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# Insurance Scheme: Inequality in Untreated Caries and Tooth Loss

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## Abstract

**Objectives:** In Thailand, access to dental care services varies based on different insurance schemes. Our objective was to determine the association of untreated caries and tooth loss with insurance schemes among adult population in Thailand.

**Methods:** This is a cross-sectional study. Secondary data from oral examinations and a questionnaire administered during Thailand's National Oral Health Survey 2017 were analyzed. Untreated caries and tooth loss were used as continuous dependent variables. Based on the insurance schemes, participants were categorized into four groups: Universal Coverage Scheme (UCS), Civil Servant Medical Benefit Scheme (CSMBS), Social Security Scheme (SSS), and "others" (uninsured, do not use, do not know). Poisson regression with robust variance and sampling weights was used to calculate the ratio of means (RM), and 95% confidence interval (CI) was used for untreated caries and tooth loss, with adjustments for age, gender, and location.

**Results:** A total of 4,534 participants were included. The mean age and number of untreated caries and tooth loss were  $39.6 \pm 2.9$  years,  $0.9 \pm 1.7$  teeth, and  $2.2 \pm 3.1$  teeth, respectively. In covariate-adjusted models, participants under the UCS showed a significantly higher chance of untreated caries compared to those under the CSMBS (RM=1.23, 95% CI=1.04–1.45). Regarding tooth loss, participants under the others category had a substantially higher chance of tooth loss compared with those with the CSMBS. (RM=1.37, 95% CI=1.02–1.85).

**Conclusions:** Insurance schemes are predictors of untreated caries and tooth loss. Expansion of coverage of all insurance schemes to facilitate access to dental services is required.

**Keywords:** access to care, epidemiology, National Oral Health Survey, untreated caries

## Introduction

Untreated caries and tooth loss cause pain, discomfort, impaired masticatory function, limited food intake, esthetic and psychosocial concerns, and poorer quality of life.<sup>(1)</sup> Untreated caries in permanent teeth is a global health challenge, affecting 3.5 billion people worldwide.<sup>(2-3)</sup> Caries is one of the major causes of tooth loss. Among aging populations, although the age-standardized prevalence of tooth loss has reduced in recent decades, the number of people with tooth loss has increased.<sup>(3-6)</sup> These prevalent oral diseases result in high direct and indirect costs.<sup>(7)</sup>

Despite the major health burden of oral diseases, oral health is constantly neglected in Universal Health Coverage (UHC).<sup>(8,9)</sup> A study in the United States reported that, compared to other healthcare services, access to dental care was the most disrupted owing to the cost of treatment.<sup>(10)</sup> Health insurance and education appeared to be the main contributors to oral health inequalities especially number of missing teeth.<sup>(11-14)</sup> The burden of UHC among low-income adults and adults with no private health insurance is high.<sup>(15)</sup> In contrast, other studies reported that people who had dental insurance were more likely to have frequent dental checkups, a larger number of remaining natural teeth, and better oral health.<sup>(16)</sup> Therefore, it has been recommended that UHC must include oral care. However, the impact of UHC on oral health is still unclear in countries with different backgrounds.

Thailand has a relatively wider insurance coverage for dental care and offers three public insurance schemes. To begin with, the Universal Coverage Scheme (UCS) insures more than 70% of the Thai population. The UCS is a tax-funded scheme that is free of charge and covers healthcare services (e.g., medical treatment, prescription drugs, and a part of dental treatment). Next, the Civil Servant Medical Benefit Scheme (CSMBS) covers around 9% of the Thai population.<sup>(17,18)</sup> The CSMBS is a tax-funded scheme that includes government employees, pensioners, and their families. Some of the dental treatment costs are covered under the UCS and CSMBS. Lastly, the Social Security Scheme (SSS) covers those who work in the private sector. The SSS covers 16% of the population in Thailand. The SSS is a mixed-funding program that includes contributions from both employees and employers.<sup>(17,18)</sup> Under the UCS and CSMBS, scaling, prophylaxis, restoration apart from esthetic or endodontic

treatments in the posterior teeth, and tooth extraction and surgical removal are free of charge. In the case of removable prosthetic treatment, renewal treatment is assured for 5 years after insertion. The SSS offers dental care for 900 TBH (28.74 USD) per year, which includes scaling, prophylaxis, restoration, and tooth extraction and surgical removal. If a treatment costs more than 900 TBH, the SSS payer is responsible for paying the dental facilities.

