

# Oral Health Status of Thai Older Adults with Different Oral Health Literacy Levels

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## Abstract

**Objectives:** The aim of this study was to assess oral health status and its links to their Oral Health Literacy (OHL) level in older adults.

**Methods:** A single visit cross-sectional study was conducted in January to February 2018 with 115 participants aged 60 or more living in Chiang Mai, Thailand. Participants were asked to complete the OHL test (OA-TOFHLiD) along with demographic details, after which an oral health screening was undertaken.

**Results:** When dichotomized participants according to their OHL level (adequate or inadequate OHL), there was a significant difference between several characteristics and oral health status in the two groups ( $p < 0.05$ ). Univariate logistic regression analysis showed that adequate OHL was associated with having good oral health in older adults ( $p = 0.001$ ).

**Conclusions:** In community-dwelling older adults, oral health status varied between people with adequate and inadequate oral health literacy; older adults with adequate oral health literacy had less oral disease, less treatment need, and better oral health.

**Keywords:** elderly people, oral health literacy, oral health status

## Introduction

The population of older adults has increased around the world while the fertility rate has decreased.<sup>(1)</sup> Many countries are becoming aged societies, with the proportion of older adults (age 65 or more) higher than 20% of the total population.<sup>(1)</sup> In Thailand, the number of adults aged 60 or higher has been increasing rapidly; in 2016 15.07% (9.93 million people) were aged over 65 and by 2020 this have risen to 19.12% (12.62 million people).<sup>(2,3)</sup> An ageing population presents challenges in providing sufficient health care and supportive health services against reduced taxation income. Older adults have an increased risk of health problems, especially older adults with

multimorbidity (an individual who has two or more chronic conditions).<sup>(4)</sup> Older adults spend more time than other age-group populations in a health setting, and require a large health workforce, consuming extensive resources.<sup>(5)</sup> It is necessary for immediate public health attention in the forms of disease prevention and enhanced health promotion to be given to this group in order to reduce unnecessary health care utilization and increase their quality of life.<sup>(6)</sup>

Since 2000, health literacy (HL) has attracted increased research attention as services seek to further categorize and stratify patient populations, as well as seeking to understand differing outcomes of therapies in

the highly heterogeneous older population.<sup>(7)</sup> The definition of HL is “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions”.<sup>(8)</sup> Patient’s adequate HL are more able to understand preventive messages and enact these compared to those with lower HL.<sup>(9)</sup> However, many older adults were found to have below basic HL in previous international studies.<sup>(10-12)</sup> In addition, limited HL was related to various health conditions, poor health behavior, and poor medication adherence.<sup>(13)</sup> Older adults with marginal or inadequate HL had higher mortality rates compared to elderly people with adequate HL.<sup>(14)</sup>

Oral health literacy (OHL) was first described in 2004, derived from the concept of HL, and has been defined as an ability to obtain, understand, and process oral health information.<sup>(15)</sup> Many studies have shown an association between OHL and oral health status and behaviors. A study of Japanese adults found that people with higher OHL had a higher number of remaining teeth, lower scores in the community periodontal index (CPI) and had fewer numbers of decayed teeth.<sup>(16)</sup> In Brazilian adults, low OHL was associated with dental caries, and inappropriate oral hygiene behaviors such as irregular tooth brushing and dental flossing.<sup>(17)</sup> Patients with higher OHL were less likely to have severe periodontal disease, compared to those with lower OHL.<sup>(18)</sup> People with lower OHL did not have dentists as their primary source of information and did not participate in decision-making about their oral health treatment.<sup>(19)</sup> Oral health of caregivers has also been shown to have an impact on children’s behavior and oral health status. In a previous study, caregivers with inadequate OHL were associated with risky oral health behaviors such as night-time bottle feeding and no daily brushing.<sup>(20)</sup>

