

Knowledge and Attitude towards Oral Health Related Behaviors of International  
Students in Chulalongkorn University, during the pandemic of covid-19



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ความรู้และทัศนคติต่อพฤติกรรมที่เกี่ยวข้องกับสุขภาพช่องปากของนิสิตต่างชาติในจุฬาลงกรณ์  
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สาขาวิชา      ชีววิทยาช่องปาก  
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KEYWORD: Attitude, Behaviors, Covid-19, Knowledge, Oral Healthcare, International Students

Isi Susanti : Knowledge and Attitude towards Oral Health Related Behaviors of International Students in Chulalongkorn University, during the pandemic of covid-19. Advisor: Assoc. Prof. Neeracha Sanchavanakit, D.D.S., Ph.D. Co-advisor: Assoc. Prof. Pagaporn Pantuwadee Pisarnaturakit, D.D.S., M.Sc., Dr.P.H.

Objectives: To determine the association of knowledge and attitude toward oral healthcare behavior of overseas university students staying in Thailand between January 2020 and July 2022 and explore the experiences of their oral health problems. Methods: A cross-sectional study conducted using an online survey in English operated through the Google platform by convenience sampling among overseas Chulalongkorn University students. The sample size was calculated by the Yamane formula with a minimum sample size of 297 after adding 10% compensation. Descriptive statistics, Chi-square test, t-test, ANOVA, and Pearson correlations were employed using IBM SPSS version 29. Results: Of 311 overseas students, 55.6% were male. The average age of students was  $27.5 \pm 4.5$  years. 68.81% of students were from ASEAN countries, and 73.31% studied in non-health science programs. The study fields, health and non-health sciences, were associated with knowledge ( $p < 0.001$ ) and attitude ( $p = 0.004$ ). Type of health insurance had an association with behavior ( $p = 0.014$ ) and the student's perspective on dental visits ( $p = 0.014$ ). There is a positive correlation between knowledge and behavior ( $p < 0.001$ ,  $r = 0.198$ ) and between attitude and behavior ( $p < 0.001$ ,  $r = 0.212$ ). Three hundred fifty-nine cases of oral health problems were experienced by 47.3% of overseas students consisting of tooth hypersensitivity (21.2%), gingivitis (15.3%), caries (14%), cracked or broken tooth (10%), severe toothache (9%) and others. There was an association between oral healthcare behavior and oral health problems ( $p < 0.001$ ), and a negative correlation was found between behavior score and the number of oral health problems ( $p < 0.001$ ,  $r = -0.204$ ). Conclusion: The oral healthcare behaviors of overseas students correlated positively with knowledge and attitude. A negative correlation was observed between behavior and the number of oral health problems. Furthermore, studying in health science programs impacts students' knowledge and attitude toward oral health, while the dental treatment coverage of health insurance affects decisions for dental visits.

Field of Study: Oral Biology

Student's Signature .....

Academic Year: 2023

Advisor's Signature .....

Co-advisor's Signature .....

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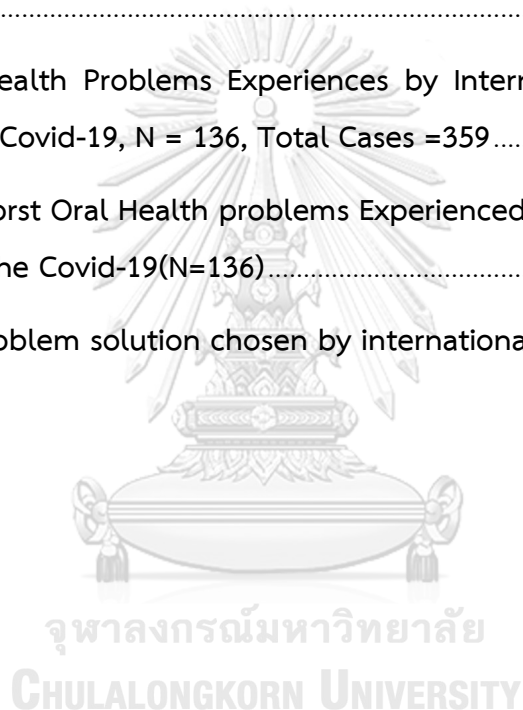
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## INTRODUCTION

### A. Research Background and Rationale

Oral health is integral to general health and associated with systemic well-being(1). The World Health Organization defines oral health as the standard condition of oral tissues that allow a person to eat, speak and socialize without active disease, discomfort, or embarrassment contributing to overall well-being. A variety of factors determines oral health status; biological factors such as host susceptibility; behavioral factors such as tooth cleansing, quality of nutrition intake, tobacco use, and dental service utilization; socio-economic factors such as level of education and income; and macro-ecological factors such as fluoridation, access to dental services(2).

Dental caries and periodontal disease are considered to be common and significant global oral health problems that are more prevalent in developing countries. Dental caries and periodontal disease are considered to be common and significant global oral health problems that are more prevalent in developing countries(3). Dental caries is a demineralization of hard tissues caused by acid from bacteria degrading dietary debris or sugar in the oral cavity(4). Untreated caries can cause tooth hypersensitivity, pain, and infection, possibly resulting in tooth loss. The disease affects general health influencing an individual's quality of life(1). Gingivitis is a common gum disease that manifests with an accumulation of soft or hard dental deposition around the tooth cervical area, redness and swelling of gum, and bleeding

gum(5). The most common cause of gingivitis is poor oral hygiene. Gingivitis is a type of reversible disease. Untreated gingivitis sometimes evolves into periodontitis, which can cause tooth loss(6). The data from previous studies demonstrated that over 80% of children and adolescents have a prevalence of gingivitis(7).

To maintain good oral hygiene, daily personal oral care, at least by toothbrushing with fluoride toothpaste and dental flossing, needs to be performed(8). Tooth brushing with the correct technique, such as modified Bass's, could remove bacteria and dental plaque without damaging the tooth construction(9), At the same time, fluoride would be incorporated into the demineralized enamel to prevent initial caries progression by forming a fluorapatite construction that is stronger and more acid-resistant than the original hydroxyapatite(10). Dental flossing eliminates accumulated dental plaque under the contact point of teeth, which is the primary cause of proximal dental caries and gingivitis(11). Regularly visiting the dentist every six months for dental check-ups would help to detect the disease early and receive prompt treatment of any oral disease(12, 13). However, during the COVID-19 pandemic, it is difficult to make dental appointments since so few clinics remained open. Moreover, the fear of this contagious disease caused people to avoid dental visits despite having dental problems. The outbreak of COVID-19 had been alarmed by the World Health Organization (WHO) and declared as a global pandemic(14),(15). The SAR-CoV2 virus can be transmitted easily through respiratory droplets, aerosol,

person-to-person contact via coughing, sneezing, droplet inhalation transmission, and contact transmission, such as contact with oral, nasal, and eye mucous membranes(16).

Dental practice has been rated among the greatest risk categories regarding viral transmission. The fact that most dental procedures generate a high volume of aerosols, and the operation is performed in close contact next to the patient raises the potential of transmission(14). The American Dental Association (ADA) recommends postponing all dental treatments except those considered urgent or emergency (17). As a result, routine maintenance, and non-emergency treatment of dental caries and gingivitis, are recommended to be postponed.

During the early onset of the pandemic, the Thai government lockdown the city to minimize the disease spreading. All levels of academic institutes were closed and turned to online study modes following the government rules and regulations. City lockdown and studying from home probably affect students' behaviors, such as food choices and dietary habits(18). Dietary habits have been reported negatively and positively impacted by the COVID-19 shutdown around the world (19, 20). The negative diet patterns were linked to poor lifestyle outcomes such as weight gain, mental health concerns, and lack of physical exercise. These lifestyle changes could affect the health status in the short and long term if sustained(21). Moreover, during the pandemic, it has been reported that the frequency of brushing teeth was



significantly increased, which brought about tooth hypersensitivity or even dislodging of filling (22).

Thailand, a member of the Association of Southeast Asian Nations (ASEAN) countries, has a high reputation for national and international education programs. Several international students worldwide come to study to obtain an academic degree. Data in 2017 demonstrates more than 12,000 international students in Thailand, indicating that Thailand is a key regional destination for studies (23).

Being away from their countries, international students may be more concerned about their general health, including oral health, as it impacts the study quality. Health insurance must be applied as per the institute regulations. However, it generally does not cover the total expense and probably none for the dental treatment. Thus, consumption and oral health care behaviors, along with students' cultural background and abroad experiences, influence awareness of individual health status during the normal situation.

However, there is no report on the oral health of international students, especially during the pandemic. The present study will be the pioneer. The study will assess the knowledge and attitude toward the consumption and oral healthcare behaviors of international students, including their experiences with oral health problems during the pandemic of COVID-19.

## **B. Research Problem and Research Gap**

Thailand has a lot of international students who must change their environments and lifestyle, which can affect their health behaviors. Due to health insurance not being covered for dental treatment, the oral health behaviors of international students could be different, especially during the covid-19 pandemic. There has yet to be a previous study about international students' knowledge and attitude about oral health toward consumption and healthcare behavior. This study will be the pioneer in studying the oral health-related behaviors of international students during studying abroad and would be beneficial for understanding the situation, particularly during the COVID-19 pandemic.

## **C. Problem statement**

Dental caries and gingivitis are common oral diseases that can influence people's quality of life. The progression of these oral diseases depends on the knowledge and attitude of people. As Thailand is a crucial education destination for students worldwide, during the COVID-19 pandemic, several international students remain in the country. The lifestyle that includes consumption behavior and oral health care are interfered with regarding studying from home, which has been reported to be associated with a high frequency of sugar intake(24), and the government restricted rules and regulations during the pandemic, as well as oral health problems due to lack of dental check-up and treatment. However, if the students are aware of their

(oral) health, types of food intake, habits, and oral care behaviors may be adapted. Therefore, the present study focused on the associations of knowledge and attitude toward consumption behavior and oral health care of international students. Experiences with dental problems were also investigated.