These insurance schemes are considered to affect the oral health of the population. Existing research pointed out that participants covered by the UCS appeared to use less dental care.<sup>(19)</sup> In addition, adult participants covered by the UCS demonstrated a significantly higher prevalence of periodontal disease than those covered by the CSMBS.<sup>(20)</sup> Moreover, older participants (defined as those aged 60 years and older) insured with the CSMBS exhibited significantly higher dental utilization than those insured with the UCS.<sup>(21)</sup>

Therefore, we hypothesized that participants covered by the UCS would demonstrate a higher prevalence of untreated caries and tooth loss than others covered by the CSMBS. Hence, we aimed to investigate the association between insurance schemes and untreated caries and tooth loss among the adult population in Thailand.

## Materials and Methods

### *Setting and participants*

This study is an observational cross-sectional study. We utilized secondary data from the most recent Thailand's National Oral Health Survey (eighth TNOHS). TNOHS was conducted by the Bureau of Dental Health, Department of Health, Ministry of Public Health, Thailand. The oral health survey questionnaire and oral examination took place from June to September 2017, with the target population being the indexed age groups from 24 provinces in 13 health regions. The TNOHS involved a three-stage, stratified, random sampling method. Systematic and quota sampling was employed. Based on the guidelines by the World Health Organization (WHO)<sup>(22)</sup>, the target age groups included: preschool children (3 and 5 years of age), teenagers (12 and 15 years of age), middle-aged adults (35-44 years of age), older adults (60-74 years of age), and late older adults (80-85 years of age). The detailed methods involved in the TNOHS have been described elsewhere.<sup>(23)</sup> The dental caries

prevalence in each age group was determined from the seventh TNOHS, a relative d of 10-15%, a 95% confidence interval, and a design effect of 2 were used to compute the sample size within each allocated area. The calculated sample size was 3,715 adults. Due to the possibility of subject absence or loss of data, the sample size was increased by 10%, resulting in a sample size of 4,128. However, the present study used data from the eighth TNOHS; thus, the data of 4,683 adults were used. The written informed consent was obtained from all adults (between 35 and 44 years of age) before the questionnaire survey began, followed by an oral examination. Reliability and validity of the data were crucial; therefore, intra-examiner and inter-examiner reproducibility was evaluated with 19 trained dentists who practiced under standardized conditions in the calibration stage, as advised by the WHO.<sup>(22)</sup> The Kappa score for caries was 0.78-0.87, indicating a substantial agreement level, and that for the periodontal status was 0.46-0.78, indicating a moderate agreement level.

### **Dependent variables**

As dependent variables, we used the numbers of untreated caries (decayed teeth [DT]) and lost teeth, evaluated through an oral examination at the eighth TNOHS. We defined untreated caries as “teeth with an unmistakable coronal cavity at the dentine level, a root cavity in the cementum that feels soft or leathery to probing, or temporary or permanent restorations with a caries lesion”.<sup>(24)</sup> When evaluating the numbers of untreated caries and lost teeth, we omitted the third molar, and all the results were based on a maximum of 28 teeth. Data of people marked with codes 9 and X were excluded (tooth excluded or not present) from our study.

### **Independent variables and covariates**

We inquired about 10 different insurance plans and integrated the responses into four categories: UCS, CSMBBS, SSS, and others. The entire population of Thailand is covered by insurance. Therefore, individuals who responded to the inquiry about the use of insurance with “uninsured,” “do not use,” and “do not know” were grouped together as “others.”

Determinants of socioeconomic status included educational and income levels. The participants had to indicate their highest level of education. The result grouped them as follows: lowest ( $\leq 6$  years), moderate

(7-9 years), high (10-12 years), and highest ( $\geq 13$  years). Moreover, the participants had to indicate their individual monthly income in USD where the exchange rate used was 1 USD = 31.31 THB. There were four income categories as follows: lowest ( $\leq 159.69$  USD), moderate (159.72-479.08 USD), high (479.11-958.16 USD), and highest ( $\geq 958.19$  USD).

