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Inequity in a market-based health system: evidence from Canada's dental sector

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Abstract:
We study the extent and drivers of income-related inequity in utilization of dental services in Canada using the concentration-index approach that has been widely applied to study equity in physician and hospital services. Because dental care is almost wholly privately financed in Canada, our estimates provide a benchmark for income-related inequity of utilization in private health systems. Although a number of studies document a link between income and utilization, our study is one of the few measuring income-related inequity in dental care utilization. A unique feature of our study is that we analyze separately equity in total dental visits and in preventive visits. This is important because the case for equity is much clearer for preventive dental care. We also examine the impact of controlling for need using a wider variety of need indicators than previous analyses. We confirm that most oral health indicators perform poorly as need adjustors because they reflect past dental care use: individuals with higher levels of utilization also are in better oral health. Our most important finding is that access to preventive care is the most pro-rich type of dental care utilization and that income-related inequity in preventive dental care utilization is three times larger than what is measured for specialist services utilization in Canada.

Abstract: 210 words.

Key words: Canada, Equity, Dental care, Prevention.

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1 Introduction

How equitable is the use of dental care? By equity, we refer specifically to income-related horizontal inequity in which the deviation of actual use from need-standardized utilization (the level of utilization expected for a given level of need) is systematically related to income. Although few studies attempt to quantitative equity of dental care utilization, it is important for a number of reasons: as we discuss below, oral health is part of quality of life, dental care influences oral health, and income, price and coverage are important determinants of dental care utilization. In addition, dental care utilization provides an interesting case study of income-related inequity: there is much more variation in the public coverage of dental care across jurisdictions than for core health care services such as physicians and hospitals. This large variation allows one to study the link between public coverage and equity. Finally, the measurement of need raises interesting methodological issues in the case of dental care that are not as prevalent for core health care services.

Although dental conditions are rarely life-threatening, oral health can have a large impact on health-related quality-of-life (Petersen 2003; Department of Health and Human Services 2000). Inability to access needed dental treatment can interfere with a person's ability to live a normal life. Oral health is also increasingly being linked to more general health. Garcia (2003), for example, documents a link between dental plaque and pulmonary infections.

Dental care, and preventive dental care in particular, is demonstrated to improve oral health (Guay 2006). Population-based studies that control for need and the direction of causality verify that dental visits lead to fewer dental caries (Bailit et al. 1985, Sintonen and Tuominen, 1989, Nguyen et al. 2007). Better access to prevention today means better oral health tomorrow and can even reduce future dental-related costs (Sintonen and Linnosmaa, 2000).

Price and income have been shown consistently to have an impact on dental care utilization. The high costs of dental care can inhibit use by those with low income and/or inadequate dental insurance: the RAND Health Insurance Experiment established there is a strong effect of co-insurance on individual dental expenditure (Manning, Bailit, and Newhouse, 1985), a finding confirmed using observational data in the U.S. by Mueller (1988). Leake (2006) estimates that, among a wide range of health conditions in Canada, total dental care expenditures are second only to cardiologic care. American adult patients (i.e., those with at least a visit in the year) spend on average $600 per year on dental care (Berenson, 2007), and the equivalent estimates

for Canada in 2005 is $450 (author calculation derived from data in the 2007 OECD health database).

Studies across high income countries consistently demonstrate an income effect on dental service utilization: Wamala, Merlo and Boström (2006) show a strong correlation between deprivation (being socially disadvantaged, meaning uncertainty regarding income and wealth) and not using dental care in Sweden. In Greece, income has a positive impact on the probability and number of visits to a dentist (Zavras, Economou and Kyriopoulos, 2004). Income and social class are two strong determinants of being a regular attendant to dentist services among the elderly in the United Kingdom (McGrath, Bedi, Dhawan, 1999). Among Americans aged 55 to 75 and not eligible to Medicaid, income is associated with the probability of any dentist visit as well as with the (conditional) number of visits (Manski and Goldfarb, 1996). The same income-utilization holds for Canada, as detailed in section 2 below.

The large variation across jurisdictions in public subsidies for dental care provides great scope for assessing the impact of public coverage on use of care. Four high-income countries in particular — US, Canada, Portugal and Spain — rely almost exclusively on private finance. In Canada 95% of dental expenditures are financed privately either by private insurance (50%) or direct, out-of-pocket payments (45%) (Marchildon, 2005). Analyzing equity in the use of dental care in such a setting provides unique insight into how reliance on private finance affects equity of health care use in developed countries, providing a useful reference point to studies of equity in the use of core publicly financed health care such as physician and hospital services.

Dental care also raises interesting methodological challenges for assessing equity. Assessing equity in health care utilization requires needs-standardization of observed utilization (observed utilization is compared to the expected level of utilization given the level of need). Needs-standardization of physician and hospital utilization relies heavily on measures of current health such as self-reported health status and chronic conditions. While the possibility of reverse causation (i.e., from past health care use to current health) in cross-sectional studies is acknowledged, evidence indicates that any resulting bias[7] is small (Jiménez-Martín, Labeaga, and Martínez-Granado, 2002). The situation is quite different for dental services and oral health. A high proportion of dental visits are preventive and, as noted already, preventive dental services are documented to be effective. Consequently, a person's current oral health strongly reflects past use of services, making current oral health a questionable indicator of

[7] Bias would stem from the fact that health status is an outcome rather than a cause of health care utilization: if such is the case, then healthier individuals tend to use more (rather than less) health care and the standardization will yield lower level of expected utilization among those in poorer health.

need. Nguyen and Häkkinen (2004) show that richer individuals tend to use more preventive dental care and to have better self assessed oral health (SAOH). And because preventive visits represent a substantial proportion of total dental visits, SAOH correlates positively with utilization, making it a poor need adjustor. A better need adjustor would reflect oral health shocks that require restorative care. The higher rate of preventive visits also makes it critical that analyses distinguish preventive and restorative care. Analyses of overall dental visit rates that use standard approaches to needs adjustment likely suffer from bias.