A systematic review has reported associations between low OHL and dental caries; however, those associations were found mostly in primary teeth of children whose parents’ OHL had been screened.<sup>(21)</sup> Another systematic review and meta-analysis suggested that there was no confirmed association between OHL and oral health behaviors, perception, knowledge, and treatment outcomes.<sup>(22)</sup> However, most of the studies included in these systematic reviews and meta-analyses were conducted in young adults or parents taking care of children. None of the studies observed or assessed the older adult

population, which may have a variety of complex factors. Most of the studies utilized word recognition OHL tools, the most frequently used were Rapid Estimate of Adult Literacy in dentistry (REALD-30 and 99).<sup>(21-23)</sup>

The previous study validated a new OHL tool for older adults, the ‘Test of Functional Health Literacy in Dentistry for Older Adults: OA-TOFHLiD’.<sup>(24)</sup> It was found the OA-TOFHLiD had good validity and reliability. It was hypothesized that older adults with higher OHL would have better oral health status. This study, therefore, aimed to explore oral health status and assess OHL of older adults, then to compare oral health status among older adults with different OHL level

## Materials and Methods

### Study participants and ethical approvals

This research study had been reviewed and approved by two institutes. The setting approval was obtained from the Human Experimentation Committee, Faculty of Dentistry, Chiang Mai University (NO. 44/2017). The sponsor of the researcher approval was obtained from the University of Manchester Research Ethic Committee 2 (Ref: 2018-2822-4728).

The target population were older adults aged 60 or more, living in Chiang Mai province and the surrounding area. The population in Chiang Mai of adults aged 60 or older in 2018 was approximately 300,000. The sample size calculation was based on the prevalence of dental caries in Thai older adults obtained from the 7<sup>th</sup> National Oral Health Survey by the Bureau of Dental Health in 2012, which was 96.4%, and assumed the precision to be 5%. The result from the sample size calculation was that 59 participants were needed based on the prevalence of active dental caries in this population. However, double the numbers of participants were added to mitigate any dropout during the questionnaire and oral examination, and to make sure that this study would include enough participants with adequate and inadequate OHL. Therefore, the total number of participants in the study was 115.

### Study design and setting

This study was hospital-based survey using convenient sampling. The data collection was conducted at the Oral Health Prevention and Promotion Clinic in the Faculty of Dentistry at Chiang Mai University, from

January to February 2018. Poster advertisements were posted at the site and online to invite any participants who lived nearby the setting one month before the study started. The data collection was conducted daily until the number of participants reached the calculated goal (n=115). Inclusion criteria were those aged 60 years old or older at the date of attending the study and had to be able to understand, read and write in Thai language without any assistance.

On the day of the study, informed consent was obtained from the participants. The questionnaire was administered after participants had given their written consent. The participants who consented needed to complete the questionnaire, which was composed of two parts: background information, and the test of Functional Health Literacy in Dentistry for Older Adults (OA-TOFHLiD). After completing the questionnaire and OHL test, the participants underwent an oral examination, which was performed by a qualified Thai dentist (Intra-rater reliability; Kappa = 0.90). The oral health status metrics were composed of dental caries status by Decay-Missing-Filled Teeth Index (DMFT, WHO), treatment needs, prosthesis status, prosthesis needs, number of natural functional teeth and number of posterior occlusal pairs.

### Study variables and statistical analysis

#### *Independent and covariate variables*

OHL was assessed by the optimized Thai version of the Test of Functional Health Literacy in Dentistry for Older Adults (OA-TOFHLiD).<sup>(24)</sup> The OA-TOFHLiD is a validated OHL assessment tool for measuring OHL in Thai older adults. It is comprised of a reading comprehension section and a prompt section. In the reading comprehension section, there are four topics: 1.) Tooth decay 2.) Gum disease 3.) Oral Hygiene Care 4.) Consent form for a tooth extraction. The questions in this section were 'fill-in-blanks' with four alternatives, the total score was 39. In the prompt section, one picture of a fluoride toothpaste label and one chlorhexidine mouthwash label were provided. Participants needed to read the labels and answer 9 questions at the end of the section. The total score of the two sections was 48. The cut-off score for the OA-TOFHLiD was 41, therefore, participants who scored 0-40 were classified as 'Inadequate OHL', and scores 41-48 were classified as 'Adequate OHL'. The time to administer the questionnaire and undertake the oral health

screening was approximately 15-20 minutes.

