# ASSOCIATION AMONG SOCIO-DEMOGRAPHIC CHARACTERISTICS AND ORAL HEALTH SERVICE UTILIZATION AMONG THAI OVER TIME

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**ABSTRACT:**

**Background:** For planning of oral health workforce and oral health service system in Thailand, better understanding in oral health care utilization behavior of population over time is needed. This study aimed to explore only individual level specifically in socio-demographic characteristics which could be influenced in oral health service utilization among Thai.

**Method:** A retrospective data analysis, which studied cohort behavior of population regarding oral health service utilization was conducted. Micro data from six waves of the Health and Welfare Survey of Thailand covering the year 2003, 2007, 2009, 2011, 2013, and 2015, were used. Descriptive analysis and binary logistic regression were used for exploring the outcome, applying three matrices of Age-Period-Cohort analysis for the perspective of time. Socio-demographic characteristics of population were divided into predisposing – individual factors, predisposing – family factors, and enable factors. Three different composition of those factors were used for exploring appropriated model for predicting dental health care demand.

**Results:** All independent variables had significant association to probability of oral health service utilization. However, the odds ratio of education of individual and role in family showed remarkable changes after controlling for age group and cohort. There were wider gaps of odds ratio among age groups after controlling for all independent variables. In the model which was controlled for predisposing-individual factors, gender showed more remarkably impact to oral health service utilization than other variables. After controlling for both predisposing- individual factors and family factors, education of individual showed remarkably impact to oral health service utilization. After controlling for all three factors, variable which showed remarkably impact to oral health service utilization was shifted to region of residence. However, in all models, education of family head impact to oral health service utilization independently from all other control variables. In term of predicted power, although there were not much different among all three models and also base model, the model that controlled for all three factor, which included age group, cohort, gender, education of individual, education of family head, region of residence, and health insurance, showed the highest power of prediction.

**Conclusion:** Information on gender, education of individual, education of family head, region of residence, and health insurance were recommended to include in forecasting of demand for dental health care. All models which included these set of variables were more appropriated for forecasting dental care demand than considering only differences among age group.

**Keywords:** Oral health service; Demand over time; Thailand

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## INTRODUCTION

Any planning need sufficient information. More complex issue like health system requires more

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evidence for supporting good decision. For achieving population health outcomes, government should invest in the right direction within limited amount of budget. Process of planning and managing six building blocks of health systems framework which mentioned by the WHO [1] is the huge issue for policy maker, especially health workforce planning which related to both supply and demand side of health sectors. Accurate information about population demand for health care in the future is definitely required for this task.

Four principle methods - population ratio, health need, health demand, and service target method, were mentioned in the projection of health workforce demand [2]. Thailand has experienced in those four methods. The health need method was used in many rounds of projection, although it is complex and need transforming service need in professional view into perceived need of population [3,4]. Therefore the latest projection, health demand method was used instead. Actual oral health service utilization was referenced for future demand [5]. However, whichever method used, the underlying assumption of projection always limits to status quo approach. Using information only at present for referring to future situation has made the big gap for planning of service system, since human lives change every day, and the actual demand for care of future population might not be stable as present situation. Therefore, this study aimed to investigate the effects of time to the association among sociodemographic factors and oral health service utilization among Thai, and to explore the socio-demographic factors that appropriate for projection of population demand for oral health care. While there are many levels of determinants affecting to health care utilization as mentioned in the behavioral model of health care utilization [6-8], this study focused only individual level specifically in sociodemographic characteristics of population. The Age-Period-Cohort (APC) analysis was used for defining the effect of time [9], under the assumption that "time changes, people changes".

## METHODS

The analysis of this study used retrospective data for exploring cohort behavior regarding oral health service utilization by using micro data from six waves of the Health and Welfare Survey (HWS) of Thailand, which covering the year 2003, 2007, 2009, 2011, 2013, and 2015.

The HWS is a cross-sectional survey, carried out by National Statistical Office. Self-reported data on welfare status and health service utilization received from members of representative households through face-to-face interview by using structured questionnaire. The information of oral health service usage appeared first time in year 2003, but not seen in 2009, then seen again in year 2007 and later surveys which done in every two years. Sampling and weighting techniques of the HWS were mentioned elsewhere [10]. The adjustments were made so that final samples, age and sex group distribution were the same as that estimated for the actual population at that time. Sample size were '68,433', '69,679', '73,087', '71,847', '71,533', and '148,430' in respective year. The population size after weighted were '63,884,552', '65,644,404', '66,788,572', '67,495,323', '66,263,166', and '67,163,733' respectively also. The weighting value from these processes was called "Population weight". In addition, this study was used another weighting value which was called "Proportional weight". The proportional weight was a constant value for each HWS, which was calculated from dividing population size by sample size. The objective of proportional weight was to reduce the size of population into smaller sample size which appropriate for using inferential statistics.

Target population of this study is all population from the HWS. Individual level data were used. All variables was recoded into the same value; and the data was verified before starting analysis; the error data was excluded from analysis.

The data was organized by divided population into groups of similar birth year, or called birth cohort, totally 7 groups. Then observe the population followed the time of surveys from 2003-2015. The outcome was probability of oral health service utilization which classified into dichotomous data. Sociodemographic characteristics which used as independent variables were divided into 3 groups. The first group was predisposing - individual factors, which were birth cohort, age group, gender, education of individual, working status of individual, marital status of individual, and role in family. The second group was predisposing – family factors, which were household size, education of family head, working status of family head, and marital status of family head. The last group was enabling factors, which were area and region of residence, and type of health insurance.

Descriptive analysis was used for exploring

**Table 1** Composition of explanatory variables and objective of models for prediction oral health service utilization

| Model | Explanatory variables | Objectives |
|---|---|---|
| 0 | each single explanatory variable | To explore association of each explanatory variable and oral health service utilization. |
| 1A | each single explanatory variable combined with age group, and birth cohort | To explore association of each explanatory variable and oral health service utilization when considering the effect of time. |
| 1B | all explanatory variables combined with age group, and birth cohort | To explore association of each explanatory variable and oral health service utilization when considering the effect of time and other independent variables. |
| 2A (base model) | age group, birth cohort, education of family head, education of individual, and gender | To set the appropriate model using as base model for testing association among three different groups of explanatory variables and oral health service utilization. |
| 3, 3A | Base model<br>+ predisposing-individual factor | To test the effect of predisposing-individual factor to oral health service utilization. |
| 4, 4A | Base model<br>+ predisposing-individual factor<br>+ predisposing-family factor | To test the effect of predisposing-individual factor and predisposing – family factor to oral health service utilization. |
| 5, 5A | Base model<br>+ predisposing-individual factor<br>+ predisposing-family factor<br>+ enabling factor | To test the effect of predisposing-individual factor, predisposing-family factor, and enabling factor to oral health service utilization. |

Noted: all models were performed both for combine age groups and separate age group. In models of separate age group, the explanatory variables for model 2 – 5 were not exactly the same, the selecting variables were depend on the level of association to oral health service utilization from model 1, 1A, and 1B

percentage distributions of population structure and family characteristics, and proportion of dental use by age group, and various independent variables. In this analysis, sample size was weighted by using population weight. Binary logistic regression with list wise deletion technique was used for exploring the relationship among sociodemographic characteristics and oral health service utilization over time. In this analysis, sample size was weighted by using proportional weight. A series of models were performed to test the effects of each independent variables, and group of independent variables, to behavior of using oral health service. The composition of explanatory variables and objective of each model were showed in Table 1.