This study employs the well-established ECuity methods based on concentration indices (Wagstaff and van Doorslaer, 2000, O'Donnell et al. 2007) to measure income-related horizontal inequity in utilization of dental care in Canada. Income-related horizontal inequity exists when two individuals with the same level of need but different incomes receive differing levels of care: if the richer individual gets more care, the inequity is said to be pro-rich; if the poorer individual get more care the inequity is said to be pro-poor. Assessing the level of inequity in utilization of dental care thus goes beyond the well-established finding of a correlation between income and dental care utilization: it measures the gap between what is needed and what is received, and allows one to compare inequity across types of services (dental versus physician or inpatient services). We initially replicate two existing analyses (Allin 2006; van Doorslaer and Masseria 2004) of equity in total dental visits but include a more comprehensive set of need variables. Studies of equity in the utilization of physician and hospital services often use self-assessed health as the primary need adjustor. In the context of dental care, however, our study used population-based health survey data that distinguishes preventive and restorative dental visits, measures the intensity of preventive use, and includes a rich set of potential need adjustors for dental care utilization, including need for emergency care, pain, and severe functional limitations requiring restorative care. The data therefore allow us to examine separately income-related equity in total visits and in preventive care visits; examine equity in the intensity of preventive care use; and test the impact of including need adjustors beyond the traditional SAOH.

Our ability to examine preventive visits represents an important improvement over existing studies. Preventive care constitutes a large proportion of overall dental care (unlike the medical sector), is effective in improving oral health, and is likely to be distributed more pro-rich than are total visits. Moreover, the degree to which income influences utilization of dental preventive care can be a strong determinant of inequalities in oral health. The one previous study of preventive visits (Stoyanova, 2003) could identify only whether the most recent visit was preventive while our data allow us to identify the number of preventive visits in the 12 months prior to the survey interview date.

We find that better representing need has only a modest effect on the estimated level of inequity in total dental visits. When we distinguish preventive visits we find that the pro-rich inequity in the probability of a preventive visit is slightly larger than is inequity in the probability of any visit, and pro-rich inequity in frequent preventive visits is substantially larger than is inequity in the probability of any visit – overall, pro-rich inequity in preventive dental care utilization is much larger than any pro-rich inequity level observed for publicly covered services. Private insurance cannot therefore guarantee the same level of equity as public coverage, an important factor being that private insurance coverage increases with income. We also show that the pro-rich inequity reflects an income and insurance gradient rather than a mere cleavage between the very poor and the rest of the population: we run a simulation where the poorest quintile receives free dental coverage and observe that it reduces the level of pro-rich inequity by 40%.

2 Income, Equity and the Utilization of Dental Care

A social gradient in dental care utilization in Canada is well-documented. The ratio of the probability of any dental visit in the previous year between those in the top and those in the bottom income quartiles was 1.5 in 1990, 1.9 in 1996-99 and 1.8 in 2003 (Leake, 2006; Millar, 2004). Private dental insurance coverage is associated with a higher probability of any dental visit, both for Canada as a whole (Millar and Locker 1998) and for the province of Saskatchewan (Kosteniuk and d'Arcy 2006). Most recently, Bhatti et al. (2007) confirm both the income gradient in use and the positive impact of private insurance on utilization even after correcting for possible selection effects. The only study of preventive care (Bedos et al. 2002) documents a positive effect of income on the probability of obtaining preventive dental care in Québec.

Two studies (vanDoorslaer and Masseria 2006; Allin 2006) have used the concentration-index approach to measure income-related equity in the use of dental care in Canada. Allin (2006) used the Canadian Community Health Survey (CCHS) to examine income-related inequity in the probability of any dental care visit. The analysis included as need variables self-assessed oral health and age. Allin found that the distribution of the probability of any dental visit is strongly pro-rich. van Doorslaer and Masseria (2006) measured equity of dental visits in Canada as part of their larger study of equity in health care among 21 OECD countries. Because of their desire to use a standardized approach across countries, only age was included as a need variable. The study confirms that jurisdictions with a low share of public financing for dental care exhibit greater pro-rich income-related inequity in utilization: Canada's pro-rich

income-related inequity in both the probability of a dental visits and the number of visits ranks 5th after the US, Portugal, Spain and Ireland among the 15 OECD countries studied.

Internationally, two other studies follow the same broad methodology to measure the inequity of dental care utilization: Nguyen and Häkkinnen (2004) in Finland and Stoyanova (2003) in Spain. Nguyen and Häkkinen (2004) analyse three measures of utilization: probability of any use, total number of visits in the past year, and number of visits conditional on having visited a dentist at least once. They employ a rich set of need adjustors, including age, sex, number of missing teeth, dentures, and pain, and find that for all descriptors healthier individuals use more care rather than less, suggesting reciprocal causality (endogeneity).

Stoyanova (2003) is the only study to examine separately visits for prevention (check-up or cleaning), restoration (filling or prosthesis) and extraction. The needs variables were the same across the three models and included age, sex, current smoking status and a series of dummies for oral health problems: at least one cavity, at least one extracted tooth due to cavity or being unsound, gum disease, at least one unsound tooth, and at least one missing tooth. The level of inequity differed notably across these three types of visits, from strongly pro-rich for prevention care to pro-poor for an extraction.

3 Methods: measuring equity in dental care

The key steps for measuring income-related equity in dental care using the concentration-index approach developed by Wagstaff and van Doorslaer (2000) and known as “ECuity” are as follows.