The background section of the questionnaire collected socio-demographics details including gender, age (dichotomized into '60-69' and '70 years old or more'), education attainment (dichotomized into 'high school or lower' and 'college or higher'), and monthly income (dichotomized into 'equal to or lower than the Thai poverty line' (THB 2,710 (\$83.5)/month) and 'higher than poverty line'). Moreover, utilization of dental services in the previous year, type of dental insurance, type of dental services used, the place of health service utilization, self-rated oral health status (0-poor to 5-excellent), self-reported oral health problems (0-no, 1-yes), and self-perceived treatment needs (0-no, 1-yes), were included in this section.

#### *Outcome variables*

In this study, several oral health statuses were obtained from oral examination using the following indices based on The 7<sup>th</sup> Thai National Oral Health Survey<sup>(25)</sup>; Active dental caries (Dt): determined according to DMFT index by WHO criteria of dental caries. A tooth was counted as 'Yes' if it was an untreated decayed tooth (primary caries), or if it was a filled tooth presenting with recurrent caries (secondary caries); Missing teeth (Mt): considered the total number of tooth loss in the mouth due to dental disease (extraction, surgical removal, or loss to periodontal disease); Filled teeth<sup>(26)</sup>: measured by counting the number of teeth with intra or extra coronal restorations; Treatment need for caries: assessed by caries characteristics and severity. Classification of treatment needs was: none, one surface filling, two or more surface fillings, crown for any reason, endodontic treatment, and tooth extraction; Numbers of natural functional teeth: considered and counted only natural teeth that could function normally and excluded teeth with severe mobility or retained roots; Numbers of posterior occlusal pairs: counted by asking a participant to bite in centric occlusion and perform jaw movement to see the number of functioning occlusal pairs (including pairs from natural teeth, fixed prosthesis, or removable prosthesis, but excluding pairs from complete dentures). The numbers of posterior occlusal pairs were between 0-8 pairs (from premolar to second molar, excluding third molar); Denture status: lower and upper arch were observed separately and categorised according to the type of prosthesis (bridge(s),

partial denture(s), or full removable denture(s)); Prosthetic need: assessed lower and upper arches separately and classified them into several categories (no need, need one-unit, need multi-unit, need full prosthesis, need to repair old denture).

**Oral health status**

The final outcome variable in this study was Oral Health Status (OHS), which was the main outcome for comprehensible assessment and further statistical analysis. OHS was the combination of several oral indices taken from prior oral examination in order to create a binary variable, good or poor OHS.

Good OHS meant a participant had no active caries, 5-8 posterior occlusal pairs, and had at least 20 natural functional teeth. If one failed to complete all three criteria, they were classified as Poor OHS.

**Statistical analysis**

SPSS statistics Macintosh, version 23.0 (IBM Corp, Armonk, NY, USA) was used to analyze the data. Descriptive statistics namely mean and SD, median and IQR, and percentage, were used to explain general characteristics of the data.

Since the characteristics of the OHL scores were not normally distributed, non-parametric statistical analyses (Mann-Whitney U test) was performed to compare oral health indices in different OHL levels (e.g., numbers of decayed, filled, missing teeth).

To confirm the hypothesis that adequate OHL was associated with having good OHS, the univariate and multivariate logistic regression were performed. In the univariate model, the dependent variable was the binary OHL level (Adequate OHL), and the main outcome variable was the dichotomous OHS (Good OHS). In multivariate model, the controlling variables, which were confounding factors and found significantly associated with OHS (tested prior using Chi-Square tests), were included in the final model to confirm association between OHL level and OHS.

**Results**

**General characteristics**

Participant characteristics are presented in Table 1. The number of participants was 115. Most of the partic-

ipants were female (89.6%). The participants' age range was between 60-84 years. The mean age was 67.02±5.13 years. Forty-one percent of the participants had college or university qualification; however, 30.4% had only primary school qualifications or no formal education. Approximately one third of the participants had monthly incomes lower than the Thai poverty line. For previous or present occupation, one third of participants used to work as government officers, and the remainders were not working in paid employment (i.e., a houseworker, or a caregiver in the family).