The analysis was processed by the software package SPSS version 22. The significant levels for binary logistic regression were performed at p-value 0.01, 0.05, and 0.0001. The power of prediction were showed in term of -2 Log likelihood, and Nagelkerke $R^2$. Hosmer & Lemeshow test was used for testing the goodness of fit of predicted equations.

Ethical consideration was approved from the ethics review committee for research involving human research subjects, health science group, Chulalongkorn University, on the condition of using secondary data (COA No. 104/2017).

## RESULTS

### Proportion of dental use and characteristic of population

The composition of population from each survey which were cross-sectional observations showed differences among years, which was consistent with the changes in overall population of Thailand according to annually estimations [11]. The proportion of self-reported dental care services use in the preceding year, Dental Use (DU), among age group were clearly seen (Table 2), childhood had the highest DU, while the lowest found in early childhood. The direction of DU changes among age group were not clear when considering by survey and birth cohort.

The independent variables could be grouping into two main groups depending on their effects to DU, the first group were variables which had similar effect to DU among age groups, while another group had different effect instead. Four variables showed same direction of changes in DU for all age groups, which were ‘Education of individual’, ‘Role in family’, ‘House size’, and ‘Education of family head’. The result showed increasing DU by level of education, both by education of themselves and by their family head’s. In term of role in family, either family head or spouse also had the highest DU;

**Table 2** Proportion of dental use by age group

| Variables | Early childhood | Childhood | Adolescent | Early adult | Adult | Late adult | Elderly |
|---|---|---|---|---|---|---|---|
| **Total** | 0.04 | 0.14 | 0.10 | 0.08 | 0.09 | 0.10 | 0.07 |
| **Survey year** | | | | | | | |
| 2003 | 0.04 | 0.17 | 0.11 | 0.09 | 0.10 | 0.11 | 0.07 |
| 2007 | 0.03 | 0.13 | 0.08 | 0.07 | 0.09 | 0.10 | 0.07 |
| 2009 | 0.03 | 0.15 | 0.09 | 0.08 | 0.08 | 0.11 | 0.08 |
| 2011 | 0.03 | 0.11 | 0.12 | 0.09 | 0.09 | 0.10 | 0.06 |
| 2013 | 0.04 | 0.14 | 0.12 | 0.09 | 0.09 | 0.10 | 0.07 |
| 2015 | 0.06 | 0.12 | 0.10 | 0.08 | 0.07 | 0.08 | 0.06 |
| **Birth cohort** | | | | | | | |
| Before 1941 | na | na | na | na | na | 0.09 | 0.06 |
| 1941-1950 | na | na | na | na | na | 0.10 | 0.09 |
| 1951-1960 | na | na | na | na | 0.10 | 0.10 | na |
| 1961-1970 | na | na | na | 0.10 | 0.09 | 0.09 | na |
| 1971-1980 | na | na | 0.10 | 0.09 | 0.08 | na | na |
| 1981-1990 | na | 0.12 | 0.10 | 0.08 | na | na | na |
| 1991-2000 | 0.07 | 0.14 | 0.10 | 0.07 | na | na | na |
| After 2000 | 0.03 | 0.14 | na | na | na | na | na |
| **Gender** | | | | | | | |
| Male | 0.04 | 0.13 | 0.08 | 0.06 | 0.07 | 0.09 | 0.07 |
| Female | 0.04 | 0.15 | 0.12 | 0.11 | 0.10 | 0.11 | 0.07 |
| **Education of individual** [a] | | | | | | | |
| Primary level | na | na | 0.08 | 0.05 | 0.07 | 0.08 | 0.06 |
| Secondary level | na | na | 0.11 | 0.07 | 0.09 | 0.13 | 0.13 |
| Tertiary level | na | na | 0.13 | 0.15 | 0.17 | 0.21 | 0.20 |
| **Work status of individual** [b] | | | | | | | |
| No work | na | na | na | 0.10 | 0.09 | 0.11 | 0.06 |
| Self-employee | na | na | na | 0.07 | 0.08 | 0.09 | 0.09 |
| Public employee | na | na | na | 0.13 | 0.15 | 0.16 | 0.12 |
| Private employee | na | na | na | 0.08 | 0.08 | 0.09 | 0.09 |
| **Marital status of individual** | | | | | | | |
| Never married | na | na | na | 0.09 | 0.10 | 0.12 | 0.07 |
| Married | na | na | na | 0.08 | 0.09 | 0.10 | 0.08 |
| Used to married | na | na | na | 0.07 | 0.08 | 0.10 | 0.06 |
| **Role in family** | | | | | | | |
| Head | na | na | na | 0.11 | 0.09 | 0.10 | 0.08 |
| Spouse | na | na | na | 0.11 | 0.10 | 0.10 | 0.07 |
| Other | na | na | na | 0.07 | 0.07 | 0.08 | 0.05 |
| **Household size** | | | | | | | |
| Small size (1-3 members) | 0.04 | 0.15 | 0.11 | 0.10 | 0.10 | 0.11 | 0.08 |
| Medium size (4-6 members) | 0.04 | 0.14 | 0.10 | 0.07 | 0.08 | 0.09 | 0.06 |
| Large size (> 6 members) | 0.03 | 0.09 | 0.09 | 0.05 | 0.06 | 0.06 | 0.05 |
| **Education of family head** [a] | | | | | | | |
| Primary level | 0.03 | 0.13 | 0.08 | 0.06 | 0.07 | 0.08 | 0.06 |
| Secondary level | 0.05 | 0.16 | 0.11 | 0.10 | 0.09 | 0.12 | 0.10 |
| Tertiary level | 0.07 | 0.22 | 0.18 | 0.17 | 0.17 | 0.20 | 0.15 |
| **Work status of family head** [b] | | | | | | | |
| No work | 0.03 | 0.13 | 0.09 | 0.08 | 0.07 | 0.10 | 0.07 |
| Self-employee | 0.04 | 0.15 | 0.10 | 0.07 | 0.08 | 0.09 | 0.07 |
| Public employee | 0.06 | 0.19 | 0.14 | 0.14 | 0.14 | 0.15 | 0.06 |
| Private employee | 0.04 | 0.13 | 0.09 | 0.09 | 0.08 | 0.10 | 0.07 |
| **Marital status of family head** | | | | | | | |
| Never married | 0.03 | 0.10 | 0.12 | 0.11 | 0.12 | 0.13 | 0.07 |
| Married | 0.04 | 0.15 | 0.10 | 0.08 | 0.08 | 0.10 | 0.07 |
| Used to married | 0.03 | 0.13 | 0.08 | 0.07 | 0.08 | 0.09 | 0.07 |
| **Area of residence** | | | | | | | |
| Bangkok | 0.05 | 0.15 | 0.17 | 0.14 | 0.14 | 0.17 | 0.14 |
| Urban | 0.04 | 0.13 | 0.12 | 0.08 | 0.09 | 0.10 | 0.07 |
| Rural | 0.04 | 0.14 | 0.09 | 0.07 | 0.08 | 0.09 | 0.06 |

**Table 2** Proportion of dental use by age group (cont.)

| Variables | Early childhood | Childhood | Adolescent | Early adult | Adult | Late adult | Elderly |
|---|---|---|---|---|---|---|---|
| **Region of residence** | | | | | | | |
| Bangkok | 0.05 | 0.15 | 0.17 | 0.14 | 0.14 | 0.17 | 0.14 |
| Central | 0.03 | 0.11 | 0.09 | 0.07 | 0.08 | 0.09 | 0.06 |
| Northern | 0.04 | 0.18 | 0.11 | 0.08 | 0.09 | 0.10 | 0.07 |
| Northeastern | 0.04 | 0.14 | 0.09 | 0.07 | 0.07 | 0.08 | 0.06 |
| Southern | 0.03 | 0.12 | 0.10 | 0.08 | 0.09 | 0.10 | 0.06 |
| **Health insurance** | | | | | | | |
| Not have any health insurance | 0.02 | 0.12 | 0.12 | 0.07 | 0.06 | 0.12 | 0.11 |
| UCS | 0.04 | 0.13 | 0.09 | 0.07 | 0.07 | 0.08 | 0.06 |
| SSS | na | na | na | 0.11 | 0.12 | 0.14 | 0.12 |
| CSMBS | 0.07 | 0.20 | 0.16 | 0.15 | 0.16 | 0.16 | 0.11 |
| Other [c] | 0.04 | 0.23 | 0.30 | 0.11 | 0.15 | 0.17 | 0.10 |

Na = Not application.

