How is oral health behaviour related to dental insurance coverage, and how does this correlation affect dental health in Canada?

Introduction

Canadian governments have historically promoted health insurance as a public health tool, recognizing it as essential to ensuring citizens' basic health needs. The study conducted by Tiwari and Franstve-Hawley (2021) suggests that the costs associated with health-related treatment, especially regular dental care, remain relatively high and unaffordable for populations without a stable income, such as those reliant on social welfare or retirees with limited savings or pension. Moreover, they state that insurance coverage strongly correlates with dental outcomes. Their findings indicate increases in insurance coverage, such as the expansion of Medicaid, have led to oral health improvement among low-income adults in the United States. Observing the importance of insurance and oral health outcomes stated by the prior research, the mechanism driving such causal relationships remains unclear, notifying that money does not directly affect improving oral health. Meanwhile, the prior study has confirmed the importance of dental behaviour for better oral health. Regular dental visits offer comprehensive benefits by maintaining dental health through early prevention, such as teeth cleaning and early detection of issues, and reinforcing the importance of personal oral health behaviours for daily tooth care (Singhal et al., 2019). Hence, we are interested in how dental behaviour acts as a potential barrier to accessing dental treatment and how the implementation of insurance eliminates this obstacle. With these concerns in mind, we want to answer the following questions by our analysis, “How

is oral health behaviour related to dental insurance coverage, and how does this correlation affect dental health in Canada?”

Data and Limitation

The raw data comprises the Cycle-1 Oral Health component of the Canadian Health Measures Survey (CHMS), gathered between 2007 and 2009. The data was collected using questionnaires distributed by three federal departments: Statistics Canada, Health Canada, and the Department of National Defence. The collection process included individuals aged 6 to 79, representing approximately 97% of the Canadian population, with around 6000 respondents from across the country. The cross-sectional data is presented at demographic level recording oral health behaviors, detailed oral health status for each tooth, and insurance status, whether it partially or fully covers dental costs.

The limitation of survey data comes from the incomprehensive results resulting from discrete or categorical responses. Specifically, our analysis does not examine the varying impacts of different insurance coverage levels on dental health outcomes by unit. Nonresponse bias is present in the survey data, which may lead to results that do not accurately represent the entire target population, yielding less representative outcomes.

Owing to the data source's broad representation (97%) of the Canadian population and the random selection procedure, we assume that selection bias is negligible. Besides selection bias, there is a risk of omitted variable bias, particularly from confounding variables. The dataset's demographic information does not include income and personal wealth status, which are factors

correlated with the effectiveness of insurance coverage. The study suggests that adults with low incomes are more responsive to insurance coverage (Chi & Masterson, 2011). In contrast, the impact of insurance coverage on the frequency of visits to dental professionals is less significant for adults with higher incomes. Without data on personal wealth status, the analysis cannot differentiate the effects of insurance across different wealth levels, potentially obscuring significant differences.

The endogeneity issue arises by confounding variables such personal wealth, genetic, and environmental factors. Hence, in this study the assumption made for IV analysis is that the endogeneity of the insurance status is eliminated in study.

Methodology

I use instrumental variable (IV) analysis to assess the causal relationship between the IV insurance status, the independent dental visit condition and the dependent variable toothache condition, controlling for age groups. The IV analysis relies on three assumptions as follows: First, the Instrument Relevance Assumption is upheld by the statistically significant result from the first-stage regression, which requires a statistically significant result. Second, the Exclusion Restriction Assumption is satisfied as insurance coverage primarily impacts toothache condition indirectly through its effect on dental visit behavior, as evidenced by the significant coefficient of -0.0509 in the reduced form regression. Third, the Independence Assumption is supported by the control for age in both stages of regression, which helps mitigate potential confounding effects from unobserved factors, ensuring the plausibility of this assumption. These three assumptions collectively validate the use of the IV methodology in this empirical investigation.

In the First-stage of the IV analysis, the goal is to evaluate the causal relationship between insurance coverage and dental visit behavior, which is essential for further investigation of its impact on dental health outcomes. A probit regression model is employed to estimate this relationship. The independent variable is the insurance status and the dependent variable is the dental visit behaviour, both represented by binary variables. By controlling for age groups, the analysis explores whether individuals with insurance coverage are more inclined to engage in regular dental visits compared to those without coverage.

During the second phase of the IV analysis, the focus shifts to the causal impact of insurance coverage on dental health outcomes. This is achieved through a reduced form regression with an independent variable of the insurance status and the dependent variable of the toothache condition. By incorporating dental visit behavior as a control variable, the direct effect of insurance on toothache condition is examined, alongside the indirect effect mediated through oral health behavior. Controlling for age groups, this stage of analysis uncovers the combined influence of insurance coverage and dental visit behavior on dental health outcomes.