For dental service utilization, two-third of subjects used dental services in the previous year. The services they accessed were preventive care, emergency care, and curative care (46.4%, 23.2%, and 19.6% respectively). The places for dental service utilization were mostly in dental schools and public hospitals. With regards to health insurance, the largest number of participants (40.9%) was covered by government employee benefits (from previous working for the government, or having spouse or children working for government), followed by 38.3% covered by universal coverage (basic health insurance for all Thai citizens), and 9.6% covered by social security health insurance (given to people who worked in private sectors).

**Table 1:** Descriptive characteristics of the participants.

Characteristics	N	Percentage
<b>Gender</b>		
Male	12	10.4
Female	103	89.6
<b>Age</b>		
60-69	84	73.0
70-82	31	27.0
<b>Education</b>		
High School or lower	61	53.0
College or higher	54	47.0
<b>Monthly income*</b>		
≤ poverty line (THB 2,710 /\$83.5)	30	26.1
> Poverty line (THB 2,710 / \$83.5)	69	60.0
<b>Dental service utilization in last year*</b>		
Use	76	66.1
Not use	33	28.7
<b>Type of health insurance</b>		
Government health benefits	47	40.9
Social security and others scheme	24	20.8
Universal Coverage scheme	44	38.3

\*There were some missing data.

### Oral health status and oral health literacy of Thai older adults

In Table 2 the participants are classified into two age groups (60-69 and 70 or older) to compare the difference in oral health between different aged older adults, and to observe overall results. The overall mean number of natural functional teeth was  $23.8 \pm 6.5$ . The mean numbers of posterior occluding pairs were  $5.5 \pm 2.4$ . The overall prevalence of active dental caries was 46.1%. The mean

numbers of active decayed teeth, missing, and filled teeth were  $1.6 \pm 2.7$ ,  $7.7 \pm 6.3$ , and  $4.2 \pm 4.7$ , respectively. The number of people who had at least one bridge in the mouth was 13 (11.30%). The number of people who had a complete denture was two (1.74%). The overall percentage of participants who had treatment needs for dental caries was 46.1%, and 54.8% for prosthetic needs.

Table 2 also shows a comparison between two different age groups of older adults. Participants aged 70

**Table 2:** Oral health indices and Oral health literacy, determined by age group.

	Age group		
	60-69 (N = 84)	70-82 (N =31)	Overall (N =115)
<b>Oral health indices</b>			
<b>Number of teeth (mean <math>\pm</math> SD)</b>			
Number of natural functional teeth	24.9 $\pm$ 5.5	20.7 $\pm$ 8.0	23.8 $\pm$ 6.5
Number of posterior occluding pairs	5.7 $\pm$ 2.2	4.6 $\pm$ 2.6	5.5 $\pm$ 2.4
<b>Caries experience (mean <math>\pm</math> SD)</b>			
Active Decay	1.3 $\pm$ 2.3	2.4 $\pm$ 3.5	1.6 $\pm$ 2.7
Missing Teeth	6.6 $\pm$ 5.2	10.6 $\pm$ 8.0	7.7 $\pm$ 6.3
Filled Teeth	4.5 $\pm$ 4.8	3.6 $\pm$ 4.2	4.2 $\pm$ 4.7
DMFT	12.4 $\pm$ 6.4	16.7 $\pm$ 12.4	13.6 $\pm$ 7.0
<b>Treatment needs for caries (N, %)</b>			
Need filling (s)	27 (32.1%)	14 (32.1%)	41 (35.7%)
Need endodontic treatment (s)	8 (9.5%)	2 (6.5%)	10 (8.7%)
Need extraction (s)	17 (20.2%)	11 (35.4%)	28 (24.3%)
Overall having treatment need for caries	35 (41.7%)	18 (58.1%)	53 (46.1%)
<b>Prosthesis status (N, %)</b>			
Having bridge (s)	4 (4.8%)	3 (9.7%)	7 (6.1%)
Having partial denture (s)	16 (19.1%)	12 (38.8%)	28 (24.3%)
Having both bridge (s) & denture (s)	0 (0%)	1 (3.2%)	1 (0.9%)
Having full removable dentures	0 (0%)	2 (6.5%)	2 (1.7%)
Overall having prosthesis	23 (27.4%)	18 (58.1%)	41 (35.7%)
<b>Prosthesis needs (N, %)</b>			
Need 1 unit of prosthesis	14 (16.7%)	6 (19.4%)	20 (17.4%)
Need 2 or more unit of prostheses	27 (32.1%)	11 (35.5%)	38 (33.1%)
Need full prosthesis	0 (0%)	0 (0%)	0 (0%)
Need to repair denture (s)	6 (7.2%)	4 (12.9%)	10 (8.7%)
Overall having prosthetic treatment need	44 (52.4%)	19 (61.3%)	63 (54.8%)
<b>Oral Health Status (OHS) (N, %)</b>			
Good OHS	43 (51.2%)	53 (46.1%)	62 (53.9%)
Poor OHS	10 (32.3%)	21 (67.7%)	41 (48.8%)
<b>Oral Health Literacy</b>			
<b>OA-TOFHLiD scores (mean <math>\pm</math> SD)</b>			
Reading comprehension (39)	32.8 $\pm$ 5.2	27.1 $\pm$ 10.0	31.3 $\pm$ 7.3
Understanding numeracy and text (9)	7.1 $\pm$ 1.8	6.1 $\pm$ 2.9	6.8 $\pm$ 2.2
Total (48)	40.0 $\pm$ 6.6	33.1 $\pm$ 12.4	38.1 $\pm$ 9.0
<b>Oral Health Literacy Level (OHL) (N, %)</b>			
Adequate OHL (score $\geq$ 41)	51 (60.7%)	12 (38.7%)	63 (54.8%)
Inadequate OHL (score<41)	33 (39.3%)	19 (61.3%)	52 (45.2%)