[a] Primary educational level was a grouping of no education, pre-primary school, and primary school. Secondary educational level was a grouping of junior high school, senior high school, and vocational certificate. Tertiary educational level was a grouping of high vocational/ technical certificate, bachelor degree, and higher than bachelor degree.

[b] Not showed result of people in member of co-operative group because of very small sample size.

[c] Nonpublic-provided health insurances such as insurance company, and employer pay.

it was nearly the same proportion. While in view of household size, there was decreasing DU when size of household was increased (Table 2). All those relation showed similar result among age groups, thus these variables were used as the clue for exploring the association to DU.

Information from aggregated data showed tendency of individual with high education. The percentage of individuals with primary educational level was decreased from 70.3% to 58.3%, from year 2003 to 2015 respectively. The percentage of small size family was increased from 37.1% to 49.6 % when family head had increased educational level from primary to tertiary level. Moreover, the percentage of people working in formal sectors, public and private employees, was increased from 28.4% to 67.7% when their education were increased from primary to tertiary level. These affected to health insurance and place of residence. The percentages of working-age people who covered by the Social Security Scheme (SSS) and the Civil Servant Medical Benefit Scheme (CSMBS) were increased from 9.1% to 41.3%, and from 3.8% to 26.6% when compared among whom which had primary and tertiary educational level in each health insurance scheme respectively. Percentage of people who lived in rural area was decreased from 72.4% to 37.0% for people with primary and tertiary educational level respectively. Different DU among marital status may be confounded by level of education, 37.3% of people with tertiary educational level was never married while only 11.3% of people with primary educational level was in this marital status.

Although DU were highest in people who were public employees, while self-employees and private employees were the lowest (Table 2). When comparing among health insurance schemes within each working status, people who covered by CSMBS always had the highest DU, followed by SSS, and the Universal Coverage Scheme (UCS). This situation is also seen in self-employees (0.15, 0.14, 0.07 for CSMBS, SSS, UCS respectively) and private employees (0.12, 0.11, 0.06 for CSMBS, SSS, UCS respectively). In addition, people whose family head were public employees showed remarkably higher DU than all other work status (Table 2).

Apart from the previous group of variables which had similar effect to DU among age groups, the second group of variables, which were ‘Gender’, ‘Place of residence (area and region)’, and ‘Marital status of family head’, were in contrast.

Different DU among genders, higher in female, were found in childhood to late adult, while same DU among genders in early childhood and elderly (Table 2). However, there were unusual effects to DU within each genders when considered with other variable, for example, females who were never married always showed the highest DU whatever educational level they were (DU of never married females were 0.10, 0.12, 0.20, DU of married females were 0.08, 0.11, 0.18, and DU of used to married females were 0.07, 0.12, 0.17 for primary,

**Table 3** Summary of OR of each variable from binary logistic regression models for predicting probability of dental service utilization of Thai

| Variables | Model 0 | | Model 1A | | Model 1B | |
|---|---|---|---|---|---|---|
| | **OR** | ***p*-value** | **OR** | ***p*-value** | **OR** | ***p*-value** |
| **Age group** | | | | | | |
| Early childhood | 0.27 | < 0.0001 | 0.27 | < 0.0001 | 0.28 | < 0.0001 |
| Childhood | Reference | | Reference | | Reference | |
| Adolescent | 0.73 | < 0.0001 | 0.70 | < 0.0001 | 0.49 | < 0.0001 |
| Early Adult | 0.57 | < 0.0001 | 0.51 | < 0.0001 | 0.35 | < 0.0001 |
| Adult | 0.58 | < 0.0001 | 0.45 | < 0.0001 | 0.27 | < 0.0001 |
| Late adult | 0.67 | < 0.0001 | 0.44 | < 0.0001 | 0.25 | < 0.0001 |
| Elderly | 0.47 | < 0.0001 | 0.36 | < 0.0001 | 0.20 | < 0.0001 |
| **Birth cohort** | | | | | | |
| Before 1941 | Reference | | Reference | | Reference | |
| 1941-1950 | 1.60 | < 0.0001 | 1.42 | < 0.0001 | 1.26 | < 0.0001 |
| 1951-1960 | 1.67 | < 0.0001 | 1.36 | < 0.0001 | 1.06 | 0.222 |
| 1961-1970 | 1.46 | < 0.0001 | 1.17 | 0.001 | 0.84 | 0.020 |
| 1971-1980 | 1.38 | < 0.0001 | 1.03 | 0.556 | 0.66 | < 0.0001 |
| 1981-1990 | 1.45 | < 0.0001 | 0.93 | 0.223 | 0.56 | < 0.0001 |
| 1991-2000 | 1.88 | < 0.0001 | 0.90 | 0.067 | 0.63 | < 0.0001 |
| After 2000 | 1.40 | < 0.0001 | 0.85 | 0.008 | 0.55 | < 0.0001 |
| **Gender** | | | | | | |
| Female | 1.46 | < 0.0001 | 1.46 | < 0.0001 | 1.58 | < 0.0001 |
| **Education of individual** [a] | | | | | | |
| Primary level | Reference | | Reference | | Reference | |
| Secondary level | 1.16 | < 0.0001 | 1.48 | < 0.0001 | 1.22 | < 0.0001 |
| Tertiary level | 2.27 | < 0.0001 | 3.04 | < 0.0001 | 1.80 | < 0.0001 |
| **Work status of individual** | | | | | | |
| Public-employee | Reference | | Reference | | Reference | |
| Private-employee | 0.54 | < 0.0001 | 0.56 | < 0.0001 | 0.91 | 0.003 |
| Self-employee | 0.50 | < 0.0001 | 0.50 | < 0.0001 | 1.06 | 0.054 |
| Member of co-operative group | 0.49 | 0.003 | 0.49 | 0.003 | 0.94 | 0.812 |
| No work | 0.63 | < 0.0001 | 0.58 | < 0.0001 | 1.02 | 0.601 |
| **Marital status of individual** | | | | | | |
| Never married | Reference | | Reference | | Reference | |
| Married | 0.85 | < 0.0001 | 0.84 | < 0.0001 | 0.84 | < 0.0001 |
| Used to married [b] | 0.76 | < 0.0001 | 0.78 | < 0.0001 | 0.75 | < 0.0001 |
| **Role in family** | | | | | | |
| Head | Reference | | Reference | | Reference | |
| Spouse | 1.03 | 0.056 | 1.01 | 0.591 | 0.86 | < 0.0001 |
| Other | 0.91 | < 0.0001 | 0.69 | < 0.0001 | 0.69 | < 0.0001 |
| **Household size** | | | | | | |
| Small size (1-3 members) | Reference | | Reference | | Reference | |
| Medium size (4-6 members) | 0.84 | < 0.0001 | 0.80 | < 0.0001 | 0.88 | < 0.0001 |
| Large size ( > 6 members) | 0.58 | < 0.0001 | 0.56 | < 0.0001 | 0.67 | < 0.0001 |
| **Education of family head** [a] | | | | | | |
| Primary level | Reference | | Reference | | Reference | |
| Secondary level | 1.43 | < 0.0001 | 1.48 | < 0.0001 | 1.20 | < 0.0001 |
| Tertiary level | 2.59 | < 0.0001 | 2.69 | < 0.0001 | 1.52 | < 0.0001 |
| **Work status of family head** | | | | | | |
| Public-employee | Reference | | Reference | | Reference | |
| Private-employee | 0.59 | < 0.0001 | 0.61 | < 0.0001 | 0.93 | 0.005 |
| Self-employee | 0.59 | < 0.0001 | 0.59 | < 0.0001 | 1.06 | 0.032 |
| Member of co-operative group | 0.53 | 0.001 | 0.52 | < 0.0001 | 1.03 | 0.897 |
| No work | 0.55 | < 0.0001 | 0.57 | < 0.0001 | 0.94 | 0.025 |