1. Calculate the income-related concentration index for dental care utilization, unadjusted for need.

2. Calculate the income-related concentration index for needs-adjusted dental care utilization.

   a) Estimate a model of utilization that includes a full set of determinants, including both need-related (e.g., age) and non-need-related variables (e.g., income, insurance coverage, education, marital status).
   b) Obtain the each individual’s needs-predicted utilization by using the coefficients from the model estimated in 2a, each individual’s actual values of all needs-related variables, but substituting the sample mean values of all non-need variables. The resulting distribution reflects what utilization would be if only needs determined use.

c) Calculate the income-related concentration index of this distribution of needs-predicted utilization.

3. Calculate income-related horizontal inequity as the difference between the unadjusted and the need-predicted concentration indices.

As noted, we examine separately total visits and preventive visits. In each case we use the two-part model of utilization in which part one pertains to the likelihood of a dental visit during the year preceding the respondent's survey interview and part two pertains to the conditional number of visits. In addition, for preventive care we examine the probability that a respondent makes preventive visits irregularly, regularly or frequently. All regressions and decompositions of the horizontal index presented here are based on OLS regressions as is standard when the measure of inequity is decomposed (using non linear regressions in estimating the concentration index imposes some linear approximations in the decomposition step). We checked the robustness of our conclusions against logistic regressions for probability variables and zero-truncated negative binomial for count dependent variables (Jones, 2000). There is no qualitative difference[8] between OLS estimates and logistic or negative binomial hence we use the simpler OLS (all results available on request).

Standardizing for need is crucial to the measurement of inequity. Studies of physician or hospital services – the vast majority of inequity studies -- measure need using a combination of demographic indicators such as age and sex and health status indicators such as self-assessed health status, the presence of chronic conditions and activity limitations (O'Donnell et al. 2007). Using current health status as a proxy for need is reasonable for physician and hospital care: an individual in poor general health with diabetes, for example, can safely be considered to need more health care than an individual in very good health with no chronic condition or activity limitations. While health care is very effective for many types of acute conditions, the effectiveness of prevention in improving baseline health status is less well demonstrated than it is for dental care. Furthermore, only a small proportion of physician care is for preventive services. Hence, although the reciprocal causality deriving from a causal impact of physician visits on current health status is potentially a concern, evidence suggests that empirically any such effect is very small. For instance, Bago d'Uva, Jones, and van Doorslaer (2007) find that equity measures are robust to controlling heterogeneity using panel data, and Windmeijer and

[8] By "no qualitative difference" we mean that the same coefficients are significantly different from 0, and all coefficients have the same sign in both the OLS and logistic/negative binomial estimations. Moreover we checked that the OLS predicted a small proportion of probabilities and visits outside of the unit interval (for probability) or positive range (for number of visits).

Santos Silva (1997) find that correction for reverse causality has little impact on estimates in an analysis of the demand for health care.

Need-standardizing the distribution of dental care creates distinct challenges. No evidence indicates systematic differences in dental needs by sex. We therefore, do not standardize by sex. More importantly, the combination of a direct, causal relationship between preventive care and oral health and the large proportion of dental visits that are preventive lead to a positive relationship between use and oral health. Furthermore, poor oral health can be associated with less need: other things equal, having fewer teeth requires less restorative care because the risk of having a caried or decayed tooth is lower (McEntee et al. 1993, Nguyen et al. 2007). These considerations imply that standardizing for oral health can yield the paradoxical result that a "higher" level of need (poorer oral health) is associated with a lower level of standardized care.

Following Nguyen and Häkkinnen (2004) we use a variety of descriptors of oral health problems available in the CCHS to address two methodologically oriented questions. First, are more objective (functional) definitions of baseline oral health, such as the number of missing teeth or functional limitations (ability to chew), better indicators of need (and to a lesser extent outcomes of past preventive dental care) than subjective measures to reverse causality? There is no ground to predict a priori that a more objective measure will be better as an indicator of need but we use the wealth of variables describing oral health in our data to empirically test the hypothesis; the empirical test will simply be to look at the strength and direction of the relationship between each measure of oral health and dental visits, a positive link between the variable and utilization indicating need rather than outcome. Second, does the addition of severe functional limitations (such as avoiding laughing or speaking in public) or recent acute pain or symptoms as need adjustors change the estimate of horizontal inequity in utilization of dental visits? We expect that severe oral health problems or suffering from pain or symptoms (e.g., bleeding gums) are more likely to be exogenous determinants of utilization because they more closely approximate oral health shocks. We test the sign of these oral-health indicators to check whether they reflect outcomes or need and assess the impact of their inclusion in the need standardization.

Because no evidence suggests that prevention is more needed or more effective within some specific categories of individuals, the analysis of preventive visits includes only age as a need adjustor. Although evidence supporting differential need for prevention by age is also weak, we include age based on the hypothesis that the effectiveness of preventive visits varies with age.

Following the analysis of equity in current utilization, we simulate the impact of giving full dental insurance to all individuals in the poorest quintile of the population (currently less than half such individual have any insurance) on the distribution of preventive dental care utilization and its level of income-related inequity. We use two alternative methods to run the simulations.

The first simulation method is based entirely on predicted values based on the estimated utilization models. The unadjusted CI is calculated from the distribution of predicted utilization when both need and non-need variables are allowed to vary at their current level. The needs-predicted use with current coverage is calculated as usual by setting need variable equal to their sample means and letting non-need variables take on their actual values. The simulation-based estimate of inequity under current coverage patterns is simply the difference between the unadjusted CI as calculated above and the CI for this needs-predicted distribution. To simulate the impact of insurance for the poor, we then calculate a second needs-predicted distribution, but this time assuming all those in the lowest income quintile have dental insurance. The estimate of income-related equity if all those in the lowest had dental insurance is simply the difference between the unadjusted CI and the CI for this second needs-predicted distribution. A comparison of the two equity estimates indicates the impact of providing such insurance to low-income individuals.