As for covariates, we used age group (“35-39 years” and “40-44 years”) and gender (“men” and “women”). Residential areas were also used as a demographic covariate. The residential locations were divided into “rural” and “urban” areas based on where the participants lived.

### **Statistical analysis**

For the descriptive analysis, we used the prevalence of untreated caries, the presence of  $< 24$  teeth<sup>(25)</sup>, and the mean of untreated caries (DT) and tooth loss (number of lost teeth) because the numbers of untreated caries and lost teeth were skewed. In covariate-adjusted models, we calculated the ratio of means (RM) and 95% confidence interval (CI) through Poisson regression with robust variance and sampling weights<sup>(26,27)</sup> for the following variables: insurance schemes, educational level, and income level. First, univariate analyses were performed. Second, the covariates; age, gender, and residential location were included in the models for insurance, education, and income. Subsequently, all the independent variables and covariates were included in a final model. STATA<sup>®</sup> 15.0 (Stata Corporation, College Station, TX, USA) was used for all the statistical analyses.

### **Ethical approval**

This study protocol was reviewed and exempted by the Human Research Ethics Committee of the Department of Health, Ministry of Public Health, Thailand (No. 353; extended no. RF 13-01-353).

## **Results**

After excluding all the participants with missing data (N=149), the final analysis included 4,534 (2,194 male and 2,340 female) participants (response rate, 93.2%). The mean age and numbers of untreated caries and lost teeth were 39.6 $\pm$ 2.9 years, 0.9 $\pm$ 1.7 teeth, and 2.2 $\pm$ 3.1 teeth, respectively. Table 1 presents the distribution of untreated caries and presence of  $< 24$  teeth among the participants.

Women who lived in rural areas, participants who had the lowest educational and income levels, and participants under the UCS had a higher prevalence of untreated caries. Moreover, men who lived in rural areas, participants with a moderate educational level, participants with the lowest income level, and participants with insurance schemes categorized as “others” had a higher chance of having < 24 teeth.

Table 2 presents the relationship between insurance schemes and untreated caries. In the covariate-adjusted models, participants under the UCS had a significantly higher chance of untreated caries (RM=1.23, 95% CI=1.04-1.45) compared with those under the CSMBS. After all the variables were simultaneously adjusted, the significance of the association disappeared. Regarding the relationship between insurance schemes and tooth loss, in the covariate-adjusted models, the participants with insurance schemes categorized as “others” had a significantly higher chance of tooth loss (RM=1.33, 95% CI=1.01-1.76) compared with those with the CSMBS. A significant association was also observed in the fully

adjusted model (RM=1.37, 95% CI=1.02-1.85). In the case of both untreated caries and tooth loss, there were no significant associations with educational and income levels.

### Discussions

This study identified the association between insurance schemes, untreated caries, and tooth loss. Participants under the UCS and “others” category (uninsured, do not use, do not know) who were 35-44 years old had a significantly higher chance of untreated caries and tooth loss, respectively, compared to CSMBS, even after adjusting for relevant confounding variables.

From an economic perspective, previous studies also reported that insurance schemes were related to oral health inequalities. A study from Korea reported that a government policy for expanding the coverage of dental health insurance reduced the inequality in unmet dental needs due to treatment costs.<sup>(28)</sup> This can be explained by the observation that the number of dental visits increases when the costs of dental services are lower. In Japan, the

**Table 1:** Prevalence of untreated caries (DT > 0) and the presence of < 24 teeth among adults aged 35-44 years old in Thailand