**Table 3** Summary of OR of each variable from binary logistic regression models for predicting probability of dental service utilization of Thai (cont.)

| Variable | Model 0 | | Model 1A | | Model 1B | |
|---|---|---|---|---|---|---|
| | **OR** | ***p*-value** | **OR** | ***p*-value** | **OR** | ***p*-value** |
| **Marital status of family head** | | | | | | |
| Never married | Reference | | Reference | | Reference | |
| Married | 0.77 | < 0.0001 | 0.73 | < 0.0001 | 1.17 | < 0.0001 |
| Used to married [b] | 0.68 | < 0.0001 | 0.65 | < 0.0001 | 1.15 | < 0.0001 |
| **Area of residence** | | | | | | |
| Bangkok | Reference | | Reference | | | |
| Urban | 0.59 | < 0.0001 | 0.57 | < 0.0001 | - | - |
| Rural | 0.53 | < 0.0001 | 0.51 | < 0.0001 | - | - |
| **Region of residence** | | | | | | |
| Bangkok | Reference | | Reference | | Reference | |
| Central | 0.51 | < 0.0001 | 0.50 | < 0.0001 | 0.57 | < 0.0001 |
| Northern | 0.63 | < 0.0001 | 0.61 | < 0.0001 | 0.76 | < 0.0001 |
| Northeastern | 0.52 | < 0.0001 | 0.50 | < 0.0001 | 0.64 | < 0.0001 |
| Southern | 0.57 | < 0.0001 | 0.55 | < 0.0001 | 0.67 | < 0.0001 |
| **Health insurance** | | | | | | |
| UCS | Reference | | Reference | | Reference | |
| SSS | 1.47 | < 0.0001 | 1.74 | < 0.0001 | 1.43 | < 0.0001 |
| CSMBS | 2.04 | < 0.0001 | 2.10 | < 0.0001 | 1.42 | < 0.0001 |
| Other [c] | 2.12 | < 0.0001 | 2.18 | < 0.0001 | 1.54 | < 0.0001 |
| Not have any health insurance | 1.02 | 0.610 | 1.08 | 0.035 | 0.90 | 0.005 |

Notes:

Model 0 was included each independent variable singly. Model 1A was included each independent variable together with age group and cohort (AC), noted that OR of A and C were come from the model included AC only. Model 1B was included all independent variables together except for area of residence

[a] Primary educational level was a grouping of no education, pre-primary school, and primary school. Secondary educational level was a grouping of junior high school, senior high school, and vocational certificate. Tertiary educational level was a grouping of high vocational/ technical certificate, bachelor degree, and higher than bachelor degree

[b] Including widowed, divorced, separated, and married but unknown status

[c] Nonpublic-provided health insurances such as insurance company, and employer pay

secondary, and tertiary educational level respectively). Although males who had primary educational level showed the highest DU among never married persons as females, male who had tertiary educational level showed the highest DU among never married persons instead (DU of never married males were 0.08, 0.07, 0.12, DU of married males were 0.06, 0.07, 0.15, and DU of used to married males were 0.05, 0.06, 0.12 for primary, secondary, and tertiary educational level respectively). However both genders who were used to married always had the lowest DU.

Among place of residence, almost all age groups, except for childhood, DU was highest among Bangkok inhabitants, followed by urban and rural. While comparing among regions, people in the Central and Northeastern region showed the lowest DU (Table 2).

**The association of DU and each independent variables**

The differences of DU within each independent variable from model 0, which included each singly independent variables, showed similar result as found from descriptive analysis. From model 1A, odds ratio (OR) among age groups and birth cohorts were smoother after controlling for each other. Only two variables, education of individual and role in family, showed remarkable changes of OR after controlling for age group and cohort. While all other variables showed similar OR either controlled for age group and cohort or not. However, after controlling for all independent variables in model 1B, OR among age groups and birth cohorts showed unusual pattern in early childhood, cohort 1981 - 1990 and after 2000. After comparing among model 0, 1A, 1B, the result showed that the gaps of OR among education of individual were widest in model 1A; then the gaps were reduced in model 1B. This also seen among education of family head. The gaps of OR among regions of residence were smallest in

**Table 4** Binary logistic regression models for the assumption that DU was affected from "Predisposing-individual factor"