#### D. Research objectives

1. To determine the association of the knowledge and attitude toward oral health-related behaviors of international students at Chulalongkorn University during the pandemic of COVID-19.
2. To investigate the experiences in oral health problems of international students at Chulalongkorn University during the pandemic of COVID-19.

#### E. Research questions

1. How is the association of the knowledge and attitude toward oral health-related behaviors of international students at Chulalongkorn University during the pandemic of COVID-19?
2. How are the experiences in oral health problems of international students at Chulalongkorn University during the pandemic of COVID-19?

#### F. Research hypothesis

There is a strong association between knowledge and attitude toward oral health-related behavior of international students at Chulalongkorn University during covid-19.

### G. Scope of Study

In this study, the researcher focused on the oral health of the international student during the pandemic without acting on other health. The knowledge and attitude measure focused on oral disease (caries and gingivitis), and oral health behaviors was focused on food-related to oral health and oral care among international students of Chulalongkorn University. Despite that, this study also investigated the oral health problems of international students during their study in Thailand during the period of covid-19.

The study population of this study is the international student who studied at Chulalongkorn University. The focus discussion is to point out the association between the socio-demographic toward knowledge and attitude toward oral health-related behavior in Chulalongkorn University during the condition of covid-19 while also looking for the correlation between knowledge and attitude toward oral health-related behavior. The result of this study will be useful for future studies, whether for the promotion or prevention of oral health treatment after post-pandemic.

## H. Conceptual Framework

INDEPENDENT VARIABLE

DEPENDENT VARIABLE

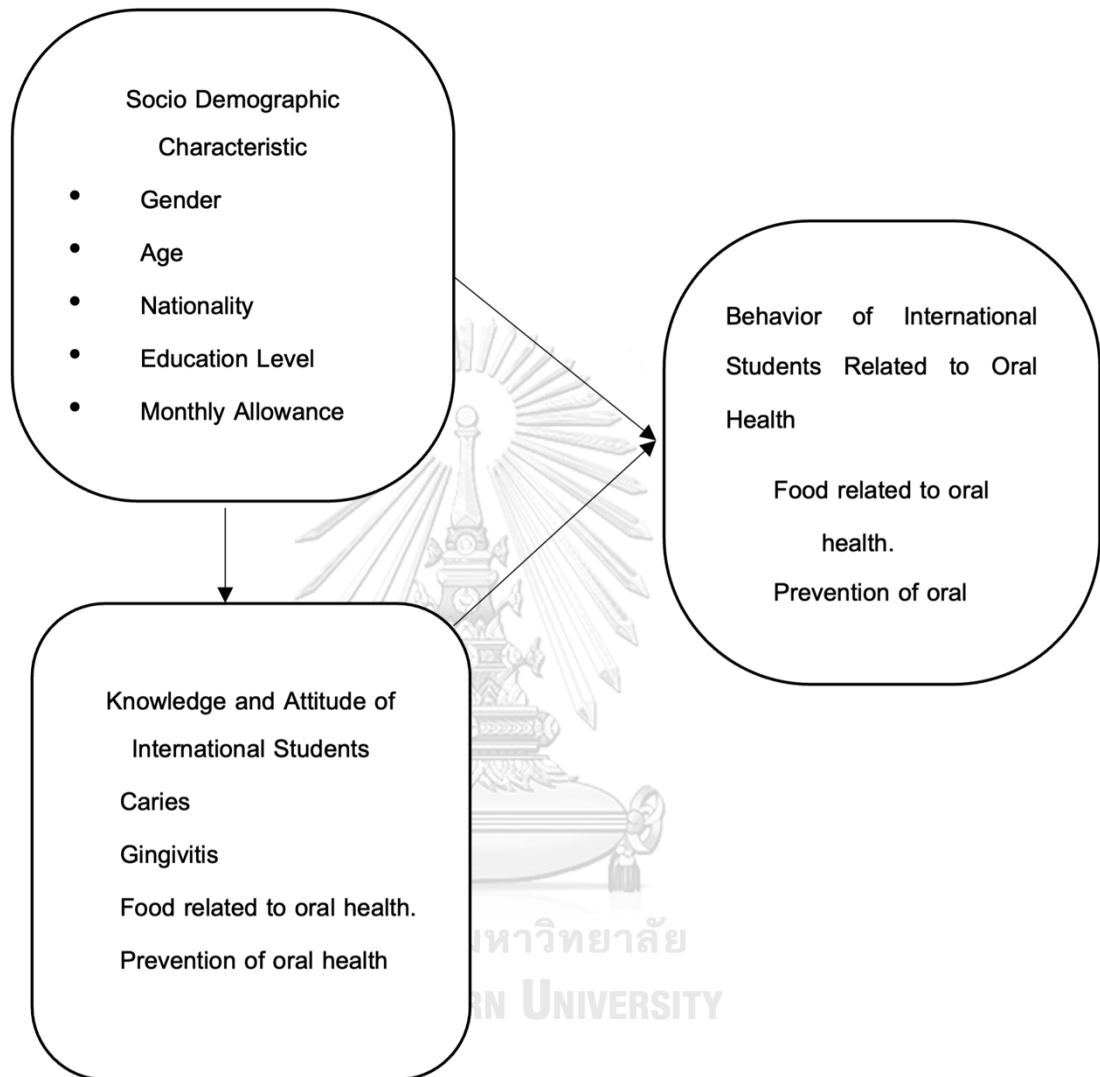


Figure 1 Conceptual Framework of Study

## I. Operational Definition

### 1. International student knowledge about caries

Knowledge of international students about the cause of caries, the symptoms, treatment, and how to prevent caries.

### 2. International student knowledge about gingivitis

Knowledge of international students about the cause of gingivitis, the symptoms, the treatment, and how to prevent gingivitis.

### 3. International student knowledge about food related to oral health.

Knowledge of international students about food related to the cause of oral problems like sweetness, beverages, the frequency of eating sugary food, also food related to help the self-cleansing of teeth which contain high fiber.

### 4. International student knowledge about prevention in oral health

Knowledge of international students about brushing teeth, flossing, the use of fluoride, and dental attendance.

### 5. International student Attitude about caries

The feeling or emotional component of international students about the cause of gingivitis, the symptom, the treatment, and how to prevent gingivitis.

### 6. International student Attitude about gingivitis

The feeling or emotional component of international students about the cause of gingivitis, the symptom, the treatment, and how to prevent gingivitis.

### 7. International student Attitude toward food related to oral health.

The feeling or emotional components of international students about food related to the cause of oral problems like sweetness, beverages, the frequency of eating sugary food, also food related to help the self-cleansing of teeth which contain high fiber.

8. International student Attitude about prevention in oral health

The feeling or emotional component of international students about brushing teeth, flossing, the use of fluoride, and dental attendance.

9. International students' behavior related to oral health.

The behavior of the international student related to oral health behavior such as toothbrushing, fluoride therapy, oral habit prevention, dental flossing, sugary dietary intake, and dental attendance during the Covid-19 pandemic.

## LITERATURE REVIEW

### 1. Oral Health

Oral health has been defined by the World Health Organization (WHO) as “the state of not having chronic mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing”(25). To encompass the entire spectrum of health and wellbeing, a new definition illustrates the intricate interactions between the various aspects of oral health, such as disease, condition status, physiological function, and psychosocial function(26).

### 2. Determining Factor of Oral Health

Apart from the pathogenesis of oral diseases, environmental, behavioral, and biological risk factors that vary from a one-to-one individual could raise the likelihood of disease progression if they are present. If a patient is diagnosed with a high risk of any dental problem, dental professionals can suggest a preventative program based on the patient’s specific needs(27). Age is a behavioral and biological determinant. It is critical to have a positive attitude towards oral health early in childhood to sustain good oral health habits throughout life. Education, social status, income, attitude, perceptions, motivations, and skills are also influencing factors(28).

In addition, nutrition, oral hygiene, knowledge, attitude, and behavior are some elements that influence oral health. If one of these variables is inappropriate,



dental cavities and gingivitis can easily develop. Good personal dental care is essential to avoid the two common oral disorders stated above (29).

Knowledge is essential for making the best decisions. Thinking patterns and knowledge are the foundations of behavior. Even if one has appropriate knowledge about why one should brush one's teeth, this does not guarantee that one would do toothbrushing. This is why oral health is determined in part by one's conduct. Thus, maintaining good oral health necessitates knowledge(30).

Attitude is another crucial aspect of maintaining good oral health. Most attitudes are established early in life due to experiences and the signals they are left behind. Attitudes are typically classified as either emotion or rationale. Changing one's attitude is tough, but it is possible through behavioral modification(31). If anyone wants to change one's behavior, appropriate knowledge is required, but the individual must also be ready and have the skills and motivation(32). Communication between the patient and the oral health care professional is one of the numerous aspects that must be considered while altering an attitude. Good Communication is built on confidence in the oral health care professional. A new attitude toward further new action must feel voluntary to be implemented into the patient's daily life(31).