or older showed poorer oral health. They had more active decayed teeth, more missing teeth, more DMFT, less filled teeth, fewer natural functional teeth, and fewer posterior occlusal pairs. In addition, when exploring treatment needs between the two age groups, it was found that participants in the older age group were more likely to have higher treatment needs for caries (e.g., fillings, crowns), and higher prosthetic needs compared to the lower age group. Interestingly, with regards to the treatment needs for caries, younger participants had higher proportion of filling needs than the older ones (45.2% vs. 32.1%), but the older group had higher proportion of tooth extraction needs (35.4% vs. 20.2%).

As can be seen in Table 2, the mean score of Thai OA-TOFHLiD in this study was 38.12 (S.D. 9.02). Overall, for the level of OHL, 63 participants (54.8%) got OA-TOFHLiD scores of 41 or more and were classified as “Adequate OHL”. 52 participants (45.2%) got scores of 40 or less and were classified as “Inadequate OHL”. The participants in the higher age group (70 or older) had lower OHL scores in all parts.

### Comparing oral health statuses in people with different oral health literacy level

In Table 3, participants were categorized as having either ‘Inadequate OHL or ‘Adequate OHL level’ by using the OA-TOFHLiD scores and set this OHL level as an independent variable.

Three main metrics of 1.) Demographic variables (age, years of education attendance, and monthly income); 2.) Perceived oral health status; and 3.) Oral health indices (number of decayed teeth, filled teeth, missing teeth, DMFT, number of natural functional teeth, and number of posterior occlusal pairs), were assessed as dependent variables between those with adequate and inadequate OHL using the Mann-Whitney U Test.

The results in Table 3 demonstrated that participants with adequate OHL and inadequate OHL were different in demographic characteristics. The median age of participants with adequate OHL was significantly lower than the inadequate OHL group ( $p=0.014$ ). The adequate OHL group also had significantly higher median years of education and significantly higher median monthly