| Variables in the equation | Model 2A | | | | Model 3 | | | | Model 3A | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| **Constant** | -1.61 | 0.07 | 0.20 | < 0.0001 | -1.22 | 0.07 | 0.30 | < 0.0001 | -1.16 | 0.07 | 0.31 | < 0.0001 |
| **Age group** | | | | | | | | | | | | |
| Early childhood | -1.29 | 0.03 | 0.28 | < 0.0001 | -1.29 | 0.03 | 0.28 | < 0.0001 | -1.28 | 0.03 | 0.28 | < 0.0001 |
| Childhood | Reference | | | | Reference | | | | Reference | | | |
| Adolescent | -0.73 | 0.03 | 0.48 | < 0.0001 | -0.75 | 0.03 | 0.47 | < 0.0001 | -0.76 | 0.03 | 0.47 | < 0.0001 |
| Early Adult | -1.02 | 0.03 | 0.36 | < 0.0001 | -1.06 | 0.03 | 0.35 | < 0.0001 | -1.04 | 0.03 | 0.35 | < 0.0001 |
| Adult | -1.23 | 0.04 | 0.29 | < 0.0001 | -1.30 | 0.04 | 0.27 | < 0.0001 | -1.28 | 0.04 | 0.28 | < 0.0001 |
| Late adult | -1.25 | 0.05 | 0.29 | < 0.0001 | -1.34 | 0.05 | 0.26 | < 0.0001 | -1.31 | 0.05 | 0.27 | < 0.0001 |
| Elderly | -1.50 | 0.06 | 0.22 | < 0.0001 | -1.57 | 0.06 | 0.21 | < 0.0001 | -1.54 | 0.06 | 0.21 | < 0.0001 |
| **Birth cohort** | | | | | | | | | | | | |
| Before 1941 | Reference | | | | Reference | | | | Reference | | | |
| 1941-1950 | 0.29 | 0.04 | 1.33 | < 0.0001 | 0.24 | 0.04 | 1.27 | < 0.0001 | 0.24 | 0.04 | 1.27 | < 0.0001 |
| 1951-1960 | 0.13 | 0.05 | 1.14 | 0.01 | 0.08 | 0.05 | 1.08 | 0.102 | 0.08 | 0.05 | 1.09 | 0.096 |
| 1961-1970 | -0.13 | 0.05 | 0.88 | 0.02 | -0.17 | 0.05 | 0.85 | 0.002 | -0.17 | 0.05 | 0.85 | 0.002 |
| 1971-1980 | -0.40 | 0.06 | 0.67 | < 0.0001 | -0.42 | 0.06 | 0.66 | < 0.0001 | -0.42 | 0.06 | 0.66 | < 0.0001 |
| 1981-1990 | -0.58 | 0.06 | 0.56 | < 0.0001 | -0.59 | 0.06 | 0.55 | < 0.0001 | -0.60 | 0.06 | 0.55 | < 0.0001 |
| 1991-2000 | -0.49 | 0.06 | 0.61 | < 0.0001 | -0.49 | 0.07 | 0.61 | < 0.0001 | -0.50 | 0.07 | 0.60 | < 0.0001 |
| After 2000 | -0.62 | 0.07 | 0.54 | < 0.0001 | -0.62 | 0.07 | 0.54 | < 0.0001 | -0.63 | 0.07 | 0.53 | < 0.0001 |
| **Education of family head** [a] | | | | | | | | | | | | |
| Primary level | Reference | | | | Reference | | | | Reference | | | |
| Secondary level | 0.31 | 0.02 | 1.36 | < 0.0001 | 0.25 | 0.02 | 1.28 | < 0.0001 | 0.38 | 0.03 | 1.46 | < 0.0001 |
| Tertiary Level | 0.63 | 0.02 | 1.87 | < 0.0001 | 0.55 | 0.02 | 1.74 | < 0.0001 | 0.72 | 0.03 | 2.05 | < 0.0001 |
| **Education of individual** [a] | | | | | | | | | | | | |
| Primary level | Reference | | | | Reference | | | | Reference | | | |
| Secondary level | 0.23 | 0.02 | 1.26 | < 0.0001 | 0.26 | 0.02 | 1.29 | < 0.0001 | 0.01 | 0.03 | 1.01 | 0.663 |
| Tertiary level | 0.72 | 0.02 | 2.05 | < 0.0001 | 0.74 | 0.02 | 2.10 | < 0.0001 | 0.53 | 0.03 | 1.70 | < 0.0001 |
| **Gender** | | | | | | | | | | | | |
| Female | 0.41 | 0.01 | 1.51 | < 0.0001 | 0.45 | 0.01 | 1.57 | < 0.0001 | 0.34 | 0.04 | 1.41 | < 0.0001 |
| **Marital status of individual** | | | | | | | | | | | | |
| Never married | | | | | Reference | | | | Reference | | | |
| Married | | | | | -0.18 | 0.02 | 0.83 | < 0.0001 | -0.22 | 0.03 | 0.80 | < 0.0001 |
| Used to married [b] | | | | | -0.30 | 0.03 | 0.74 | < 0.0001 | -0.38 | 0.05 | 0.68 | < 0.0001 |
| **Role in family** | | | | | | | | | | | | |
| Head | | | | | Reference | | | | Reference | | | |
| Spouse | | | | | -0.12 | 0.02 | 0.89 | < 0.0001 | -0.29 | 0.04 | 0.75 | < 0.0001 |
| Other | | | | | -0.40 | 0.02 | 0.67 | < 0.0001 | -0.38 | 0.03 | 0.68 | < 0.0001 |
| **Interaction among gender and education of individual** | | | | | | | | | | | | |
| gender(Male)*edu(Primary) | | | | | | | | | Reference | | | |
| gender(Female)*edu(Secondary) | | | | | | | | | 0.41 | 0.03 | 1.50 | < 0.0001 |
| gender(Female)*edu(Tertiary) | | | | | | | | | 0.32 | 0.04 | 1.38 | < 0.0001 |
| **Interaction among gender and education of family head** | | | | | | | | | | | | |
| gender(Male)*EDU(Primary) | | | | | | | | | Reference | | | |
| gender(Female)*EDU(Secondary) | | | | | | | | | -0.20 | 0.03 | 0.82 | < 0.0001 |
| gender(Female)*EDU(Tertiary) | | | | | | | | | -0.25 | 0.04 | 0.78 | < 0.0001 |
| **Interaction among gender and role in family** | | | | | | | | | | | | |
| gender(Male)*Role(Head) | | | | | | | | | Reference | | | |
| gender(Female)*Role(Spouse) | | | | | | | | | 0.20 | 0.05 | 1.22 | < 0.0001 |
| gender(Female)*Role(Other) | | | | | | | | | -0.01 | 0.04 | 0.99 | 0.680 |
| **Interaction among gender and marital status of individual** | | | | | | | | | | | | |
| gender(Male)*Marital(Never) | | | | | | | | | Reference | | | |
| gender(Female)*Marital(Married) | | | | | | | | | 0.04 | 0.04 | 1.04 | 0.251 |
| gender(Female)*Marital(Used to) | | | | | | | | | 0.10 | 0.06 | 1.11 | 0.092 |
| **n** | 414179 | | | | 414,146 | | | | 414,146 | | | |
| **% of dental use** | 8.92 | | | | 8.92 | | | | 8.92 | | | |

**Table 4** Binary logistic regression models for the assumption that DU was affected from "Predisposing-individual factor" (cont.)

| Variables in the equation | Model 2A | | | | Model 3 | | | | Model 3A | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| **-2 Log likelihood** | 239,024 | | | | 238,654 | | | | 238,259 | | | |
| **Nagelkerke R Square** | 0.052 | | | | 0.055 | | | | 0.056 | | | |
| **Hosmer and Lemeshow Test - $\chi 2$** | 137.6, df = 8, p < 0.0001 | | | | 127.2, df = 8, p < 0.0001 | | | | 82.2, df = 8, p < 0.0001 | | | |

Notes:

[a] Primary educational level was a grouping of no education, pre-primary school, and primary school. Secondary educational level was a grouping of junior high school, senior high school, and vocational certificate. Tertiary educational level was a grouping of high vocational/ technical certificate, bachelor degree, and higher than bachelor degree.

[b] Including widowed, divorced, separated, and married but unknown status.

model 1B; but the ranking was the same as model 0 and 1A. OR of people who covered by SSS were much higher than UCS in model 1A when compared to model 0; but the gaps were smaller for all categories of health insurance in model 1B. The different OR among working status, both for individual and family head, which found in model 0 and 1A, were nearly gone in model 1B. DU of family heads who were never married was shifted from the highest in model 0 and 1A to the lowest in model 1B. The OR among age group, gender, and role in family were remarkably change in model 1B, while household size and marital status of individual did not show any difference from model 0 and 1A (Table 3).

**The association of DU and groups of independent variables**

The base model for all assumption was generated by selecting independent variables from previous result. Model 2A which included education of family head, education of individual, gender, age group, and cohort were selected because of significant association to DU and higher predicted power. Three assumptions of association among groups of independent variables and DU were examined. The first group included only predisposing-individual factor. Model 3 and 3A represented this assumption by adding marital status of individual and role in family from base model. Interaction of gender and education of individual, gender and marital of individual, and gender and role in family were also explored.

The result showed that after controlling for marital status of individual and their role in family, OR among education of individual and among genders were wider, in contrast with education of family head. Moreover, there was combining effect among gender and education of individual, high educated female showed more DU than high educated male, while the effect among gender and education of family head was in contrast. The interaction among gender and their marital status to DU was not different (Table 4).

Model 4 and 4A represented the second assumption that DU was affected from both predisposing-individual factor and predisposing-family factor, by adding role in family and household size from base model. Interaction among education of individual and role in family, and household size and role in family were also explored.