Variables		Total (%) N = 4534	% DT > 0	Mean of DT	% Number of teeth < 24	Mean of tooth loss
Age	35-39 years old	2245 (49.5)	36.0	0.86 (1.7)	14.4	2.11 (3.0)
	40-44 years old	2289 (50.5)	37.3	0.87 (1.7)	15.6	2.25 (3.1)
Gender	Male	2194 (48.4)	35.9	0.86 (1.7)	15.3	2.22 (3.0)
	Female	2340 (51.6)	37.4	0.87 (1.7)	14.8	2.15 (3.1)
Location	Urban	2260 (49.8)	34.8	0.82 (1.7)	13.7	2.11 (2.9)
	Rural	2274 (50.2)	38.5	0.91 (1.7)	16.4	2.25 (3.2)
Educational level*	Highest (≥ 13 years)	1363 (30.1)	35.5	0.84 (1.7)	13.1	2.11 (2.9)
	High (10-12 years)	1344 (29.6)	35.9	0.86 (1.8)	14.9	2.18 (3.2)
	Moderate (7-9 years)	647 (14.3)	36.6	0.87 (1.6)	17.8	2.26 (3.2)
	Lowest (≤ 6 years)	1180 (26.0)	38.9	0.89 (1.7)	15.9	2.21 (3.0)
Income level	Highest (≥ 958.19 USD)	357 (7.9)	36.7	0.85 (1.7)	15.7	2.12 (2.8)
	High (479.11-958.16 USD)	1067 (23.5)	34.6	0.78 (1.7)	12.5	2.13 (3.0)
	Moderate (159.72-479.08 USD)	2238 (49.4)	36.6	0.90 (1.8)	15.6	2.20 (3.1)
	Lowest (≤ 159.69 USD)	872 (19.2)	39.2	0.89 (1.6)	16.4	2.20 (3.1)
Insurance	Civil Servant Medical Benefit Scheme (CSMBS)	934 (20.6)	33.3	0.73 (1.5)	12.4	2.04 (2.7)
	Social Security Scheme (SSS)	1359 (30.0)	35.8	0.88 (1.8)	14.3	2.11 (3.0)
	Universal Coverage Scheme (UCS)	2150 (47.4)	38.6	0.92 (1.8)	16.1	2.26 (3.2)
	Others (uninsured, do not use, do not know)	91 (2.0)	38.5	0.75 (1.2)	26.4	2.73 (3.3)

\*determined by years of education attainment: lowest (elementary school), moderate (junior high school), high (high school), and highest (bachelor degree or more).

**Table 2:** Association of educational level, income, and insurance scheme with untreated caries (DT) and tooth loss (number of lost teeth) determined by Poisson regression among the adults aged 3-5-44 years old in Thailand

Variables	Untreated caries (DT)					Tooth loss				
	Univariate RM	95% CI	Covariate adjusted RM**	95% CI	Fully adjusted RM***	Univariate RM	95% CI	Covariate adjusted RM**	95% CI	Fully adjusted RM***
<b>Educational level*</b>										
Highest (≥ 13 years)	Ref.		Ref.		Ref.	Ref.		Ref.		Ref.
High (10-12 years)	1.04	0.89-1.21	1.03	0.88-1.20	0.92	0.99	0.89-1.11	0.98	0.88-1.10	0.96
Moderate (7-9 years)	1.07	0.89-1.28	1.05	0.87-1.27	0.91	1.05	0.72-1.14	1.04	0.91-1.19	1.00
Lowest (≤ 6 years)	1.10	0.95-1.29	1.09	0.93-1.28	0.93	1.04	0.75-1.15	1.02	0.91-1.14	0.97
<b>Income (per month)</b>										
Highest (≥ 958.19 USD)	Ref.		Ref.		Ref.	Ref.		Ref.		Ref.
High (479.11-958.16 USD)	0.91	0.72-1.15	0.91	0.72-1.16	0.91	1.05	0.71-1.15	1.05	0.89-1.23	1.05
Moderate (159.72-479.08 USD)	1.07	0.87-1.33	1.07	0.86-1.32	1.00	1.05	0.77-1.31	1.05	0.90-1.22	1.01
Lowest (≤ 159.69 USD)	1.08	0.86-1.35	1.06	0.84-1.33	0.98	1.04	0.73-1.31	1.04	0.88-1.23	0.97
<b>Insurance</b>										
Civil Servant Medical Benefit Scheme (CSMBS)	Ref.		Ref.		Ref.	Ref.		Ref.		Ref.
Social Security Scheme (SSS)	1.18	0.99-1.41	1.17	0.98-1.40	1.17	1.03	0.93-1.48	1.03	0.92-1.16	1.06
Universal Coverage Scheme (USC)	1.24	1.06-1.46	1.23	1.04-1.45	1.24	1.09	0.97-1.59	1.08	0.98-1.21	1.13
Others (uninsured, do not use, do not know)	1.07	0.74-1.55	1.07	0.74-1.55	1.08	1.33	0.73-1.60	1.33	1.01-1.76	1.37

DT = decayed teeth, RM = ratio of means, CI = confidence interval, Ref. = Reference

\*determined by years of education attainment: lowest (elementary school), moderate (junior high school), high (high school), and highest (bachelor degree or more).