### 3. Common Oral Health Problems in Early Adulthood

#### 1. Caries

##### a. Etiology

Dental caries is the most common oral disease impacting 2.4 billion people worldwide, and untreated dental caries causes the most frequent health issue(33). Dental caries is caused by the interaction of several etiological elements that may be present simultaneously to commence and advance the disease. The major cariogenic bacteria that metabolize fermentable carbohydrates such as glucose, sucrose, and fructose to create organic acids, primarily lactic acid, are *Mutans streptococci* and *lactobacilli*(34). Interactions among the tooth structure, the microbial biofilm generated on the tooth surface, fermentable carbohydrates, salivary composition, and vulnerable genetic influences affect the pathogenesis and progression of dental caries.

*Cariogenesis* is a dynamic process comprising tooth demineralization and remineralization stages that occur in rapid succession. An equilibrium of alternating periods of demineralization and remineralization during the day under typical settings is individual. Demineralization occurs when free sugars are consumed and metabolized into acids causing PH lower than 5. Fluoride in the mouth and particular qualities of saliva, such as greater flow rate and buffering capacity, tend to inhibit demineralization and can lead to remineralization and lesion arrest(35). Regularly

using fluoride toothpaste demonstrates the global drop in caries prevalence in recent decades. Conversely, if free sugar exposure is frequent, the pH will remain low for an extended time, tipping the balance in favor of demineralization and subsequent caries development(36).

b. Risk factors

Caries is a disease that affects both children and adults(37). According to WHO, the two leading causes of dental caries are excessive sugar consumption and insufficient fluoride exposure(38). A lack of fluoride does not cause caries; however, the fluoride ion can significantly reduce caries on biofilm-covered tooth surfaces in the oral cavity(35). Fluoride in toothpaste is thought to be crucial in reducing dental caries(38).

Dental health-related behaviors such as high-sugar, high-carbohydrate meals, poor oral hygiene, lack of fluoride in toothpaste, and irregular bedtime toothbrushing significantly impact oral health. In addition, social and physical environments such as limited access to topical fluoride and avoiding dental appointments regarding dental fear or anxiety are all key risk factors for dental caries in adults. Insufficient income to acquire valuable goods and healthy foods may prevent families and individuals from fully controlling their dental health(25). A high number of carious permanent teeth has been linked to a low frequency of toothbrushing, which averages one or less per day versus twice or more per day(39).

Sugar's role in caries etiology is well accepted, and there is strong evidence that both the amount and frequency of fermentable carbohydrates consumed are linked to caries development(40). The commercial determinants of health were described by Kickbusch and colleagues in 2016 as the strategies and tactics used by the company to promote goods and products that can cause health problems(41). The strategy encompasses consumers from the individual level to the global consumer society, including the world political economy. Sugary soft drinks and added sugar in processed foods are vital sources of sugar in the worldwide diet, and the global sugar business serves as an excellent illustration of commercial determinants of health(25).

### c. Treatment

Dental caries management should strive to discover initial lesions, determine caries activity, do a caries risk assessment, prevent future carious lesions, preserve dental tissue, and keep teeth as long as possible. Cavitated lesions should be stopped or treated using a minimally invasive procedure(42).

The following lesions can be handled conservatively without filling: white spot lesions, including early occlusal lesions, proximal lesions on a bitewing x-ray restricted to the enamel, and cavitated and non-cavitated root surface lesions that can be reached with cleaning tools. If a recurrent lesion close to restoration is cleanable, it does not require restoration(43).

The International Caries Consensus Collaboration released recommendations for carious tissue excision and managing cavitated lesions in 2016. If surface cavitation is present, whether it is accessed by cleaning equipment or not, the lesion must be restored(42).

## 2. Gingivitis

### a. Etiology

Gingivitis is an oral disease that can be reversed, unlike dental caries. It occurs at any population age. Pathogenesis is gingival tissue inflammation induced by dental plaque accumulation at the cervical tooth area, causing gingival irritation and inflammation. Suppose the disease is left untreated along with the chronic infection by a specific group of bacterial accumulation. In that case, *Porphyromonas Gingivalis* can be developed into periodontitis with the additional characteristic of bone loss, which can lead to tooth loss. With appropriate dental plaque control, inflammatory redness and swollen bleeding gum can be recovered to healthy normal gingival tissue(44). Gingivitis can enhance the risk and progression of several systemic diseases, such as diabetes and coronary heart disease. As a result, dental plaque control is critical for maintaining oral health and general health(45).

### b. Prevention

Gingivitis can be prevented by effectively removing tooth plaque(46). Toothbrushing is the most common method for maintaining personal oral hygiene.

There is strong evidence that toothbrushing and other mechanical cleaning processes, such as flossing, can effectively manage dental plaque if thoroughly cleansing daily and regularly(47).

c. Treatment

The principle of gingivitis treatment is removing soft and hard dental deposits, plaque, and calculus, followed by comprehensive oral hygiene training(48).

### 3. Tooth impaction

a. Definition

An impacted tooth entirely or partially un-erupts because of its position against another tooth, bone, or soft tissue so that future eruption is unlikely(49). The most prevalent tooth impaction is the third molar. The typical period of its eruption is between the ages of 17 and 21; therefore, young people commonly face pain from the unable to erupt the third molar(50). The eruption period is also affected by factors such as types of diet, masticatory force, gender, race, and genetic inheritance(51).

b. Causes

Several causes of the third molar impaction have been proposed. The steady evolutionary reduction in the size of the human mandible/maxilla has resulted in a mandible/maxilla that is too small to contain the corresponding molars(52). It has also been proposed that people's diets do not encourage deliberate mastication,

decreasing jaw growth stimuli. Cross-breeding among people across races causes disproportion in the jaws and, thus, the teeth(53).

### c. Management of Impacted teeth

The treatment strategies are determined by the patient's complaint and medical history. Additional investigation by radiographic assessment brings about the correct diagnosis and treatment plan. The appropriate treatment plan can be as follows(54).

#### a) Observation

Long-term surveillance is appropriate if the impacted tooth is embedded in bone with no access to the follicle and no history or indications of concomitant pathology, especially in the elderly. An annual/biannual examination is indicated if no indications for direct surgical therapy emerge.

#### b) Exposure

This method is considered if there is a chance that it can erupt into a functional occlusion. However, it is blocked by a follicle, sclerotic bone, hypertrophic soft tissue, odontoma, or other obstruction. If the second molar is missing, an exposed third molar should be considered.

#### c) Removal

The principal reasons for removing impacted teeth are to address related pathology and to intervene in a pathological process that is reasonably foreseeable(55).

#### 4. Habits related to dental problems.

##### a. Eating hard food

Both teeth and periodontium have been developed naturally to resist masticatory stresses and strains in some extent. Repetitive stresses on teeth would initially can generate micro-cracks in the enamel and dentin, which can be further extended and later causing hypersensitive tooth and toothache called cracked tooth syndromes(56).

Preferring hard food eating, being a habit, such as cartilage or chestnut have the correlation with the frequency of broken filling or cracked tooth(57). Studied show that around 74.5% of the broken or cracked tooth were from hard food eating habit(58).

##### b. Wrong brushing technic

Tooth brushing more frequent or for longer periods of time or with a scrubbing technique rather than a less damaging method(59), alone or in combination with toothpaste, has been reported to cause cervical abrasive lesion of tooth, gingival tissue abrasion, and gingival recession, as well as plays a role in the etiology of dentine hypersensitivity(60),(61, 62).



#### 4. Dental and Oral Disease Prevention

##### 1. Daily Personal Oral Care

###### Tooth Brushing

The most crucial non-professional intervention in preventing dental caries is brushing with fluoride toothpaste regularly. Toothbrushing mechanically breaks out and removes the dental biofilm and bacterial populations, while toothpaste's fluoride aids in the remineralization of carious lesions(63).

Modification Bass technique is recommended for toothbrushing, particularly for adults (64). Brushing teeth should be done at least twice a day(65) with the optimal duration for brushing teeth being 2 minutes using the modified Bass technique(66). Using a toothbrush and toothpaste with fluoride at least 1000 ppm is also recommended to prevent caries(67).

###### Flossing

According to the individual publications evaluation, floss has a good adjunctive effect on plaque levels(68). In a recent Cochrane analysis discovered that flossing combined with tooth brushing had a statistically significant benefit over tooth brushing alone in terms of lowering gingival inflammation(69).

Flossing once daily, in addition to brushing, has been found to promote periodontal health(69) The same has been established for interdental brushing(70, 71). Interdental brushes are superior to people with gingivitis. It is appropriate for

patients with periodontitis who lose the interdental papilla to eliminate dental plaque accumulating in the interdental area(72).

## 2. **Decrease of sugar consumption**

According to a significant body of evidence, dietary sugars are linked to dental caries(73). In a systematic review, Moynihan and Kelly (2014) discovered an association between sugar consumption and dental caries(74). Those in ‘high sugar’ consumption groups were more likely than those in ‘low sugar’ intake groups to develop dental caries on average across all trials (risk ratio= 7.15). This review also discovered that the association between sugar intake and caries persisted even when fluoride therapies were considered. However, because the studies varied, not all information could be included in the final meta-analysis. Despite this restriction, the authors found that the evidence supported a clear link between caries prevalence and frequency of sugar intake.

Thus, Sugar consumption reduction is a key focus area in preventing dental caries, not only through individual diet guidance but also through community-level initiatives and national legislation (75).

## 3. **Fluoride (toothpaste, mouth wash)**

Fluoride in toothpaste is a significant factor in the decrease in dental cavities(38). Fluoride can be applied topically or systemically to the teeth(76). Systemic fluoride from consumed sources can only be deposited in developing

teeth. The dynamic equilibrium between demineralization and remineralization of the tooth surface post-eruption is influenced by topical fluoride. Fluoride is found naturally in water and can also be added to milk(77) toothpaste(10) drops, mouth rinses, gels(78) foams, and varnishes are all other sources of fluoride(76, 79). Since the late 1960s, WHO has recommended the use of fluoride for population-based dental caries prevention(38).