Result from model 4 showed the same pattern of DU changes among genders, education of individual, and education of family head as found in model 3. While interaction among role and education of individual showed that although spouse and other members in family had lower DU than the head. This different gaps were smaller if they had higher education. Irregular interaction among role in family and household size was seen, more equal of DU among roles in family in medium size household, while the gap was stable for large size household (Table 5).

Model 5 and 5A represented the last assumption that DU was affected from all factors together, which were predisposing factor both individual factor and family factor, and enabling factor, by adding region of residence and health insurance from base model. The interaction among independent variables in model 5A were explored for region of residence and education of individual, and region of residence and health insurance.

The result from model 5 contrasted from model 3 and 4. The changes of OR among gender, education of individual, and education of family head were all decreased. After controlling for interaction in this model, OR among education and health insurance were wider, while OR among regions were smaller. However, people in the Northeastern region always had lowest DU even

**Table 5** Binary logistic regression models for the assumption that DU was affected from "Predisposing-both individual factor and family factor"

| Variables in the equation | Model 4 | | | | Model 4A | | | |
|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| **Constant** | -1.24 | 0.07 | 0.29 | < 0.0001 | -1.08 | 0.07 | 0.34 | < 0.0001 |
| **Age group** | | | | | | | | |
| Early childhood | -1.27 | 0.03 | 0.28 | < 0.0001 | -1.27 | 0.03 | 0.28 | < 0.0001 |
| Childhood | Reference | | | | Reference | | | |
| Adolescent | -0.79 | 0.03 | 0.45 | < 0.0001 | -0.87 | 0.03 | 0.42 | < 0.0001 |
| Early Adult | -1.15 | 0.03 | 0.32 | < 0.0001 | -1.24 | 0.04 | 0.29 | < 0.0001 |
| Adult | -1.41 | 0.04 | 0.24 | < 0.0001 | -1.50 | 0.04 | 0.22 | < 0.0001 |
| Late adult | -1.47 | 0.05 | 0.23 | < 0.0001 | -1.56 | 0.05 | 0.21 | < 0.0001 |
| Elderly | -1.73 | 0.06 | 0.18 | < 0.0001 | -1.82 | 0.06 | 0.16 | < 0.0001 |
| **Birth cohort** | | | | | | | | |
| Before 1941 | Reference | | | | Reference | | | |
| 1941-1950 | 0.26 | 0.04 | 1.30 | < 0.0001 | 0.26 | 0.04 | 1.29 | < 0.0001 |
| 1951-1960 | 0.10 | 0.05 | 1.10 | 0.051 | 0.10 | 0.05 | 1.10 | 0.044 |
| 1961-1970 | -0.15 | 0.05 | 0.86 | 0.004 | -0.15 | 0.05 | 0.86 | 0.005 |
| 1971-1980 | -0.41 | 0.06 | 0.67 | < 0.0001 | -0.40 | 0.06 | 0.67 | < 0.0001 |
| 1981-1990 | -0.57 | 0.06 | 0.57 | < 0.0001 | -0.58 | 0.06 | 0.56 | < 0.0001 |
| 1991-2000 | -0.46 | 0.06 | 0.63 | < 0.0001 | -0.45 | 0.06 | 0.64 | < 0.0001 |
| After 2000 | -0.60 | 0.07 | 0.55 | < 0.0001 | -0.58 | 0.07 | 0.56 | < 0.0001 |
| **Education of family head** [a] | | | | | | | | |
| Primary level | Reference | | | | Reference | | | |
| Secondary level | 0.24 | 0.02 | 1.27 | < 0.0001 | 0.24 | 0.02 | 1.27 | < 0.0001 |
| Tertiary Level | 0.54 | 0.02 | 1.71 | < 0.0001 | 0.63 | 0.02 | 1.87 | < 0.0001 |
| **Education of individual** [a] | | | | | | | | |
| Primary level | Reference | | | | Reference | | | |
| Secondary level | 0.26 | 0.02 | 1.30 | < 0.0001 | 0.22 | 0.03 | 1.25 | < 0.0001 |
| Tertiary Level | 0.77 | 0.02 | 2.15 | < 0.0001 | 0.53 | 0.03 | 1.70 | < 0.0001 |
| **Gender** | | | | | | | | |
| Female | 0.43 | 0.01 | 1.54 | < 0.0001 | 0.42 | 0.01 | 1.53 | < 0.0001 |
| **Household size** | | | | | | | | |
| Small size (1-3 members) | Reference | | | | Reference | | | |
| Medium size (4-6 members) | -0.13 | 0.01 | 0.88 | < 0.0001 | -0.22 | 0.02 | 0.80 | < 0.0001 |
| Large size ( > 6 members) | -0.40 | 0.03 | 0.67 | < 0.0001 | -0.38 | 0.07 | 0.68 | < 0.0001 |
| **Role in family** | | | | | | | | |
| Head | Reference | | | | Reference | | | |
| Spouse | -0.10 | 0.02 | 0.91 | < 0.0001 | -0.18 | 0.03 | 0.83 | < 0.0001 |
| Other | -0.27 | 0.02 | 0.77 | < 0.0001 | -0.49 | 0.03 | 0.62 | < 0.0001 |
| **Interaction among education of individual and role in family** | | | | | | | | |
| edu(Primary)*Role(Head) | | | | | Reference | | | |
| edu(Secondary)*Role(Spouse) | | | | | 0.05 | 0.04 | 1.05 | 0.247 |
| edu(Secondary)*Role(Other) | | | | | 0.12 | 0.04 | 1.13 | 0.002 |
| edu(Tertiary)*Role(Spouse) | | | | | 0.13 | 0.04 | 1.14 | 0.001 |
| edu(Tertiary)*Role(Other) | | | | | 0.45 | 0.04 | 1.57 | < 0.0001 |
| **Interaction among household size and role in family** | | | | | | | | |
| HH_size(Small)*Role(Head) | | | | | Reference | | | |
| HH_size(Medium)*Role(Spouse) | | | | | 0.12 | 0.03 | 1.13 | < 0.0001 |
| HH_size(Medium)*Role(Other) | | | | | 0.14 | 0.03 | 1.15 | < 0.0001 |
| HH_size(Large)*Role(Spouse) | | | | | 0.08 | 0.10 | 1.09 | 0.425 |
| HH_size(Large)*Role(Other) | | | | | 0.00 | 0.08 | 1.00 | 0.997 |
| **n** | 414,179 | | | | 414,179 | | | |
| **% of dental use** | 8.92 | | | | 8.92 | | | |

**Table 5** Binary logistic regression models for the assumption that DU was affected from "Predisposing-both individual factor and family factor" (cont.)

| Variables in the equation | Model 4 | | | | Model 4A | | | |
|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| **-2 Log likelihood** | 238,370 | | | | 238,223 | | | |
| **Nagelkerke R Square** | 0.056 | | | | 0.056 | | | |
| **Hosmer and Lemeshow Test - $\chi 2$** | 151.7, df = 8, p < 0.0001 | | | | 107.6, df = 8, p < 0.0001 | | | |

Note:

[a] Primary educational level was a grouping of no education, pre-primary school, and primary school. Secondary educational level was a grouping of junior high school, senior high school, and vocational certificate. Tertiary educational level was a grouping of high vocational/ technical certificate, bachelor degree, and higher than bachelor degree