In the final step of the IV analysis, we compute the IV estimate by the formula: IV Estimate = Covariance(Dental Visit Behavior, Toothache Condition) / Covariance(Dental Visit Behavior, Insurance Status). It reveals the dynamics between insurance coverage, dental visit behavior, and dental health, thus contributing to a deeper understanding of how insurance influences dental health outcomes through its impact on behavior.

Results:

Table 1. First-stage Regression Table

OLS Regression Results

Dep. Variable:	Dental Visit Behaviour	R-squared:	0.147
Model:	OLS	Adj. R-squared:	0.146
Method:	Least Squares	F-statistic:	409.7
Date:	Sat, 09 Dec 2023	Prob (F-statistic):	6.42e-165
Time:	21:32:54	Log-Likelihood:	-1863.7
No. Observations:	4764	AIC:	3733.
Df Residuals:	4761	BIC:	3753.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.6208	0.015	42.630	0.000	0.592	0.649
Insured	0.3162	0.012	27.298	0.000	0.293	0.339
Age Group	-0.0070	0.002	-2.839	0.005	-0.012	-0.002

Omnibus:	873.307	Durbin-Watson:	2.011
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1423.715
Skew:	-1.281	Prob(JB):	6.99e-310
Kurtosis:	3.781	Cond. No.	15.0

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

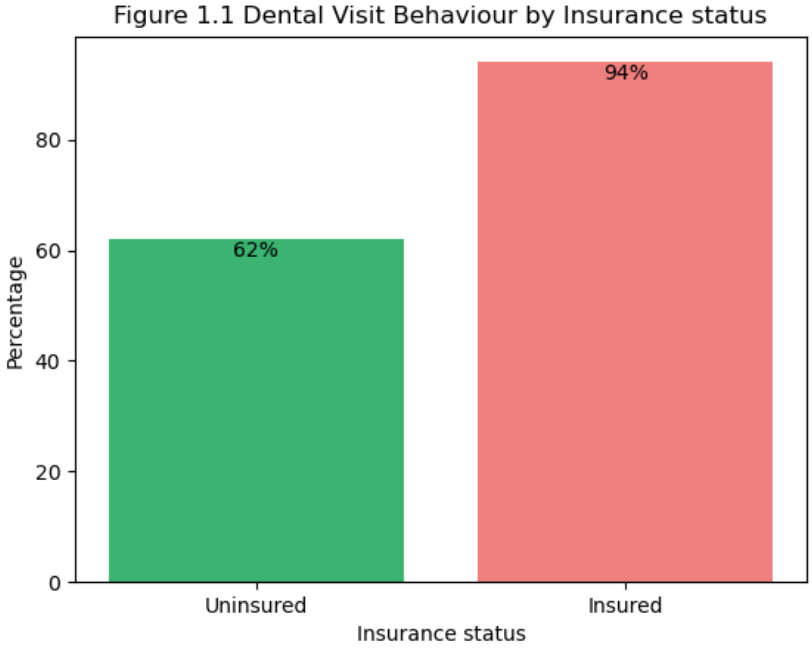

Figure 1.1. Visualization of the results of First-stage Regression

The results of the first-stage regression complemented by Figure 1.1 reveal significant differences that provide valuable insights into the relationship between insurance coverage and dental visit behavior. All coefficients are significant at a 0.01 significance level, resulting in significant difference across the people with contrary dental visit behaviour for each variable. Holding age groups constant, individuals without insurance coverage have a predicted probability of approximately 62.08% for avoiding regular dental visits due to cost constraints, whereas having insurance coverage increases the probability of individuals opting for regular annual dental visits by approximately 31.62 percentage point more likely to engage in regular dental check-ups compared to those without coverage. This effect represents a substantial 50.93% increase in the likelihood in proportion to the baseline probability for those without insurance coverage. This finding underscores the positive influence of insurance in promoting oral health behavior. The negative coefficient for age of -0.007 indicates that as individuals get older while other factors remain constant, they tend to be slightly less likely to avoid dental visits due to cost constraints.

Table 2. Reduced Form Regression Table

OLS Regression Results

Dep. Variable:	Toothache	R-squared:	0.004
Model:	OLS	Adj. R-squared:	0.004
Method:	Least Squares	F-statistic:	10.59
Date:	Sat, 09 Dec 2023	Prob (F-statistic):	2.59e-05
Time:	21:33:36	Log-Likelihood:	-993.87
No. Observations:	4764	AIC:	1994.
Df Residuals:	4761	BIC:	2013.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.1165	0.010	11.761	0.000	0.097	0.136
Insured	-0.0521	0.010	-5.124	0.000	-0.072	-0.032
Dental Visit Condition	0.0559	0.004	14.139	0.000	0.048	0.064
Age Group	-0.0069	0.002	-3.421	0.001	-0.011	-0.003

Omnibus:	2461.107	Durbin-Watson:	2.006
Prob(Omnibus):	0.000	Jarque-Bera (JB):	10915.683
Skew:	2.666	Prob(JB):	0.00
Kurtosis:	8.155	Cond. No.	1.86e+16

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.86e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