\*\* Educational level, income, and insurance were separately included in the models with adjustments for age, gender, and residential location.

\*\*\* All independent variables and covariates were included in the model.



reduction in co-payments for dental care has increased the number of dental visits.<sup>(29)</sup> Another previous study demonstrated that children who were enrolled in insurance programs were more likely to use dental services.<sup>(30)</sup> From a global perspective, lower-income countries have lower oral healthcare coverage and higher socioeconomic inequality than higher-income countries.<sup>(31)</sup>

Time is also a barrier to accessing dental care. Studies from Germany and Australia reported that waiting in long queues and requiring longer appointment durations were obstacles to accessing healthcare services.<sup>(32,33)</sup> In our study, participants under the UCS had a higher risk of having untreated caries compared to those under the CSMBS. An explanation for this could be that only CSMBS approves dental visits outside of office hours. However, neither UCS nor CSMBS covers dental care in private dental clinics, unlike SSS. Generally, the waiting time in private dental clinics is shorter than that in public dental clinics. Dental utilization under the UCS was lower than that under the other insurance plans, even though it allowed for cost-free access to dental treatment. The UCS could be that individuals can only access dental treatment in public dental care facilities during office hours. Under the UCS, long waiting times for dental appointments are considered a barrier to using public dental services.

Thus, the present study also confirmed that accessibility related to time is also an important factor affecting dental visits. Therefore, the expansion of insurance coverage to include treatment in private dental clinics could improve access to dental care in Thailand.

These findings have important implications for policymaking related to insurance and universal healthcare. The proceedings of the 74<sup>th</sup> session of the World Health Assembly (2021) and of other sessions highlighted the importance of UHC to tackle untreated dental conditions.<sup>(34)</sup> Lower utilization of dental treatments, as well as the lack of a public oral health policy and financial support from the government, have been linked to poor oral health.<sup>(35)</sup> Thailand has already made strides towards aligning dental care with UHC initiatives by including a minimum benefit package for prevention programs, such as the early detection of oral diseases, during regular dental checkups. However, dental care costs for treating oral diseases are not covered by all insurance schemes. To reduce the level of inequality in accessing dental care, UHC must include oral health care services, such as

cost-effective, minimally invasive intervention.<sup>(36)</sup> The result in this study clearly shows that, in comparison to the reference group, the others group had a significantly higher chance of tooth loss. Despite the small sample size, there might be a population-wide impact if this group isn't encouraged to start utilizing their insurance. The remaining teeth were removed before proper treatment was given. Moreover, during the coronavirus disease (COVID-19) pandemic, a comprehensive digital oral health program should have been developed as part of public health policies. Digital oral health provides an opportunity to enhance healthy behavior and to reduce common risk factors and threats related to oral diseases and other non-communicable diseases, which could contribute to the reduction of oral health inequalities.<sup>(37)</sup>

The key advantage of our study was the fact that it followed a large epidemiological survey that took into account the Thai adult population and offered data regarding the insurance schemes, untreated caries, and tooth loss. The limitation of our study was that it was a cross-sectional study; therefore, a true cause-and-effect relationship between the independent variables and outcomes could not have been established. To identify causal relationships, longitudinal studies are necessary. Conducting an in-depth qualitative study of individuals who do not use insurance or are unfamiliar with the insurance are necessary to obtain suggestions for further public policy development.

## Conclusions

Participants under the UCS and those who were uninsured, paid privately, or did not know about insurance had a significantly higher risk of untreated caries and tooth loss. In other words, untreated caries and tooth loss may be predictable by insurance schemes. Reorientated oral health services, both public and private partnerships, and greater access to dental health services in all insurance schemes are necessary and required in Thailand.

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## Conflicts of Interest

The authors declare no conflict of interest.

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