The second simulation method is based in part on the actual distribution and in part on a simulated distribution. The advantage is that it retains more of the observed variation in use; the disadvantage is that it is perhaps less rigorous. The unadjusted CI is calculated on the observed distribution as usual; similarly, the needs-predicted distribution under current arrangements is calculated as usual. To simulate the needs-predicted utilization under the insurance program, for all those in the lowest income quintile who do not currently have insurance, we add BINS (the marginal effect of insurance on use) to their observed utilization and calculate the CI and HI for these simulated values.

Because our second simulation method retains most of the variation across individuals it is expected to yield a larger estimate of the effect of insuring the poor than what obtains with the first method. Moreover it is certainly closer to the true effect we aim at measuring. We present the results from the first simulation method as well, though, since they provide a lower bound of the effect, based on the (wrong) assumption of no individual variation in utilization beyond what is explained in the linear regression model.

4. Data and variables

The data come from the 2003 Canadian Community Health Survey (CCHS). The total survey sample comprises 135,573 respondents. We excluded 2497 respondents from the Territories (where the dental care system works in a different way than in the Provinces) and 4996 respondents below age 15. We further dropped the following due to missing data: 1108 with no information on dental utilization; 22,641 observations with no information on income – a focal variable in the analysis; 1026 with no information on dental insurance, and approximately 5000 observations due to missing information on one or more other variables. This left an analysis sample of 98, 387.

The CCHS includes both a mandatory core component that is completed by respondents in all provinces and optional components completed at the discretion of individual provinces. Respondents in the provinces of British Columbia and Ontario completed a more detailed set of questions related to dental care services than did residents of other provinces. Consequently, as described below, some components of our analysis are based on the full national sample while others are based on respondents in British Columbia and Ontario only.

Utilization variables

Utilization measures for use/non-use of any dental visit and for the total number of dental care visits are derived from the question: “Not counting when you were an overnight patient, in the past 12 months, how many times have you seen, or talked on the telephone, about your physical, emotional or mental health with a dentist or orthodontist?”

A question explicitly identifying preventive visits was asked only of respondents in British Columbia and Ontario. For these two provinces, measures of preventive care utilization are derived from the question: “Do you usually visit a dentist for a check up: (a) More than once a year; (b) about once a year; (c) less than once a year; (d) only for emergency care?” We construct three alternative measures preventive care utilization:

some preventive care: a dummy variable that takes the value of 1 if the respondent answered (a), (b) or (c) and a value of 0 otherwise;

regular preventive care: a dummy variable that takes the value of 1 if the respondent answered (a) or (b) and a value of 0 otherwise; and

frequent preventive care: a dummy variable that takes the value of 1 if the respondent answered (a) and a value of 0 otherwise.

For the full sample we construct a proxy measure of preventive care utilization by combining responses to two questions: the above question regarding the total number of dental visits during the past year and a question regarding whether the individual had a tooth extraction during the year. The proxy prevention variable ("proxy preventive care") takes a value of 1 if a respondent had at least 1 visit in the year but did not have an extraction, and 0 otherwise.

Independent Variables

Need variables

The need variables include age, self-assessed oral health, and a set of variables to oral-health indicators that have not been used in previous Canadian studies. The national sample includes two additional need measures: a respondent's ability to chew (firm food, no firm food but apple, vegetables only) and the frequency with which the respondent experiences pain in the teeth (from often to never). The former is a functional definition of oral health while the latter is a symptomatic definition. Although ability-to-chew partially reflects past dental care, it is more objective than SAOH, and, for some individuals, might signal some a kind of health shocks requiring dental care. Pain frequency more closely represent an oral health shock unrelated to past use.

For respondents in British Columbia and Ontario only the survey includes additional oral health measures. Information on extractions and dentures allows us to construct a binary measure indicating whether a respondent has one or more missing teeth. Functional limitations due to oral health include: difficulty speaking (yes/no); avoids conversation (very often, often, sometimes, rarely, never) due to poor oral health; and avoids laughing/smiling due to poor oral health (very often, often, sometimes, rarely, never). We use the above three indicators to construct a binary variable ("social limit") that takes on a value of one if the respondent answered yes to the first item or any option other than never to either of the last two questions. Finally, Ontario and BC data also include responses to a question regarding need for emergency dental care in the previous month as a result of: toothache; sensitivity to hot or cold; pain in jaw or joints; pain in the mouth or face; bleeding gums; dry mouth; bad breath. We created a binary variable, "emergency care," indicating any kind of need of emergency care in the past month. This is our preferred measure of health shocks and we expect it to be a determinant of the decision to seek dental care rather than primarily outcome of past utilization.

We employ different needs indicators for the analyses of total visits and preventive care, and for the analysis of use/non-use versus the total and conditional number of visits. Again, there is little evidence upon which to base these decisions, but when analyzing the probability of any visit we include age and teeth emergency in past month as need variables; when analyzing the total and conditional number of visits we include the two measures just mentioned plus all other oral health variables (social limitations, ability to chew, self-assessed oral health, and teeth vacancy). The need for emergency care is most likely to be a determinant of the decision to visit a dentist; all other capture an aspect of severity that would be expected to influence the number of visits.