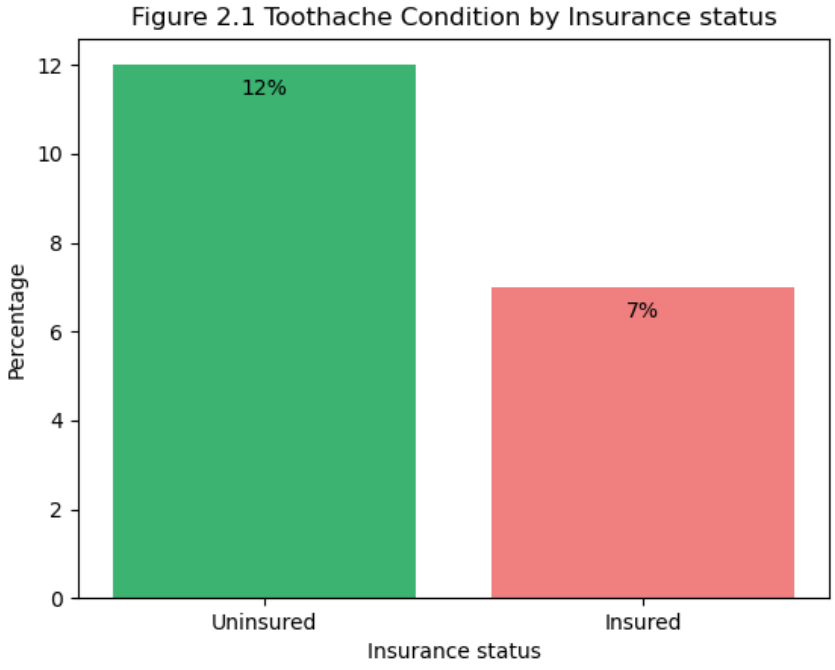

Figure 2.1. Visualization of the results of Reduced Form Regression

In the reduced form analysis, a deeper examination of the complicated relationship among insurance coverage, oral health behavior, and dental health outcomes is examined, while controlling for the age groups. The findings presented in Table 2 complemented by the visualization in Figure 2.1 reveal that insurance coverage bears a significant influence in diminishing the likelihood of individuals experiencing toothache conditions. The results are statistically significant at 0.01 significance level. Holding age groups constant, individuals with insurance are approximately 5.21 percentage points less likely to suffer from toothache conditions compared to those uninsured individuals. This effect size reinforces the protective role that dental insurance plays in the context of dental health outcomes. Furthermore, when assessing the proportional deviation from the baseline, insurance coverage results in a 44.7% decrease in the probability of toothache conditions in proportion to the people without any insurance coverage.

The IV estimate, calculated as the ratio of the reduced form coefficient for insurance coverage (-0.0521) to the first-stage coefficient for dental visit behavior (0.3162), yields a value of -0.1649. This IV estimate carries significant implications for our study, emphasizing the interplay between insurance coverage, oral health behavior, and dental health outcomes. The negative sign of the estimate underscores that individuals with insurance coverage tend to experience a reduced likelihood of toothache conditions. Statistically, this implies that individuals with insurance are approximately 16.49 percentage points less likely to suffer from toothache conditions compared to those without coverage, when controlling for age group. In relative terms, this IV estimate signifies a considerable 26.02% decrease in the probability of toothache conditions relative to the constant in the first-stage regression model, where dental

visit behavior is influenced by cost constraints and lacks insurance coverage. This finding underscores the pivotal role of insurance coverage in enhancing dental health outcomes through its influence on promoting dental visit behavior. It reinforces the idea that accessible dental insurance not only encourages proactive oral health behavior but also translates into tangible improvements in dental health outcomes. Thus, our study provides compelling evidence that emphasizes the importance of policies aimed at increasing dental insurance accessibility, as they have the potential to yield substantial public health benefits by reducing the incidence of dental health issues and associated costs.

Conclusion

The results from the IV analysis conclude a significantly positively correlated relationship between insurance and toothache, further examining the importance of promoting insurance in the sense of mitigating bad oral health outcomes. This study is crucial for extensive analysis of the association between insurance disparity and health inequality through the aspect of oral health outcomes. The causal relationship suggests that addressing disparities in dental insurance accessibility can contribute to reducing health inequalities, as it empowers individuals to prioritize preventive dental care, and thereby reducing the financial burden associated with dental issues. In conclusion, there is a trade-off between the amount of insurance assigned to citizens and the overall improvement of oral health. Further study should focus on the marginal benefit of increasing dental insurance to find a threshold that maximizes the effect of insurance. This type of study is limited to using the data with binary outcome classes, and discrete variables on insurance coverage can make this more applicable for policy making. Despite binary

outcomes, the limited amount of covariates used in this IV experiment cannot comprehensively analyze other confounding factors affecting people's decisions on dental visits. For further extension on this topic, I should control for confounders such as employment status, family size, as well as income level to address more hypothetical endogeneity issues.

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