**Table 3:** Comparing variables and oral health indices in participants with different oral health literacy levels.

Variables	Oral Health Literacy level (Median (IQR))		
	Inadequate Oral Health Literacy	Adequate Oral Health Literacy	$p$ -value <sup>δ</sup>
<b>Demographic</b>			
Age (years)	68.0 (63.2-72.0)	65.0 (62.0-68.0)	0.014*
Year of Education (years)	6.0 (6.0-12.0)	14.0 (12.0-16.0)	<0.001**
Monthly Income (THB)	1,750.0 (1,750.0-8,250.0)	15,000.0 (9,000-21,413.5)	<0.001**
<b>Perceived Oral health</b>			
Self-rated oral health status (0-poor to 5-excellent)	2.0 (2.0-3.0)	2 (2.0-3.0)	0.802
<b>Oral Health Status</b>			
Decayed Teeth (teeth)	2.0 (0.0-4.0)	0 (0.0-1.0)	<0.001**
Missing Teeth (teeth)	6.5 (4.0-12.0)	5.0 (4.0-7.0)	0.057
Filled Teeth (teeth)	1.0 (0.0-3.8)	4.0 (1.0-10.0)	<0.001**
DMFT (teeth)	13.0 (9.0-17.8)	12.0 (7.0-18.0)	0.319
Number of Natural Functional teeth (teeth)	24.0 (19.0-27.0)	27.0 (24.0-28.0)	0.007*
Number of Posterior Occluding Pairs (pairs)	5.0 (2.2-7.0)	6.0 (6.0-8.0)	0.003*

<sup>δ</sup> $p$ -value obtained from Mann-Whitney U Test

\*  $p < 0.05$

\*\*  $p < 0.001$

income ( $p<0.001$ ), compared to the inadequate OHL group.

Participants with adequate OHL had better oral health statuses than those with inadequate OHL. The median number of decayed teeth in the inadequate OHL group was significantly higher than the adequate OHL group ( $p<0.001$ ). Additionally, the median number of filled teeth, numbers of natural functional teeth, and numbers of posterior occlusal pairs in the adequate OHL group were significantly higher than the inadequate OHL group ( $p=0.001$ ,  $0.007$ , and  $0.003$  respectively). However, there were no significant differences in perceived OHS, numbers of missing teeth, and overall DMFT between participants with adequate and inadequate OHL.

#### Association between oral health literacy and oral health status

Adequate OHL was significantly associated with good OHS in univariate logistic regression analysis, presented in Table 4. From the univariate model (Model I), participants with adequate OHL had a higher probability of having good oral health (Crude OR=6.21,  $p<0.001$ ).

However, when adjusted by controlled variables (level of education, type of health insurance, and monthly income), the association between adequate OHL and good OHS was not significant (Adjusted OR=2.07,  $p=0.168$ ), but monthly income became the significant factor associated with having good OHS (Adjusted OR=4.34,  $p=0.014$ ), presented in Model II.

## Discussion

In this study, our primary aim was to assess OHL level in older adults and compare it to their OHS. Our findings show the proportion of older adults with adequate OHL and inadequate OHL were pretty similar (54.8% and 45.2% respectively). OHL scores were significantly different in people with different background characteristics. Participants in the younger-old age group (60-69 years old), with college or higher education, having monthly income higher than the poverty line, and with government insurance benefits had significantly higher OHL scores. The results from this study corresponded to the previous OHL studies in which people with lower age, higher educational level, and higher incomes had higher oral health literacy.<sup>(17,27,28)</sup> Participants who have government insurance are likely former government employees (pensioners) or have a government employee as a close family member and have higher educational levels and better health insurance than subjects with other types of insurance.

Dental service utilization was not found to be a significant predictor of OHL, as with a previous study in American older adults.<sup>(29)</sup> This could be due to the Thai health insurance system provides free dental care to all older adults with no limit of usage. Free dental services are situated in every district hospital in Thailand. In addition, active oral health care (e.g., home visits, a mobile unit in a community center) is also sometimes provided. People with adequate or inadequate OHL can access such

**Table 4:** Univariate and multivariate logistic regression analysis to confirm association between oral health literacy level and oral health status