Non-need Variables

Household income is the non-need variable of primary interest. Income is measured as continuous variable based on the following question: "What is your best estimate of the total income, before taxes and deductions, of all household members from all sources in the past 12 months?" Total household income was adjusted for household size and composition using the modified OECD equivalence scale, which gives a weight of 1.0 to the first adult, 0.5 to the second and each subsequent person aged 12 and over, and 0.3 to each child aged under 12 in the household.

A subset of observations (37,098) did not provide their best estimate for income; among them, however, 14,457 provided a categorical response (in 11 categories). For these respondents only we imputed a continuous value of income as follows. For the sub-sample of individuals that provided a continuous response we regressed income on the relevant income category from the 11 category scale, education, age, sex, province, rural or urban residence, and occupational status. We then used the estimated coefficients from this regression to impute income for the sub-sample for which we categorical income information. This allowed us to assign a more specific income within the category the individual had indicated. A test showed that 77% of the imputed income values fell within the identified income category; 22% fell outside the identified income category, though in all but three cases by less than $5000; three highly discordant observations were excluded.

Other non-need variables are: marital status, immigrant status, race/ethnicity, smoking status, urban/rural status, and province of residence.

Table 1: Description of Utilization Analyses

Utilization Measure	Dependent Variable	Need descriptors	Sample
Total Dental Visits	Use/Non-Use previous year	Baseline: Age and self-assessed oral health	National sample
		Model 2: Age, SAOH, ability to chew, and teeth pain	National sample
		Model 3 (preferred): Age, and emergency care	British Columbia and Ontario only
	Conditional number of visits and Total number of visits	Baseline: Age and SAOH,	National sample
		Model 2: Age, SAOH, ability to chew, and teeth pain	National sample
		Model 3 (preferred): Age, SAOH, ability to chew, teeth vacancy, social limitations, and emergency care	British Columbia and Ontario only
Preventive Visits (i) some (ii) regular (iii) frequent	Yes/No for each level of preventive care	Age	British Columbia and Ontario only
Preventive Visits - proxy	Yes/No	Age	National sample

Descriptive statistics for all the control variables are provided in table 2.

Table 2: Summary statistics: Independent Variables

Variable	Mean (weighted)	Std.
Income	37061.92	28037.34
Log(income)	10.4687	0.5703
Male	0.4972	0.5000
Education:		
Less than secondary education (ref.)	0.1988	0.3991
Secondary Education	0.2692	0.4435
Higher Education	0.5321	0.4990
Work Status:		
Employed	0.6493	0.4772
Student	0.1277	0.3337
Not working(ref.)	0.2230	0.4163
Immigrant Status:		

Immigrant 0-10 years	0.0562	0.2303
Immigrant 10-20 years	0.0438	0.2047
Native or Immigrant > 20 years (ref.)	0.9000	0.3001
Marital Status:		
Married	0.6390	0.4803
former married	0.1193	0.3241
Single (ref.)	0.2416	0.4281
Race/Ethnicity:		
White	0.8645	0.3423
Black	0.0173	0.1302
Aboriginal	0.0141	0.1178
Asian	0.0832	0.2762
Other (ref.)	0.0157	0.1242
Have dental insurance	0.6247	0.4842
Smoking status:		
Current smoker	0.2430	0.4289
Former smoker	0.4237	0.4941
Never Smoked(ref.)	0.3333	0.4714
Residence – Urbanization:		
Urban Core of Census Metropolitan Area (CMA) or Census Agglomeration (CA)*	0.7124	0.4527
Urban Fringe within CMA/CA	0.0239	0.1526
Rural Fringe w/in CMA/CA	0.0650	0.2466
Urban outside CMA/CA	0.0665	0.2491
Rural outside CMA/CA	0.1208	0.3259
Secondary Urban core within CMA/CA (ref.)	0.0114	0.1062
Age:		
Age <35 (ref.)	0.3209	0.4668
Age 35-44	0.2284	0.4198
Age 45-64	0.3215	0.4671
Age 65-75	0.0784	0.2689
Age 75+	0.0507	0.2194
Self-Assessed Oral Health:		
Excellent(ref.)	0.2296	0.4206
Very good	0.3180	0.4657
Good	0.3080	0.4617
Fair	0.1056	0.3073
Poor	0.0388	0.1932
Chewing Ability:		
Difficulty Chewing firm food	0.0376	0.1902
Difficulty Chewing apple	0.0675	0.2509
Difficulty Chewing vegetable	0.0246	0.1548
Teeth Pain:		

Often	0.0411	0.1985
Sometimes	0.1311	0.3687
Rarely	0.2108	0.4079
Never (ref.)	0.6171	0.4861
Missing Teeth[+]	xxx	Xxx
Social Limitations dur to Oral Health[+]	xxx	Xxx
Emergency Care[+]	Xxx	Xxx

*Census metropolitan areas (CMAs) consist of one or more adjacent municipalities situated around a major urban core with a population of at least 100,000. Census agglomerations (CAs) are defined similarly to CMAs except that the size of the urban core is smaller -- at least 10,000.
[+]Residents of Ontario and British Columbia only

5. Results:

5.1 Descriptive Results

Just under two-thirds (64%) of Canadians visit a dentist each year and they make, on average, 1.3 visits annually (Table 3A). Approximately two thirds of Ontario and British Columbia residents make at least one preventive visit annually, and close to 40% make more than one preventive visit annually. The proxy measure of preventive care slightly underestimates preventive visits.

Table 3B confirms the income gradient of dental care utilization: the probability of any visit within the year as well as the average (unconditional) number of visits per year increase almost twofold from the lowest income quartile to the highest. The pattern is of a true gradient, with, each income quartile having a higher probability than the quartile immediately below, and not of a threshold effect at low incomes.

14% of respondents assess their oral health as fair or poor and 38% report suffering from the teeth pain sometimes. From 10% to 23% of respondents state some recent need for emergency care. Less than 5% of respondents have social or functional limitations due to poor oral health.

