les populations plus démunies (ou plus aisées). Les analyses statistiques ont été pondérées en fonction de la complexité de l'enquête et standardisées selon l'âge.

RÉSULTATS : Les indices de concentration des résultats de santé buccodentaire (dents cariées = -0,25, dents manquantes = -0,15) étaient supérieurs à ceux des résultats de santé générale (obésité = -0,05, hypertension artérielle = -0,04). Les indices de concentration des résultats de santé buccodentaire, contrairement aux résultats de santé générale, étaient statistiquement significatifs.

CONCLUSION : Il y avait des inégalités liées au revenu pour les résultats de santé buccodentaire, la maladie étant davantage concentrée chez les pauvres. Les inégalités de santé buccodentaire étaient plus prononcées que les inégalités de santé générale. L'écart entre le financement des soins de santé buccodentaires et les soins de santé généraux explique probablement les différences dans l'ampleur des inégalités liées au revenu pour ce qui est de la santé buccodentaire et de la santé générale.

MOTS CLÉS : facteurs socioéconomiques; santé buccodentaire; revenu; obésité; pression artérielle