Fluoride varnish is a highly concentrated type of fluoride used for decades as a clinician-applied caries prevention strategy in children and adolescents(80). Despite that, Fluoride and chlorhexidine mouth rinses may benefit healthy oral health. Fluoride mouthwashes have been proven effective in reducing dental caries, and gingivitis(81, 82, 83), while chlorhexidine mouthwashes effectively prevent plaque growth(84, 85).

#### 4. Dental check-ups

According to numerous studies, visiting the dentist regularly helps maintain good oral hygiene(86, 87, 88, 89). Dental attendance is also linked to a beneficial impact on a person's reported quality of life (QoL) (90, 91, 92). Hence, routine dental examinations at a dentist's office are advised. In the United Kingdom, it is a part of the National Health Service (NHS) guidance (93). However, during the COVID-19 pandemic, there was a significant decrease in dental visits(94, 95).

## 5. Corona Virus

### 1. Definition and Etiology

COVID-19 (coronavirus disease 2019) was named by WHO on February 11, 2020, for the disease caused by SARS-CoV2 (severe acute respiratory syndrome coronavirus 2). It started in Wuhan, China, in late 2019 and has spread worldwide. SARS-CoV-2 is a single-stranded RNA-enveloped virus with many glycosylated spike proteins on its surface that bind to the host cell receptor angiotensin-converting enzyme 2 (ACE2), which then be cleaved by the transmembrane protease serine 2 (TMPRSS2) enzyme allowing the virus to enter the cells. A novel coronavirus has been identified as the cause of the acute respiratory infection (96, 97).

WHO proclaimed COVID-19 a pandemic after many infected cases and deaths were reported in numerous countries. It has been shown to spread from person to person through the respiratory system via respiratory droplets and secretions by coughing, sneezing, talking, physical contact with an infected person at low infective doses, or touching a contaminated surface(98) (99). SARS-CoV-2 can survive for several days depending on the types of material surfaces and temperature(100).

### 2. Epidemiology

Multiple unexplained pneumonia cases have been recorded in some hospitals in Wuhan City, Hubei province, China, since December 2019, with a history of exposure to a large Hua'nán seafood market. A novel coronavirus has been identified as the cause of the acute respiratory infection. The number of cases

without a history of exposure to the Hua'nan seafood market grew. Furthermore, there were clustered and confirmed cases without a travel history to Wuhan. In addition, confirmed cases in several international nations or regions have been discovered without apparent exposure to the Wuhan seafood market(101).

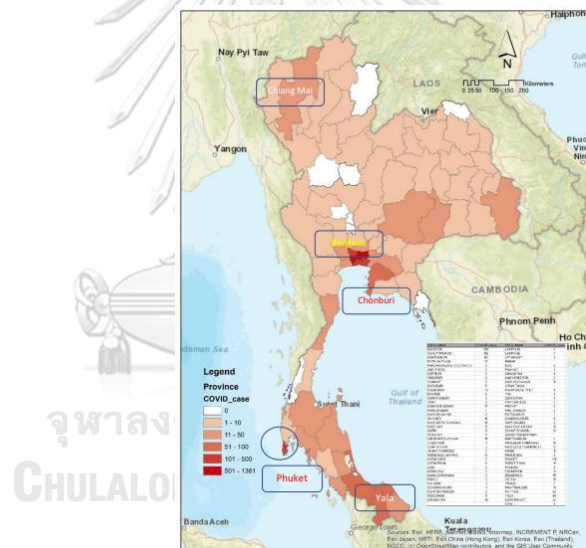
COVID-19 has various effects on humans. Patients showed a broad spectrum of symptoms and severity. At the same time, risk variables such as age, gender, and comorbidities were identified as raising the risk of complications and mortality.

SARS-CoV-2 is mainly transmitted from person to person through family members, including relatives and acquaintances who have had close contact with patients or incubation carriers. Among the patients of non-residents of Wuhan, 31.3 percent recently traveled to Wuhan, and 72.3 percent had contact with persons from Wuhan. COVID-19 patients contacted the virus from healthcare workers in 3.8 percent of cases, according to the National Health Commission of China's report released on February 14, 2020(102). Infections of healthcare workers were found in 33–42 percent of SARS cases, while transmission between patients was found in 62–79 percent of MERS-CoV cases (103).

This acute respiratory infectious disease spreads mainly through the respiratory system via droplets, respiratory secretions, and direct contact at low infective doses (99). The incubation time ranges from 1 to 14 days, with most cases lasting 3–7 days. Moreover, throughout the latency phase, COVID-19 is infectious

(104). It is highly contagious in humans, particularly among the elderly and those with underlying illnesses. Patients ranged in age from 47 to 59 years old, with females accounting for 41.9–45.7 percent of the total (99, 102). COVID-19 patients had symptoms like SARS-CoV-2 patients, including fever, malaise, and cough (105). Most adults and children infected with SARS-CoV-2 had mild flu-like symptoms. However, a few patients became critically ill and developed acute respiratory distress syndrome, respiratory failure, multiple organ failure, and even death (106).

### 3. The Covid-19 outbreak in Thailand.



**Figure 2 Distribution of COVID-19 cases in Thailand (source of data: Disease Control Department, Ministry of Public Health)**

For the first wave of the COVID-19 outbreak, the first officially announced infected case was a Chinese female tourist in Bangkok. Later, additional 15 infected Chinese individuals were discovered between January 12-31, taking 19 days to spread from one to fifteen cases. Cases from nearby provinces, Nakhonpathom and

Nonthaburi, were gradually discovered. The disease spread from one case in Bangkok to 100 cases in 9 provinces in 63 days by March 15, doubled to 200 cases in 23 provinces in 3 days by March 18, 400 cumulative infected cases by March 21, 800 cases by March 24, and 1600 cases by March 31. Most infected cases were found in tourist-famous provinces such as Bangkok, Chonburi (Pattaya beach and nearby), and Phuket. Figure 1 illustrates the number of confirmed cases in each province(107).

#### 4. Impact of covid-19 on oral health

There were more than 2.9 million cases and more than 205,000 deaths worldwide by April 26, 2020. The Centers for Disease Control and Prevention (CDC), the American Dental Association (ADA), the National Health Service (NHS), and other health regulatory bodies have advised dentists on how to regulate dental services and guided how to protect themselves, their coworkers, and their patients from this infection in response to this pandemic(17).

During the pandemic of COVID-19, most of the dental clinics have been closed(17). This situation causes society hard to find dental and oral health care services. A study demonstrated that 80.5 % of the participants believed there was a high risk of transmission of COVID-19 in a dental office. Based on the research information, SAR-CoV-2 could be found in the oral cavity since the ACE2 receptor, and TMPRSS2 have also been demonstrated in the epithelial cells of the oral mucosa and salivary glands(108). Oral lesions in people infected with COVID-19 have

been identified in several countries, even though rarely. Another study showed a similar result: dental treatments have high aerosol that would cause the transmission covid-19. However, the result also demonstrated decreased tooth brushing, flossing, and mouth-washing, whereas around 21.7% of the participants experienced oral health problems during the COVID-19 pandemic(109). The prevalence of untreated caries increased due to delayed treatment and other oral diseases problems such as dislodging filling, fracture teeth, oral lesions, gingivitis, periodontitis, and orofacial pain(110).

#### 6. Relationship between Knowledge, Attitudes, and Behaviors

The ambiguous relationship between knowledge and behavior is one of the grounds for integrating several construct assessment approaches(111). A recent study reveals that the association is far more complex, implying that the interaction is reciprocal and dynamic(112). From one point of view, what an individual does can influence his attitude about an issue and how he feels about it.

Alternatively, attitudes can be matched with behavior, implying that behaviors can inform attitudes (113) and attitudes influence attention(114). As a result, attitudes can influence what an individual perceives and, as a result, acquire knowledge.

Attitude is not always a strong predictor of behavior(115, 116). The association among these three dimensions, knowledge, attitude, and behavior, are dynamic and



sometimes reciprocal. It is thus advantageous and sensible to perform such a study because these three dimensions can and do interact.

However, still controversy; some studies demonstrate a strong correlation between knowledge and attitude toward behavior(117), and some other studies show no significant correlation among those groups(118).

### **7. Factors Affecting student Consumption Behavior**

Many factors affect student consumption, such as gender, peers, environment, knowledge, attitude, and delinquent behavior. Gender has a good contribution to health behavior. 40% of men are in unhealthy behavior, poor diet, no exercise, and substance use, compared to those only 22% of women(119). Parental drinking influenced men's health behavior, but peer drinking influenced women's health behavior(120). In addition, the study discovered gender disparities in the extent to which sociodemographic status and environments influence health behavior. Besides, income or economic level is highly correlated with oral health and disease(121). The level of education influences students' knowledge and probably affects the student's behavior. A study by Márquez et al., 2019 demonstrated the significant association between oral health knowledge and oral quality of life(122).

Eating behavior also has an association with culture(123). Another study found that the internationalization of education has significantly contributed to the changes experienced in the eating habits and cultural adaption of the indigenes. International

students tend to try new food in order to get familiar with the new environment(124). Food intake is a symbol of both collective and individual identities. It is firmly rooted in cultural rituals and processes. Food traditions and consumption have a similar effect on psychological well-being. The outcomes of this study reflect earlier research that views food consumption as a route for socializing and familiarization with international cuisine(125). Cuisine intake not only aids sociability but eating with international friends provides a sense of a new culture because food expresses distinct cultures(126).