**Table 6** Binary logistic regression models for the assumption that DU was affected from "Predisposing factor both individual factor and family factor, and enabling factor"

| Variables in the equation | Model 5 | | | | Model 5A | | | |
|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| **Constant** | -1.33 | 0.07 | 0.26 | < 0.0001 | -1.58 | 0.07 | 0.21 | < 0.0001 |
| **Age group** | | | | | | | | |
| Early childhood | -1.29 | 0.03 | 0.27 | < 0.0001 | -1.28 | 0.03 | 0.28 | < 0.0001 |
| Childhood | Reference | | | | Reference | | | |
| Adolescent | -0.68 | 0.03 | 0.51 | < 0.0001 | -0.66 | 0.03 | 0.52 | < 0.0001 |
| Early adult | -1.03 | 0.03 | 0.36 | < 0.0001 | -1.01 | 0.03 | 0.36 | < 0.0001 |
| Adult | -1.23 | 0.04 | 0.29 | < 0.0001 | -1.22 | 0.04 | 0.30 | < 0.0001 |
| Late adult | -1.25 | 0.05 | 0.29 | < 0.0001 | -1.24 | 0.05 | 0.29 | < 0.0001 |
| Elderly | -1.50 | 0.06 | 0.22 | < 0.0001 | -1.50 | 0.06 | 0.22 | < 0.0001 |
| **Birth cohort** | | | | | | | | |
| Before 1941 | Reference | | | | Reference | | | |
| 1941-1950 | 0.30 | 0.04 | 1.35 | < 0.0001 | 0.30 | 0.04 | 1.35 | < 0.0001 |
| 1951-1960 | 0.14 | 0.05 | 1.15 | 0.004 | 0.15 | 0.05 | 1.16 | 0.003 |
| 1961-1970 | -0.10 | 0.05 | 0.91 | 0.063 | -0.09 | 0.05 | 0.91 | 0.081 |
| 1971-1980 | -0.36 | 0.06 | 0.70 | < 0.0001 | -0.35 | 0.06 | 0.70 | < 0.0001 |
| 1981-1990 | -0.53 | 0.06 | 0.59 | < 0.0001 | -0.52 | 0.06 | 0.59 | < 0.0001 |
| 1991-2000 | -0.43 | 0.07 | 0.65 | < 0.0001 | -0.42 | 0.07 | 0.66 | < 0.0001 |
| After 2000 | -0.56 | 0.07 | 0.57 | < 0.0001 | -0.54 | 0.07 | 0.58 | < 0.0001 |
| **Education of family head [a]** | | | | | | | | |
| Primary level | Reference | | | | Reference | | | |
| Secondary level | 0.25 | 0.02 | 1.28 | < 0.0001 | 0.25 | 0.02 | 1.29 | < 0.0001 |
| Tertiary Level | 0.50 | 0.02 | 1.65 | < 0.0001 | 0.50 | 0.02 | 1.65 | < 0.0001 |
| **Education of individual [a]** | | | | | | | | |
| Primary level | Reference | | | | Reference | | | |
| Secondary level | 0.17 | 0.02 | 1.19 | < 0.0001 | 0.42 | 0.04 | 1.53 | < 0.0001 |
| Tertiary Level | 0.56 | 0.02 | 1.75 | < 0.0001 | 0.91 | 0.04 | 2.49 | < 0.0001 |
| **Gender** | | | | | | | | |
| Female | 0.41 | 0.01 | 1.50 | < 0.0001 | 0.41 | 0.01 | 1.50 | < 0.0001 |
| **Health insurance** | | | | | | | | |
| UCS | Reference | | | | Reference | | | |
| SSS | 0.26 | 0.02 | 1.29 | < 0.0001 | 0.23 | 0.03 | 1.26 | < 0.0001 |
| CSMBS | 0.33 | 0.02 | 1.39 | < 0.0001 | 0.38 | 0.04 | 1.46 | < 0.0001 |
| Other [b] | 0.42 | 0.04 | 1.52 | < 0.0001 | 0.56 | 0.06 | 1.75 | < 0.0001 |
| Not have any health insurance | -0.11 | 0.04 | 0.90 | 0.005 | 0.13 | 0.05 | 1.14 | 0.015 |
| **Region of residence** | | | | | | | | |
| Bangkok | Reference | | | | Reference | | | |
| Central | -0.53 | 0.02 | 0.59 | < 0.0001 | -0.28 | 0.03 | 0.75 | < 0.0001 |
| Northern | -0.21 | 0.02 | 0.81 | < 0.0001 | 0.06 | 0.03 | 1.06 | 0.047 |

**Table 6** Binary logistic regression models for the assumption that DU was affected from "Predisposing factor both individual factor and family factor, and enabling factor" (cont.)

| Variables in the equation | Model 5 | | | | Model 5A | | | |
|---|---|---|---|---|---|---|---|---|
| | **B** | **S.E.** | **OR** | ***p*-value** | **B** | **S.E.** | **OR** | ***p*-value** |
| Northeastern | -0.39 | 0.02 | 0.68 | < 0.0001 | -0.10 | 0.03 | 0.90 | 0.001 |
| Southern | -0.36 | 0.02 | 0.70 | < 0.0001 | -0.16 | 0.03 | 0.85 | < 0.0001 |
| **Interaction among region of residence and education of individual** | | | | | | | | |
| REG(BKK)*edu(primary) | | | | | Reference | | | |
| REG(Central)*edu(secondary) | | | | | -0.22 | 0.04 | 0.81 | < 0.0001 |
| REG(Central)*edu(tertiary) | | | | | -0.36 | 0.05 | 0.70 | < 0.0001 |
| REG(Northern)*edu(secondary) | | | | | -0.35 | 0.05 | 0.70 | < 0.0001 |
| REG(Northern)*edu(tertiary) | | | | | -0.53 | 0.06 | 0.59 | < 0.0001 |
| REG(Northeastern)*edu(secondary) | | | | | -0.42 | 0.04 | 0.66 | < 0.0001 |
| REG(Northeastern)*edu(tertiary) | | | | | -0.65 | 0.05 | 0.52 | < 0.0001 |
| REG(Southern)*edu(secondary) | | | | | -0.16 | 0.05 | 0.85 | 0.001 |
| REG(Southern)*edu(tertiary) | | | | | -0.36 | 0.06 | 0.69 | < 0.0001 |
| **Interaction among health insurance and region of residence** | | | | | | | | |
| INS(UCS)*REG(BKK) | | | | | Reference | | | |
| INS(SSS)*REG(Central) | | | | | -0.05 | 0.05 | 0.95 | 0.284 |
| INS(SSS)*REG(Northern) | | | | | 0.06 | 0.06 | 1.06 | 0.337 |
| INS(SSS)*REG(Northeastern) | | | | | 0.19 | 0.06 | 1.21 | 0.001 |
| INS(SSS)*REG(Southern) | | | | | 0.07 | 0.07 | 1.07 | 0.298 |
| INS(CSMBS)*REG(Central) | | | | | -0.02 | 0.06 | 0.98 | 0.762 |
| INS(CSMBS)*REG(Northern) | | | | | 0.01 | 0.06 | 1.01 | 0.817 |
| INS(CSMBS)*REG(Northeastern) | | | | | -0.05 | 0.06 | 0.95 | 0.370 |
| INS(CSMBS)*REG(Southern) | | | | | 0.00 | 0.06 | 1.00 | 0.996 |
| INS(Other)*REG(Central) | | | | | -0.32 | 0.10 | 0.73 | 0.002 |
| INS(Other)*REG(Northern) | | | | | -0.29 | 0.13 | 0.75 | 0.031 |
| INS(Other)*REG(Northeastern) | | | | | 0.11 | 0.13 | 1.11 | 0.401 |
| INS(Other)*REG(Southern) | | | | | -0.50 | 0.17 | 0.61 | 0.003 |
| INS(not any)*REG(Central) | | | | | -0.48 | 0.10 | 0.62 | < 0.0001 |
| INS(not any)*REG(Northern) | | | | | -0.61 | 0.14 | 0.54 | < 0.0001 |
| INS(not any)*REG(Northeastern) | | | | | -0.37 | 0.15 | 0.69 | 0.012 |
| INS(not any)*REG(Southern) | | | | | -0.10 | 0.13 | 0.90 | 0.429 |
| **n** | 413,875 | | | | 413,875 | | | |
| **% of dental use** | 8.92 | | | | 8.92 | | | |
| **-2 Log likelihood** | 237,451 | | | | 237,144 | | | |
| **Nagelkerke R Square** | 0.060 | | | | 0.061 | | | |
| **Hosmer and Lemeshow Test - $\chi$2** | 92.7, df = 8, p < 0.0001 | | | | 64.7, df = 8, p < 0.0001 | | | |