Table 3: Summary statistics: Dental Utilization
(3A) Total population

Health Utilization	Canada		Ontario		BC	
	Mean	Std.	Mean	Std.	Mean	Std.
Probability any dental visit	0.644	0.479	0.707	0.455	0.682	0.466
Total number -- Dental visits (unconditional)	1.304	1.622	1.494	1.676	1.424	1.642

Some preventive care	N/A	N/A	0.681	0.466	0.772	0.420
Regular preventive care	N/A	N/A	0.626	0.484	0.696	0.460
Frequent preventive care	N/A	N/A	0.367	0.482	0.408	0.492
Proxy for preventive care	0.611	0.488	0.643	0.479	0.621	0.485

(3B) By income quartile

	Lowest income quartile	Q2	Q3	highest
Probability of any visit	0.443	0.609	0.728	0.807
total number of visits	0.868	1.245	1.456	1.676
Preventive care (Ontario)				
Some preventive care	0.474	0.636	0.746	0.811
Regular preventive care	0.413	0.57	0.683	0.767
Frequent preventive care	0.209	0.30	0.417	0.487
Proxy preventive care	0.439	0.581	0.706	0.778

5.2 Equity: Total Dental Visits

Table 4 reports results from the baseline model for the probability of any visit to a dentist. The distribution of both total dental visits (CI=0.1322 and HI=0.1333) and the probability of a dental visit (CI=0.122, HI=0.1118) are significantly pro-rich. These estimates are slightly larger than those obtained by Allin (2006), which used the same need variables but a categorical rather than continuous income measure and included fewer non-need controls. The CI's for the unadjusted and the adjusted distributions of the conditional number of visits are also positive and significant but are notably smaller, indicating that most of income-related inequity in dental care utilization stems from the decision to visit rather than on the number of subsequent visits.

Lastly, the residuals (the portion of the difference between the CI and the HI that is not captured by the factors in the decomposition) are large and positive -- +0.059 for total dental visits and +0.040 for probability of dental visits -- indicating that some systematic determinants of dental care not captured by the survey are positively correlated with income.

Table 4: Inequality and inequity in dental utilization in Canada, 2003: Baseline Model

	Total Number	Probability	Conditional
CI	*0.1322*	*0.1228*	*0.0098*
	[.125, .139]	*[.119, .127]*	*[.003, 0.015]*
HI	*0.1333*	*0.1118*	*0.0209*
	[.126, .140]	*[.108, .116]*	*[.015, .027]*
Error	*0.0589*	*0.0397*	*0.0000*
N	98,390	98,390	58,070

Notes: 95% confidence intervals shown in brackets; Error is the generalized concentration index of the error term.

Table 5 presents the CIs, HIs and decompositions of the CIs for the distributions of total dental visits when an expanded set of need variables is included. Panel 6(A) present the findings for model 2 (need = age, self-assessed oral health, ability to chew, and frequency of pain) separately for Canada, Ontario and British Columbia; Panel 6(B) presents the findings for Model 3 that includes the most comprehensive set of need variables (for the conditional number of visits model only), available in Ontario and British Columbia only. Adding more need variables leaves the estimate of income-related inequity (HI) unchanged (e.g., for total visits for Canada, HI of 0.1353 for model 2 versus 0.1333 for baseline model; for Ontario, 0.110 for both models 2 and 3).9 Overall, need variables make only a minor contribution to income-related inequality in dental care use. Income and dental insurance contribute to a significant pro-rich distribution of dental care visits: the direct impact of income explains between 50% and 60% of total income-related inequity; the concentration of private insurance among higher income individuals explains another 30%. Urban/rural status has an impact on utilization, but, because it is only weakly associated with income, its overall effect on income-related inequity is small. The same is true with province. SAOH contributes positively to income-related inequity in utilization, confirming that SAOH represents the outcome of dental care rather than the need for dental care.

The distributions of total dental visits in Ontario and British Columbia are slightly less pro-rich than for the country as a whole: total visit HIs of 0.1103 and 0.099 in B.C. versus 0.1353 for Canada, and incidence HIs of 0.0833 and 0.0951 versus 0.1105. No income-related inequities are found in the conditional number of visits for ON or BC.

Table 5: Inequality and Inequity in Total Dental Visits
5(A): Model 2 with age, SAOH, chewing ability and frequency of pain as need variables

	Total Number			Probability			Conditional		
Variables	Canada	Ontario	BC	Canada	Ontario	BC	Canada	Ontario	BC
CI	*0.1316* *[.124, .138]*	*0.1052* *[0.095,0.116]*	*0.1041* *[0.088,0.120]*	*0.1228* *[.119, .127]*	*0.0967* *[0.091,0.103]*	*0.0984* *[0.089,0.108]*	*0.0091* *[.003, 0.015]*	*0.0086* *[.000, 0.017]*	*0.0057*
HI	*0.1353* *[.128, .143]*	*0.1103* *[0.100,0.120)*	*0.099* *[0.090,0.122]*	*0.1105* *[.107, .114]*	*0.0833* *[0.078,0.089]*	*0.0951* *[0.077,0.096]*	*0.0243* *[.018, .030]*	*0.0283* *[0.017,0.034]*	*0.0258* *[0.005,0.032]*
Non-need	**0.1215**	**0.1009**	**0.0944**	**0.0991**	**0.0741**	**0.0789**	**0.022**	**0.0266**	**0.015**

[9] Among our need indicators, pain frequency, and oral-health-related functional and social limitations show the least evidence of being the result of past dental utilization. In contrast, "any missing tooth" is clearly endogenous with use, making it a poor need adjustor that reflects use rather than need.