The study of the evaluation of knowledge, attitude, and consumption behavior during the COVID-19 pandemic showed that behavioral habits positively affect oral health(127). Also, during the COVID-19 pandemic in Turkey, the study demonstrates an increase in impulsive eating and changes in behavioral patterns regarding nutritional intake or food choices(128). In comparison, the study in England shows an increase in sugar and snack consumption during the pandemic, specifically within the lockdown period(129). However, all the above studies have yet to be in the international student population.

## METHODOLOGY

### 1. Study Design

This research is a cross-sectional study, conducted through a survey.

### 2. Setting

The research was carried out in January – June 2023 in Chulalongkorn University.

### 3. Study Population

The study population of this research is the international student who study in Chulalongkorn University during the covid-19.

### 4. Sampling Method

The sampling method was conducted using non-probability sampling: Convenient sampling, recruit everyone who is convenient for the researcher and meets the criteria until sample size is reached or within a specified time.

The inclusion and exclusion criteria as follow:

Inclusion criteria.

1. International student of Chulalongkorn University
2. Above 18 years old
3. Staying in Thailand during the pandemic of covid-19 during the period of January 2020 until June 2022

Exclusion criteria

1. Being an international student in dental professional programs

#### 4. Sample size

This study used sample size for survey using Taro Yamane Formula(130).The following simple formula was used to estimate the number of total sample:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{826}{1 + 826 (0.05)^2}$$

$$n = 270$$

Where:

$n$  = Sample size

$N$  = Total population

$e$  = Standard error (5%)

From that formula the minimum sample size is 270 respondents. Then

10% compensation of the sample was added to anticipate missing or incomplete data. In total the minimum samples size is 297.

## 5. Research variable

### 1. Independent variable

The independent variables of this study are the knowledge, attitude of international students, gender, age, nationality, education level, monthly allowance, and insurance.

### 2. Dependent variable

Oral health care related behaviors during the pandemic of covid-19 of international students

## 6. Research instrument

The data collection was carried out using an online questionnaire via a google form. This is a self-administered questionnaire. The questionnaire was used as a research instrument, the validity and reliability of this newly developed questionnaire has been tested.

The questionnaire consisted of five parts. The first part contained the respondents' sociodemographic data, age, nationality, educational status, monthly allowance, and insurance.

The second part contained questions regarding knowledge of oral disease. This section aims to determine the extent of knowledge on oral disease, oral habits, and oral health care. Respondents answer 12 questions

with “yes”, “no” and “I don’t know”. Respondents were given a score of 1 if they answer correctly, 0 if they answer it wrong and I don’t know.

The third section included questions for measuring the attitudes about oral disease, oral habits, and oral health care. This component consisted of 13 statements with 5-point Likert scale “strongly agree”, “agree”, “neither agree or disagree”, “disagree” and “strongly disagree”, if the statement is the positive statement the given point was 1 for strongly disagree, 2 for disagree, 3 for neither agree or disagree, 4 for agree and 5 for strongly agree. Moreover, it was vice versa if the statement was in the negative statement.

The fourth section included questions about oral health related behavior. This section attempted to discover the consumption behavior, oral care, and dental attendance during the pandemic of covid-19. The respondents were given 11 statements with multiple choice to see the behavior during the pandemic and it combined with the question of the comparison during the pandemic with measure with “increased”, “decreased” and “no change”.

The fifth section included questions about the oral health problems experienced by international students during the pandemic of covid-19. There were multiple answers which may be suitable for their experiences.

## 7. Validity and reliability of research instrument

The researcher initially tested the validity and reliability of the questionnaire prior to conducting the survey. The validity and reliability tests were performed to assess whether the questionnaire was appropriate for use as a research instrument.

A validity test as conducted using content validity, the questionnaire was created in English and assessed by three experts(131).

The IOC points in calculations provided into three scales rating for consistency and congruencies of each item. All experts had to choose only one answer as the given mark from these three alternatives of choices: +1 = Congruent with clear understanding, 0 = Uncertain or not sure whether item related to the study, -1 = Not understand or not congruent or related to this study. Total points for each item must have a consistency value equal to or above 0.50. However, the IOC less than 0.5 was modified or discarded (132).

IOC mark was calculated using equation below:

$$IOC = \frac{\sum R}{N}$$

IOC = Item-Objective Congruence Index

R = Point given by specialists

$\sum R$  = Total points from each specialist

N = Numbers of specialist

**Table 1 Validity of Knowledge's Question**

Statement	IOC	Result
Acid production by bacteria from food debris causes tooth decay	1	Accepted
Frequently eat sweetening increase the probability to have tooth decay	0.33	Adjusted
Drinking Soft drink frequently can cause tooth sensitivity	0.67	Accepted
Do not have tooth ache indicates there is no tooth decay	1	Accepted
Tooth decay will not recur after tooth filling treatment	1	Accepted
Regular dental plaque removal prevents tooth decay	1	Accepted
Using fluoride toothpaste regularly prevents tooth decay	1	Accepted
Do not have tooth sensitivity indicate there is no tooth decay	0.67	Accepted
Fibers in fruits and vegetables scrape and buff the tooth surface help to remove plaque	0.33	Adjusted
Dental plaque deposition causes red and swollen gums	1	Accepted
Bleeding gum while brushing teeth indicates the gingivitis	1	Accepted
Regular dental plaque removal prevents gingivitis	1	Accepted
Regularly flossing can prevent gingivitis	1	Accepted

**Table 1** describes the result of content validity of three experts, from the result only two questions had the IOC below 0.5, furthermore the question already adjusted before finally used for the research instruments. Meanwhile for the validity of Attitude's Question in general past the validity content where all the IOC had result more than 0.5.(as shown I table 2.)



Table 2 Validity Result of Attitude's Questions

No	Statements	IOC	Result
1	Having dental caries is normal everyone has it	0.67	Accepted
2	No matter the kind of food I have, if I clean my teeth properly, I won't have tooth decay	1	Accepted
3	It's better to use fluoride toothpaste since it helps to prevent the tooth decay	1	Accepted
4	Everyone has gum bleeding	0.67	Accepted
5	People with bleeding gum usually have mouth odor	1	Accepted
6	Herbal toothpaste is good for strengthen the gum	1	Accepted
7	The early detected of oral problem can be easily solved with simple or uncomplicated treatment	1	Accepted
8	It does not matter for the brushing technic if you brush your teeth frequently	0.67	Accepted
9	Rinse with mouthwash can replace dental flossing.	1	Accepted
10	Flossing regularly is needed to clean the plaque	0.67	Accepted
11	Food debris and/or dental plaque can be removed by mouth rinsing	0.67	Accepted
12	High-fiber foods are beneficial for oral health	0.67	Accepted
13	High sugar consumption is not good for general health and/or oral health	1	Accepted
14	The coverage for dental treatment is expensive	0.67	Accepted

The reliability tests were carried out in 30 samples from outside the population who shared the same characteristics as the study sample. The number of samples utilized in the instrument trial was 30 samples(133). The Cronbach's Alpha coefficient was analyzed. The Cronbach's Alpha coefficient more than 0.7 indicated the good internal consistency of the instrument (131, 134).

**Table 3 Cronbach's Alpha of Reliability Test**

Content Reliability	Cronbach's Alpha
Knowledge's Questions	0.800
Attitude's Questions	0.722

**Table 3** describes the result of the reliability test; in conclusion the result showed the questionnaire had good consistency where the Cronbach alfa more than 0.7.

#### 8. Data collection

Primary data was collected online by google form-based questionnaire. The data was collected starting on 18<sup>th</sup> January 2023 until 14<sup>th</sup> March 2023.

#### 9. Steps of Research

1. Ethical consideration approval
2. Measurement tools validity and reliability test
3. Adjusting the questionnaire into google form.
4. Data collection
5. Data entry and management
6. Data analysis and report writing
7. Final research examination

## 10. Data analysis

The data from the questionnaires was analyzed using IBM SPSS software analysis. The first analysis uses Descriptive analysis of socio-demographic characteristics, Kolmogorov-Smirnov, and Levine's test to know the distribution and homogeneity of the data.

Then, descriptive analysis was employed to calculate responses to each question on knowledge, attitude and consumption, and oral hygiene behavior of international students. T-test and one-way ANOVA Test were used to evaluate the association between variables. The correlation between knowledge and attitude toward behavior was evaluated using the Pearson correlation coefficient. The changes in behavior before and after the pandemic of covid-19 was described as descriptive analysis.

Table 4 Description of Research Variable

No	Variable	Categories	Scale
1	Age	1; 18 – 30 years old 2; > 30 years old	Ordinal
2	Gender	1; Male 2; Female	Nominal
3	Education level	1; Undergraduate 2; Master 3; PhD 4; Postdoctoral	Ordinal
4	Monthly allowance	1; < 10,000 Baht 2; 10,000-12,500 Baht 3; 12,501-15,000 Baht 4; 15,001-17,500 Baht 5; 17,501-20,000 Baht	Ordinal
5	Field of study	1; Health Science 2; Non-Health Science	Nominal
6	Insurance	0; no 1; General Health 2; Dental and general Health	Nominal
7	International student's knowledge score about oral health	-	Interval
8	International student's attitude score about oral health	-	Interval
9	International student's oral health related behavior	-	Interval

## 11. Ethical consideration

Ethical approval for this cross-sectional study had been reviewed and granted by the ethics committee from the Faculty of Dentistry of Chulalongkorn University (Reference code HREC-DCU 2022-110). Written informed consent was obtained from all participants, and the participants were informed that they could withdraw from the research or unfinished the questionnaire at any time.