Note:

[a] Primary educational level was a grouping of no education, pre-primary school, and primary school. Secondary educational level was a grouping of junior high school, senior high school, and vocational certificate. Tertiary educational level was a grouping of high vocational/ technical certificate, bachelor degree, and higher than bachelor degree

[b] Nonpublic-provided health insurances such as insurance company, and employer pay

they had the same education as other regions. People in all regions still had lower DU than Bangkok although they had more education. There was not much different DU among regions for each type of public-provided health insurance, except for SSS in the Northeastern which had remarkably higher DU than this group in other regions (Table 6).

## DISCUSSION

The data used in this study was aggregated from six waves of HWS of Thailand. Individual level data was reorganized into the group of birth cohort and age group for accessing changes of DU by time. However, original data from each wave was not included the same birth cohort for each age group;

and the same birth cohort also change to older age group as time passed. Therefore, consideration of age and cohort together was needed when dealing with this type of data. As the result in this study showed smoother trend of DU among age groups after controlling for birth cohort, which confirmed the differences among generations. In the same way for considering in the view of cohort, the smoother trend after controlling for age group also confirmed the changes of DU when people were growing up.

The effect of each independent variable and their interactions to DU were similar to previous studies. The first important characteristic was different DU among age groups, especially lower DU among working age and elderly people. Even in high income countries, there also had the same situation. Younger people in the UK had more regular dental visit than older [12], the same as lower dental visit among older people in the Kingdom of Saudi Arabia [13]. Unequal DU in working age also found in the US, and one reason was mentioned to barrier in accessing to dental care in term of health insurance benefits [14]. The effect of this enabling factor would be discussed later.

The next variable for discussion would be gender. The higher DU among females in childhood to late adult group were consistent with previous study [12]. Interactions among gender and other variables in model 3A confirmed that differences between male and female were independently effect to DU. Although this study could not explain the reason of their differences, it could confirm the importance of including gender in any forecasting of dental care demand, especially when consideration for adolescent and working age but not for other age group, such as elderly which the differences among genders were nearly gone after controlling for other variable [15].

In contrast with role in family, even the result after controlling for all independent variables together showed independent effect to DU by the role itself, in the same way as gender, after exploring its interaction to other variables in model 4A. This study found that different gaps of DU among roles were diminished by education and household size. These result might be confounded by the category of role in family which used in this study. Since all other members in family was categorized into the same group either they were relatives or servants, those variables could identify their differences. In short by category used in this study, education of individual and household size had clearer effect to DU than role in family.

The next importance variable was education of individual. It showed remarkable relation to DU both by descriptive analysis and binary logistic regressions. Education is not direct composition of health system; but it is social determinant of health [16]. Many studies found impact of education to health. One of those suggested that investment of education in national level lead to better health relate behavior [17]; another one mentioned to different type of health care used by people with different educational level [18]. This study confirmed high impact of education to health, in term of dental care utilization. In context of country with universal health coverage for population, differences of DU were clearly seen among education levels. Although the benefits of education system to population health were beyond scope of this study, these initial findings could be encouraged to health related researchers and policy makers to investigate more on efficiency and effectiveness of investment in education for sustainable health outcome.

In part of predisposing-family factor, two variables in this group were education of family head and household size. It showed stable OR after controlling for time variables. The result in this study showed that even the region of residence, which could be used to represent unequal distribution of provider, were controlled or not, the effect of household size to DU were still the same. In other words, size of Thai's family had high influence on DU, no matter how distribution of dental health service provider was. This result was coincided with Andersen's finding since the initial phase of his study about behavioral model of health care utilization; which he mentioned to the maximum influence on use of health care by family composition although the equitable distribution of health care were assumed [19].

In part of enabling factor, although there was evidence supported that the coverage of health insurance led to enhancing of health service utilization, the actual access to care, such as available of provider, need to be evaluated [20]. In Thailand, the report of dental health workforce showed the half-half sharing proportion of dentist in public and private health sectors, and unequal distribution among regions [21]. For those situations together with the fact that public health sector was the main provider for UCS and CSMBS, which had different budget and payment method for people under coverage [22]. We could not refuse that the

fee for service of CSMBS had more incentive for providers than capitation fee of UCS [23]. Although the UCS provided all necessary dental care in the package, the result from this study confirmed existing problem of unequal access to care. In contrast with SSS, people under their coverage can use dental care benefits at both public and private providers. More choices of provider within their benefits could decrease barrier from waiting time and cost for care, which were the main reasons of unmet need [24]; thus the result showed higher DU for this group than UCS. To achieve equity in health as the main concept of UCS, expansion of both health care resources and coverage of health insurance alone could not directly improve access to care. Innovative strategy is needed for subsidizes this group of people which were the real problem.

Although independent variables in this study were categorized into three group of factors, the effect of each variable to DU could not separately interpret without consideration of other related variables. The changes of OR among each independent variable to DU after controlling for all independent variables confirmed the must of using binary logistic regression analysis, since they had interaction effects to each other as found in many studies [15, 25, 26].

Group of independent variables with decreasing OR, which were education of both individual and family head, working status of both individual and family head, marital status of family head, region of residence, and health insurance, showed the close relation among them. These might be related to the access of education and dental care. As found from previous study that the different patterns of health service usage between urban and rural area were affected from scarcity and reallocation of resources [27].

This study was the first time of dental heath related study in Thailand that using aggregated data from a series of population based surveys. Since the data used in this study was well processed by national level organization, there were no sociodemographic differences between our study samples and the actual country population [11]. Furthermore the technique of considering variables of time, age group and cohort gave the possibility of exploring changes of dental use by time, which led us more understanding this complex associations. However, there were some limitations. Firstly was study design which imitated to be cohort design; but it was still not the real cohort. Secondly, the outcome of predicted model would be more valid if we could adjust for other characteristics, for example, type of dental care used, frequency of used, and place of used. Lastly, it was limitation of this data set. There was no information about economical or financial characteristic of samples, also clinical characteristic of their oral health; thus compositions of factors mentioned in the behavioral model of health care utilization [6, 7] which applied for conceptual framework was not completed. Further study should consider these limitations. Combining information from several data bases is needed for better outcomes. Adding multi-level of analysis should be considered.

## CONCLUSION

All models in this study were more appropriate for forecasting dental care demand than considering only differences among age group. The related variables that improve power of prediction included gender, education of both individual and family head, region of residence, and type of health insurance. In term of predicted power of model, there were not much different among all three models and base model; therefore, if we need to predict DU in the whole picture of population, and the related information including available models, all models could be used with similar benefit.

### Policy recommendation

Further forecasting of demand for dental care should consider more variables than using only age group. The information on gender, education of individual, education of family head, region of residence, and health insurance were recommended to include in forecasting. These sets of variables will help to clarify existing inequality.

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### Conflict of interests

The author declare that there is no conflict of interests regarding the publication of this article

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