Income	0.0659	0.0624	0.0433	0.0461	0.0371	0.032	0.0198	0.0243	0.0115
Gender	-0.0042	-0.0038	-0.0043	-0.0028	-0.0024	-0.0025	-0.0014	-0.0014	-0.0018
Education	0.0052	0.0014	0.0019	0.0105	0.0051	0.0049	-0.0034	-0.0032	-0.0013
Work	0.0051	0.0036	0.0019	0.0033	0.001	0.0016	0.0012	0.0027	-0.0005
Immigration	-0.0018	-0.0028	-0.0023	0.0012	0.0026	-0.0004	-0.0029	-0.0044	-0.0016
Marital Status	0.0015	0.0018	0.0018	0.0038	0.004	0.0026	-0.0024	-0.0019	-0.001
Race	0.0019	0.0049	0.0036	0.0008	0.002	0.0017	0.0009	0.0025	0.0013
Insurance	0.0378	0.0323	0.0453	0.0278	0.0232	0.0342	0.0086	0.0081	0.0093
Smoking	0.0018	0.0013	0.0026	0.0023	0.0013	0.003	-0.0003	0.0001	-0.0003
Region	0.0017	-0.0002	0.0006	0.0014	0.0002	0.0018	0.0004	-0.0002	-0.0006
Province	0.0066			0.0047			0.0015		
Need	**-0.0041**	**-0.0227**	**-0.0021**	**0.0122**	**0.0068**	**0.0066**	**-0.0151**	**-0.0185**	**-0.0126**
Age	0.0008	-0.0046	0.0003	0.0020	-0.0023	0.0015	-0.0002	-0.0017	-0.0005
SAOH	0.0059	0.0033	0.0042	0.0100	0.0099	0.0046	-0.0039	-0.0061	-0.0056
Chew-ability	-0.0035	-0.0047	0.0012	0.0020	0.0011	0.0019	-0.0047	-0.0046	-0.0005
Teeth pain	-0.0073	-0.0167	-0.0078	-0.0018	-0.0019	-0.0014	-0.0063	-0.0061	-0.0060
Error	*0.0143*	*0.0268*	*0.0118*	*0.0112*	*0.0160*	*0.0143*	*0.0019*	*0.0005*	*0.0030*

Notes: 95% confidence intervals shown in brackets; Error is the generalized concentration index of the error term.

Table 5(B): Model 3 for Ontario only: age, SAOH, chewing ability, missing teeth, social limitations and emergency care as need variables.

Variables	*Total number*	*Probability*	*Conditional*
*CI**	*0.1052* *[0.095,0.116]*	*0.0967* *[0.091,0.103]*	*0.0086* *[0.000,0.017]*
*HI**	*0.1110* *[0.010,0.121)*	*0.0975* *[0.092,0.103]*	*0.0283* *[0.020,0.037]*
Non-need	**0.102**	**0.0868**	**0.0292**
Income	0.0636	0.0461	0.026
Gender	-0.0036	-0.0028	-0.0013
Education	0.0013	0.0065	-0.003
Work	0.0034	0.002	0.0028
Immigration	-0.0033	0.0025	-0.0048
Marital Status	0.0021	0.0047	-0.0014
Race	0.005	0.0018	0.0026
Insurance	0.0322	0.0243	0.0083
Smoking	0.0015	0.0015	0.0002
Region	-0.0002	0.0002	-0.0002
Need	**-0.0114**	**-0.0008**	**-0.0196**
Age	-0.0065	-0.0008	-0.0024
SAOH	0.0049		-0.0042

Chew ability	-0.0042		-0.0039
Any missing teeth	0.0093		-0.0007
Socially limited	-0.0086		-0.0031
Emergency care	-0.0063	0.0000	-0.0053
*Error***	*0.0089*	*0.0108*	*-0.0009*

Notes: 95% confidence intervals shown in brackets; Error is the generalized concentration index of the error term. Results for B.C. similar but not presented.

Table 6 presents the CIs, HIs and decompositions for the alternative measures of preventive care utilization. The HIs are all significantly positive, indicated pro-rich income inequity. There is little difference in estimated inequity for some preventive care, regular preventive care and the proxy measure of preventive care, and these point estimates are similar to those obtained for the probability of any dental visit (Table 5). However, the HI for the distribution of frequent users of preventive care is notably more pro-rich, with income-related equity estimated to be 50% higher than for the other measures. Among all variables, only income and holding private dental insurance significantly and positively contribute to horizontal inequity for all proxies. Because dental insurance is concentrated among higher-income individuals and increases the likelihood of preventive care, it contributes to the pro-rich bias.

Table 6: Inequality in preventive care utilization and its decomposition: Ontario and British Columbia

Panel A: Ontario

Variable	Some	Regular	Frequent	Proxy
CI	*0.0980*	*0.1153*	*0.1719*	*0.1087*
	[0.096,0.108]	*[0.110,0.123]*	*[0.154,0.179]*	*[0.103,0.117]*
HI	*0.1017*	*0.1165*	*0.1664*	*0.1102*
	[0.092,0.104]	*[0.108,0.122]*	*[0.159,0.184]*	*[0.102,0.116]*
Non-need				
Income	0.0600	0.0698	0.1108	0.0525
Sex	-0.0031	-0.0038	-0.0037	-0.0033
Education	0.0079	0.0066	0.0061	0.0076
Work status	0.0029	0.0043	0.0053	0.0028
Immigrant	0.0019	0.0022	0.0009	0.0032
marital status	0.0028	0.0035	0.0020	0.0046
Race	-0.0013	-0.0016	-0.0008	0.0029
Dental Insurance	0.0154	0.0204	0.0331	0.0253
Smoking	0.0013	0.0014	0.0010	0.0018
Region	0.0004	0.0004	0.0012	0.0001
Need				
Age	0.0036	0.0012	-0.0055	0.0015
Error	0.0060	0.0110	0.0215	0.0097