## 12. Limitation of Study

1. The pandemic of covid-19 is composed of several surging waves from starting until now, so there are different situation details regarding the disease and government regulations that may inconsistently affect the participant behaviors.
2. This study was conducted at Chulalongkorn University and only represent part of the population of international students in Thailand.
3. The bias that may occur in this study is recall bias. The participant probably does not clearly remember the answers about oral health-related behaviors before the pandemic.

## 13. Benefit of study

1. Research Benefit for Oral Health Practitioner

Given the current Covid-19 pandemic situation, many individuals are prioritizing their concerns related to the pandemic over their oral health.

However, this study's data can be utilized to develop effective promotive and preventive programs for international students.

2. Benefit for Researcher

The results of this study can serve as a useful point of reference for future research aimed at identifying the key factors that impact the oral health-related behavior of international students in the post-pandemic era.

3. Benefit for institution

The findings of this study can aid in establishing a fresh dental health promotion program or policy for international students.

4. Benefit for policy makers

The findings of this study could be considered while developing policies related to accessing dental healthcare services in the post-pandemic era. This may involve improving screening procedures before dental treatments at healthcare facilities and utilizing remote dental care services such as Tele-dentistry.

## Results

### 1. Demographic and characteristic of international students

The sociodemographic of the international students who participated in this research is described in figure 3 until figure 5.

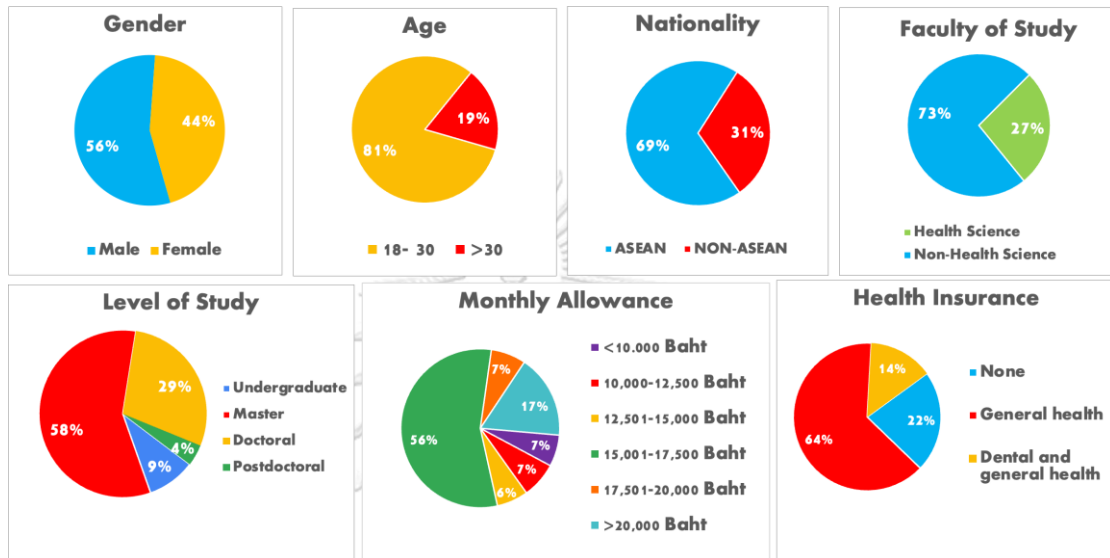
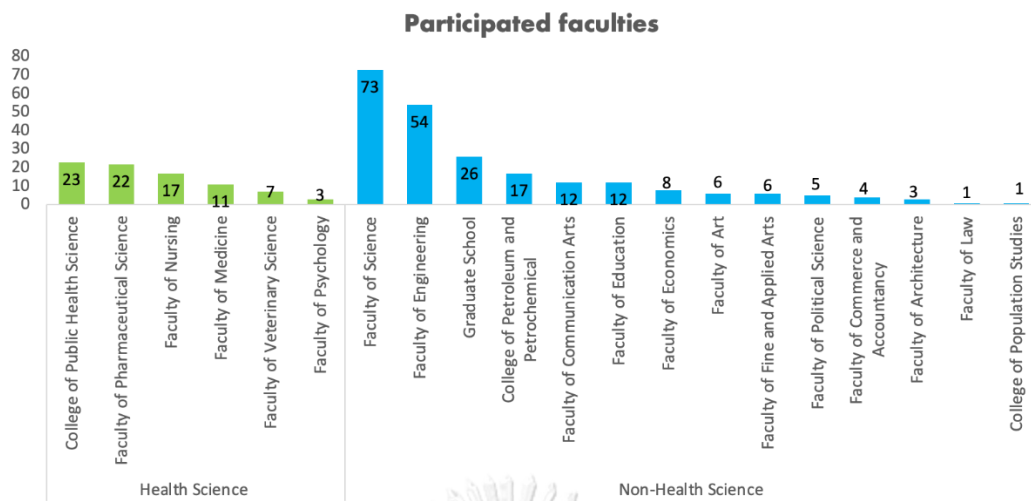


Figure 3 sociodemographic and characteristic of international students N=311

figure 3 showed the frequency and characteristic of international students who participated in this study, in total there are 345 international students who finished the questionnaire, however, after cleaning the data it was found that 34 students are not suitable according to the inclusion criteria and exclude from this study, where the total sample that used for analysis result is 311.



**Figure 4** distribution of participants' responses by nationality

The international students who participated is from 23 different countries, ASEAN, and Non-ASEAN countries, including Indonesia, China, Cambodia etc. (as shown in figure 4) from different faculties such as faculty of Science, Engineering, Graduate school etc. as shown in figure 5. 173 males (55,6%) filled the online questionnaire. The international students age was 18-29 (81,4%) where 180 (57,87%) in master's degree study. The students have the monthly allowance of 15,000 - 17,500 Baht for a month (55,6%). However, only 14.1% students who had both general health and dental insurances, while there were 22.2 students who even does not have health insurance during their study in Thailand.



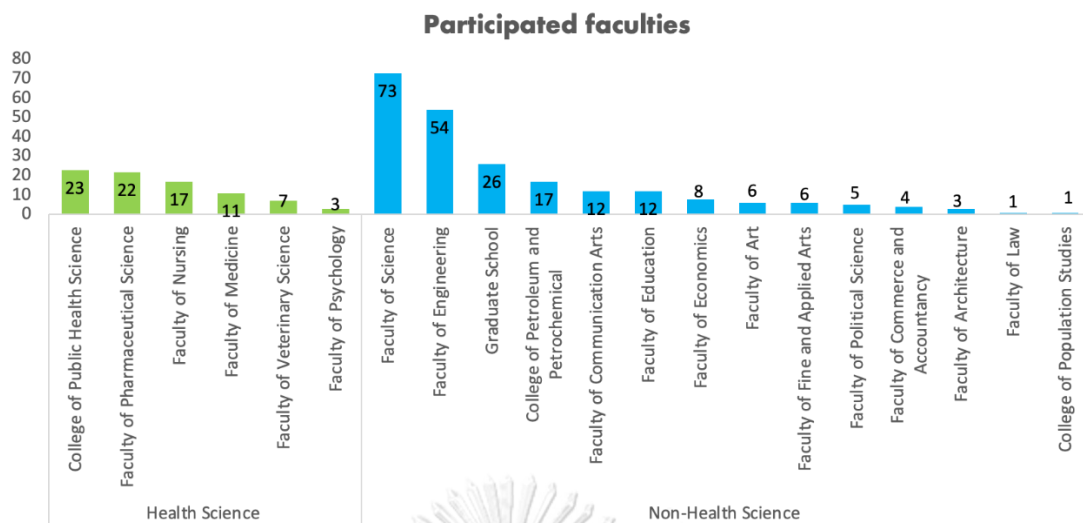


Figure 5 distribution of participants' responses by faculty of study

From 311 students who studied during the pandemic, 230 (74%) of them stayed at the period lockdown of covid-19 April 2021-October 2021 (the starting point of covid-19 infection start to increase in Thailand, where 81 (26%) stayed at unlock down period (figure 6).

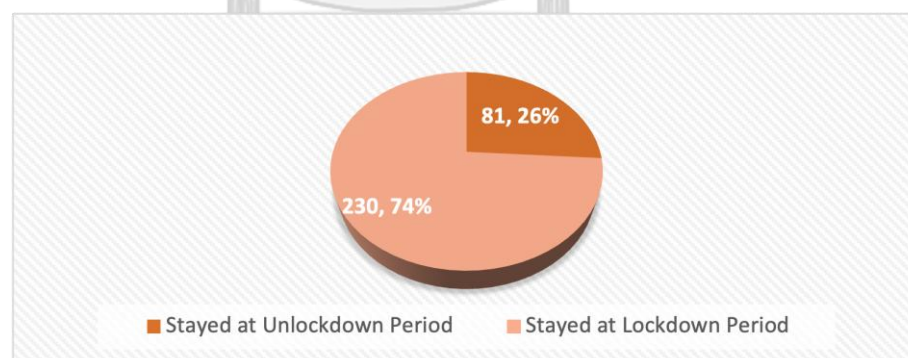
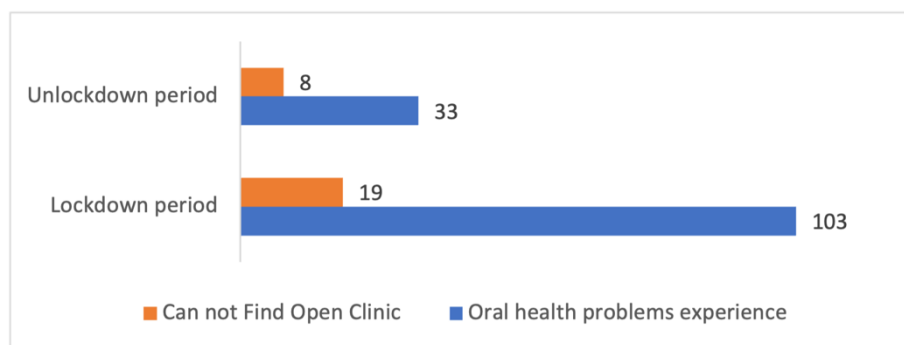


Figure 6 Total international student who stayed in lockdown or lockdown (April 2021-October 2021) and un-lockdown period of covid-19, N=311

Interestingly, 43% (103 of 230) of students in lockdown period experienced oral health problems whereas 18.5% experienced the case where they need to see

the dentist but cannot be able to find an open clinic. 41% (33 of 81) of international students in the unlocked down period also had oral health problems where 24% (8 of 33) were unable to find the dentist as shown in **figure 7**.