Independent variable	Good oral health status (OHS)					
	Univariate Analysis (Model I)			Multivariate Analysis (Model II)		
	Crude OR	CI	p-Value	Adjusted OR	CI	p-value
OA-TOFHLiD level (Adequate Oral Health Literacy)	6.21	2.72, 14.20	<0.001**	2.07	0.74, 5.83	0.168
<b>Confounding variables</b>						
Education (College or higher)	3.22	1.50, 6.92	0.003*	1.47	0.53, 4.09	0.464
Type of health insurance (Government health benefits)	2.95	1.67, 6.38	0.006*	2.06	0.77, 5.51	0.149
Monthly income (> Poverty line THB 2,710 / \$83.5)	6.90	2.36, 20.16	<0.001**	4.34	1.34, 14.05	0.014*

\* $p<0.01$

\*\* $p<0.001$

services whenever they need, with less impact of OHL on making a decision to use the care. i.e., the need to balance a financial decision against a health decision is not required. In addition, the dental service utilization rate in this study was high (66.1%) with most participants utilizing preventive care. In comparison, only 38.6% of older adults from the 8th Thai National Oral Health Survey had utilized dental services in the previous year with the most frequent reason cited as tooth extraction, which is classified as an emergency service. Therefore, the subjects in this study may not be representative of the general Thai older adults due to the higher standard of inclusion criteria (older adults who can read and write on their own and have utilized dental services at this setting before), the sample recruitment was therefore prone to participation bias. In addition, the participants who were interested in this study may be more likely to be active in self-care and health prevention, which could be the reason why they volunteered to take part in this study. These participants could also have higher OHL than ones who decided not to join the study if they were conscious of their oral health knowledge and literacy.

When participants were classified by age, the 70 or older group had poorer oral health status, fewer natural functional teeth, higher treatment need (including prosthesis provision). The results also highlight that participants with adequate OHL had significantly better oral health, which was consistent with the previous OHL study in the American adults aged 36-70.<sup>(30)</sup> This includes having lower active or untreated caries, having a higher number of fillings, having more remaining functional teeth, and having a higher number of posterior occlusal pairs. The reason may be that individuals with adequate OHL have skills in taking care of their oral health by obtaining oral health information, processing it, and implementing it effectively; as a result, they could achieve better oral health than those with inadequate OHL. These results almost entirely agree with a recent systematic review of OHL and OHS outcomes.<sup>(21)</sup> In that review, the number of missing teeth, restored teeth, natural functional teeth, and prosthesis need were significantly associated with OHL, while the remainder of oral health outcomes e.g., the number of carious teeth and prosthesis use were not associated with OHL. Nevertheless, one-third of the studies included in the systematic review were related to pediatric and parental OHL, and

none of them exclusively studied the older adult population. In addition, the majority of the studies used word recognition tools, for example, REALD-30<sup>(31)</sup>, which is a different type of OHL tool (a word recognition) from the OA-TOFHLiD used in this study.

The association between OHL and OHS was not entirely confirmed in this study. From the univariate analysis, the results show an adequate OHL, as measured by the instrument, was associated with having good OHS in older adults. However, when adjusted by the confounding factors, the significant association between adequate OHL and good OHS was disappeared, but monthly income become the significant factor associated with having good OHS. This could be because OHL did not uniquely explained OHS, but OHS was affected by multifactor, and this study displayed that income had the greatest statistical power to show association with OHS. The relationship between income and oral health was also confirmed in the previous critical review.<sup>(32)</sup>

One limitation in our study is that we could not explain the directional effect and causal relationships of OHL and other background variables on OHS due to the limitation of the sample size, which was not large enough to perform analyses such as a Path analysis.<sup>(33,34)</sup> Therefore, future studies are recommended to utilize this OHL test in a larger number of participants, across various settings including rural and urban communities in order to obtain participants with diverse demographic backgrounds. In addition, we did not collect oral hygiene behaviors, for example, frequency of brushing and flossing, nor did we measure plaque or periodontal status; variables that could be affected by OHL as found in earlier studies.<sup>(30,35)</sup> Therefore, there is a need to study the association between OHL, periodontal status and oral hygiene behavior of older adults in the future.

## Conclusions

This study was the first study to assess OHS and compare between different OHL levels of older adults in Thailand. The results found that people with different OHL levels had significantly different background characteristics. Older adults with adequate OHL had better OHS. In conclusion, OHL is associated with OHS in older people. As such, it may be a new approach to promote oral health of older adults.



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