Panel B: British Columbia

Variable	Some	Regular	Frequent	Proxy
CI	*0.0981*	*0.1204*	*0.1578*	*0.1155*
	[0.091,0.106]	*[0.111,0.130]*	*[0.140,0.176]*	*[0.104,0.127]*
HI	*0.0917*	*0.1156*	*0.1547*	*0.1113*
	[0.084,0.099]	*[0.106,0.125]*	*[0.137,0.173]*	*[0.100,0.123]*
Non-need				
Income	0.0443	0.0553	0.0659	0.0422
Sex	-0.0028	-0.0032	-0.0047	-0.0032
Education	0.0075	0.0079	0.0078	0.0076
Work status	0.0001	-0.0009	0.0034	0.0016
Immigrant	0.0024	0.0001	-0.0006	0.0001
marital status	0.0028	0.0027	-0.0001	0.0041
Race	0.0016	0.0016	0.0013	0.0030
Dental Insurance	0.0255	0.0368	0.0547	0.0362
Smoking	0.0033	0.0035	0.0049	0.0046
Region	0.0002	0.0003	0.0009	0.0005
Need				
Age	0.0065	0.0048	0.0030	0.0042
Error	0.0003	0.0069	0.0182	0.0104

Inspection of the concentration curves (not shown) for the four measures of preventive care utilization revealed pro-rich bias over the whole income distribution in all cases, indicating that the overall inequity is not the result of a threshold effect above and below a particular income level that would represent more clearly a problem of affordability for low-income individuals.

The impact on inequity in the use of preventive dental care of providing dental insurance to the poorest quintile in Ontario and British Columbia is shown in tables 7A (method 1) and 8B (method 2). Covering the poor would substantially reduce but not eliminate inequity of utilization of preventive care. According to our preferred simulation method (the second one) inequity would decrease by 29% to 34% in Ontario and by 31% to 39% in B.C (as already mentioned it is our preferred method because it uses the observed variation across individuals and, as a result, is closer to the true effect). The impact is stronger in the latter province both because the coefficients on being insured are larger than in Ontario and because private insurance is more highly concentrated among the wealthy. The first simulation method (no individual variation beyond the regression model) provides a lower bound of the impact of covering the poor that would decrease the level of pro-rich inequity by between 5% and 10% of the initial (predicted) level in Ontario and from 10% to 15% in B.C.

Table 7: Simulation Results: Insuring the poorest quintile, Ontario and British Columbia.

Panel 7A: Simulation Method 1

	Ontario				British Columbia			
	Some	Regular	Frequent	Proxy	Some	Regular	Frequent	Proxy
CI	0.062	0.071	0.104	0.068	0.066	0.078	0.100	0.071
CI*	0.059	0.067	0.094	0.062	0.060	0.069	0.085	0.062
Decrease	4.8%	6.2%	9.2%	9.1%	8.4%	11.8%	15.1%	13.2%
HI	0.061	0.071	0.107	0.068	0.063	0.076	0.097	0.069
HI*	0.058	0.066	0.097	0.061	0.057	0.066	0.081	0.059
Decrease	5.2%	7.1%	9.7%	10.4%	10.0%	13.4%	16.6%	14.9%

Panel 7B: Simulation Method 2

	Ontario				British Columbia			
	Some	Regular	Frequent	Proxy	Some	Regular	Frequent	Proxy
CI	0.098	0.115	0.172	0.109	0.098	0.120	0.158	0.116
CI*	0.070	0.083	0.108	0.079	0.071	0.083	0.108	0.079
Decrease	29.1%	28.5%	37.0%	28.8%	27.4%	28.5%	37.0%	28.8%
HI	0.102	0.117	0.166	0.110	0.017	0.116	0.155	0.111
HI*	0.068	0.082	0.110	0.078	0.068	0.080	0.102	0.075
Decrease	33.1%	29.6%	33.9%	28.5%	33.1%	31.3%	38.7%	31.0%

6. Discussion

Our analysis confirms the pro-rich inequity in total dental care visits in Canada found in van Doorslaer and Masseria (2006) and Allin (2006). Adding need adjustors beyond SAOH has little impact on the estimates. The contributions of needs adjustors to inequality in utilization are always small. The relationship between income and dental care utilization is little affected by needs-adjustment: the rich (and insured) simply use more dental services, and oral health never plays a substantial role in the concentration of utilization.

Health status' failure to play a substantial role in inequity in dental care utilization may be due in part the high proportion of visits that are for prevention. The need for preventive care is similar for everyone and is not motivated by poor oral health. This is confirmed by the results indicating that the level of income-related inequity in the utilization of preventive dental care is very close to the level of inequity in the utilization of total visits. The only exception is for frequent preventive care, for which utilization is particularly pro-rich. There is no evidence suggesting that

more than one check-up visit a year is better for oral health than one per year and our results suggest that, with a broad definition of prevention (at least one per year), there is not much difference in inequity between prevention and all types of dental care services, but that, with a stricter definition (more than one preventive visit a year) preventive services are much more inequitably accessed than general dental services.

Lastly, access to dental care by the poor has recently emerged as a policy issue in Canada's largest province, Ontario, with the government committing to insure children on social assistance. Our simulations indicate that providing dental insurance to the poorest quintile would reduce but not eliminate inequity in dental care utilization. A program targeted at the lowest income has limited impact because the link between income and prevention use in dental care manifests as a gradient along the whole income distribution rather than only at the lower end.

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