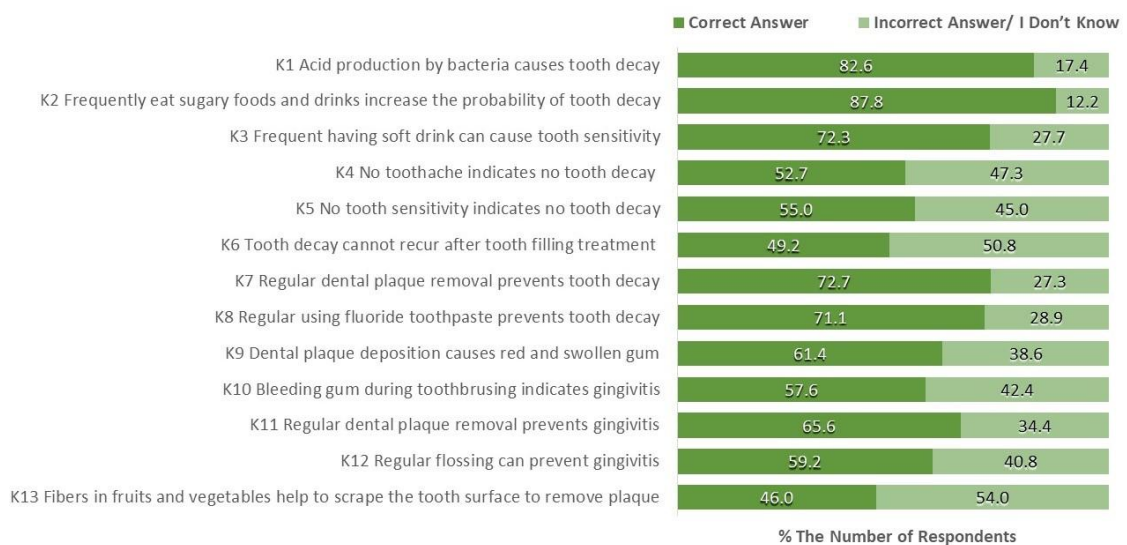


**Figure 7** The Distribution of Oral Health Experience by The Students During Lockdown and Un-lockdown Period and The Number of Students Who Unable to Find an Opened Clinic, N = 136.

In general, this data indicates that the proportion of students who had oral health problem have the similarity in the proportion throughout the study period (136/311=43.73%) compared to between the totally lockdown period (103/230=44.78%) and un-lockdown period 33/81=40.74%). In other words, the “difficulty in finding opened” clinic also quite similar or slightly increase in proportion 18.45% and 24.45% where the slightly increase after lockdown period probably because of the fear to visit the dentist (135) who made the students want to postponed the treatment and on the other hand the other reason it might be the delayed opened clinic due to the new regulation for the tools and equipment for dental procedures (136).

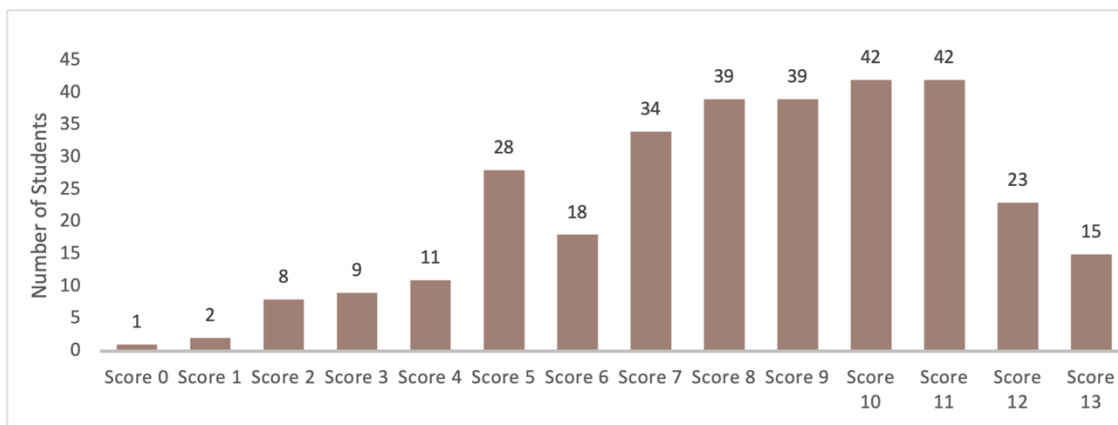
## 2. Knowledge about oral disease, food related to oral health and oral health prevention.

When looking at the sub-categories of knowledge (**figure 8**), most of the overseas students have good knowledge about the causes of dental caries (>80%; K1, K2, K3) and how to prevent dental caries (>70%; K7, K8).



**Figure 8** the percentage distribution of the answer of knowledge related to oral health of international students N = 311

However, around half of the students did not know about the symptoms of caries and the possibility of recurring dental caries after treatment (K4, K5, K6). For gingivitis, less than those of dental caries, only 60% of overseas students have the correct knowledge of the cause (K9), how to prevent (K11, K12, K13) gingivitis, and misunderstanding of gum bleeding as a physiologic phenomenon (K10).



**Figure 9** distribution of total scoring of right answer of knowledge for oral health by international student

When analyzing the total right answer for each question, from **figure 9** the data showed the knowledge of international students where majority of the population has a fair knowledge where 234 (75.24%) have the score above the average (6.5), however, only 5% (15) students who able to correctly answer all the question.

### 3. The result of attitude of oral health toward oral disease, food related and oral health prevention.

Regarding to the attitude, from **figure 10** we can see the tendency of attitudes of international students the darker the blue color indicate that the students are totally agree with the statement, however if the color tend to be light blue indicate that the respondents tend to be totally disagree with the content. However, we need to take note that the statement is divided into positive and negative statements.

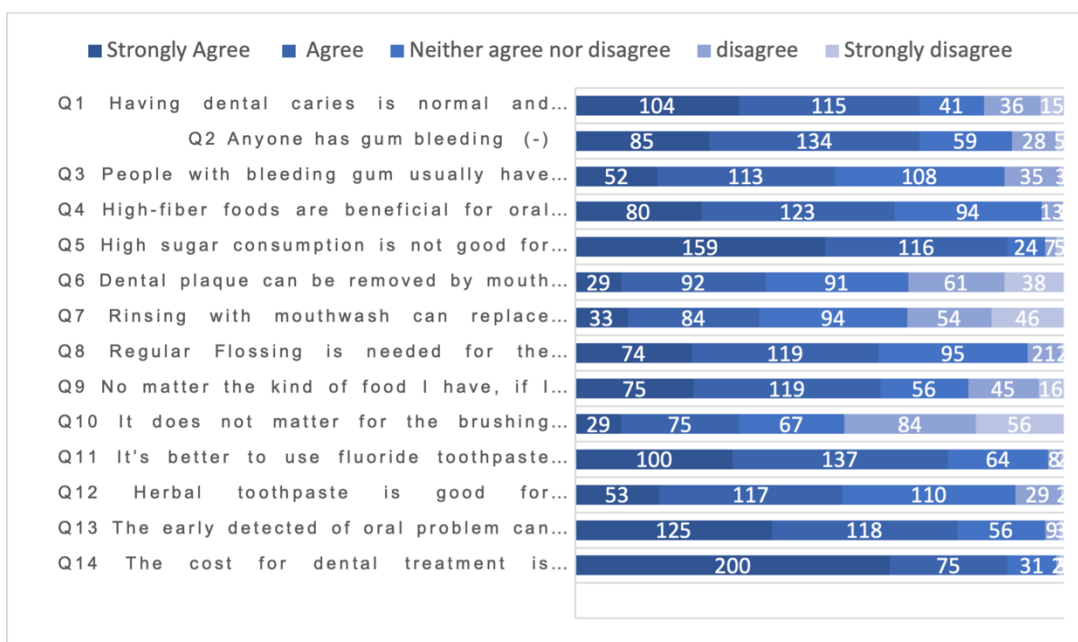


Figure 10 The comparison of answer distribution answer of attitude of international students related to oral disease, food related to oral health and oral health prevention.

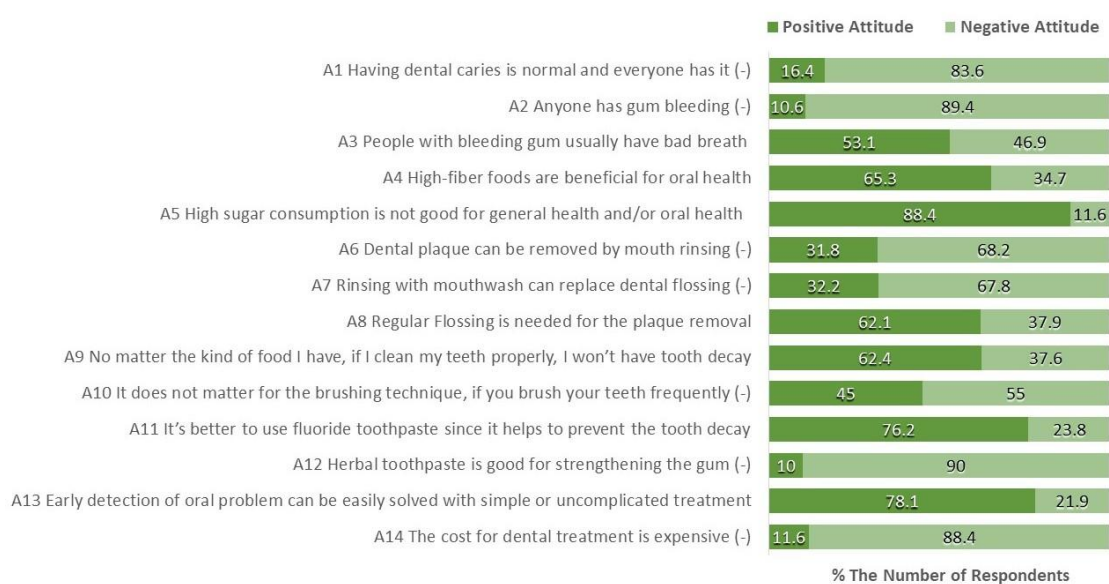


Figure 11 the percentage comparison of answer proportion of positive and negative attitude of international students (N=311).

The statements for measuring the attitudes were performed with a 5-point Likert scale. For analysis, the answers were grouped into positive and negative attitudes, as shown in **figure 11**. Around 90% of overseas students believed that dental caries and gum bleeding are regular

(A1, A2), while some thought gum bleeding relates to bad breath (53.1%; A3). Most students had the right attitude on sugary consumption related to oral health problems (88.4%; A5) better than the benefit of high-fiber foods on tooth self-cleansing (65.3%; A4). Around 70% of the students have exemplary attitudes toward oral health prevention, including regular plaque removal by flossing, tooth brushing with fluoride toothpaste, and regular dental visiting (A8, A9, A11, A13); however, more concern is needed on toothbrushing technique (45%; A10). Misunderstanding of the use of mouthwash on plaque removal (32%; A6, A7), including herbal toothpaste's role in strengthening the gum (10%; A12). Finally, the hesitance for a dental visit from the treatment cost (11.6%; A14).

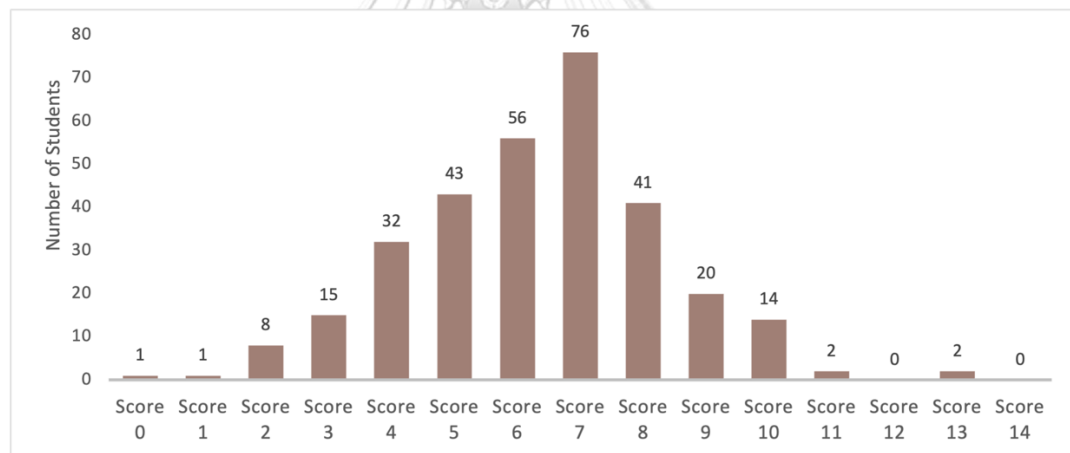


Figure 12 distribution of total scoring of attitude for oral health by international student

Figure 12 describes that in general the attitude of international students obtains the score below the mean score, score 7 and below (232 students) compared to above the mean (79 students). This figure suggested that the attitude of international students tends to be negative attitude.

#### 4. The behavior of international students related to oral disease, food related to oral health and oral health prevention.

**Table 5 the behavior of international students related to oral disease, food related to oral health and oral health prevention.**

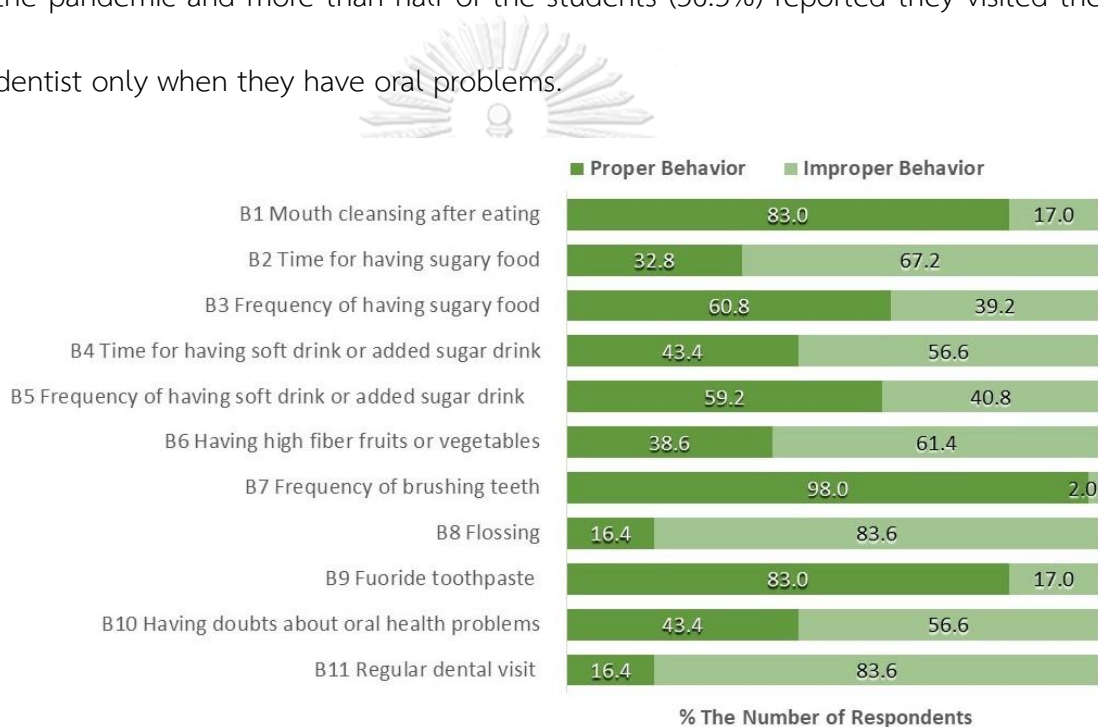
No	Question	Responses	N	(%)	Proper Behavior (1) N (%)	Improper Behavior (0) N (%)
Q1	What do you do with your mouth after finishing a meal during the Covid-19 pandemic?	Do nothing	53	17	258 (83%)	53 (17%)
		Drinking plain water	139	44.7		
		Rinsing the mouth	62	20		
		Tooth brushing	57	18.3		
Q2	When do you usually eat sugary or sweet foods such as desserts, cookies, cakes, snacks, chocolate bars, or other sugary foods during the Covid-19 pandemic? (Can select more than one choice)	Rarely or never	61	19.6	102 (32.8%)	209 (67.2%)
		Immediately after meals (breakfast, lunch, dinner)	41	13.2		
		Between Meals (between breakfast and lunch or between lunch and dinner)	166	53.4		
		Before going to bed (after dinner)	43	13.8		
Q3	How often do you have these kinds of sugary or sweet foods such as desserts, cookies, cakes, snacks, chocolate bars, or other sugary foods during the Covid-19 pandemic?	Rarely or never	44	14.2	189 (60.8%)	122 (39.2%)
		A few times/week	145	46.8		
		Once a day	81	26.1		
		More than once a day	41	12.9		
Q4	When do you usually have soft drinks or added sugary drinks such as iced coffee, and iced tea during the Covid-19 pandemic? (Can select more than one choice)	Rarely or never	89	28.6	135 (43.4%)	176 (56.6%)
		Immediately after meals (breakfast, lunch, dinner)	46	14.8		
		Between Meals (between breakfast and lunch or between lunch and dinner)	150	48.2		
		Before going to bed (after dinner)	26	8.4		
Q5	How often do you usually have soft drinks or added sugary drinks such as iced coffee, and iced tea during the Covid-19 pandemic?	Rarely or never	73	23.5	184 (59.2%)	127 (40.8%)
		A few times/week	111	35.7		
		Once a day	89	28.6		
		More than once a day	38	12.2		
Q6	How often do you have high-fiber fruits or vegetables such as apples, pears, and green vegetables, during the Covid-19 pandemic?	Rarely or never	23	7.1	120 (38.6%)	191 (61.4%)
		A few times/week	168	54.2		
		Once a day	73	23.5		
		More than once a day	47	15.2		
Q7	How often do you brush your teeth during the	None	7	1.9	304 (98%)	7 (2%)

No	Question	Responses	N	(%)	Proper Behavior (1) N (%)	Improper Behavior (0) N (%)
	Covid-19 pandemic?					
		Once a day	41	13.2		
		Twice a day	190	61.3		
		3 times a day	56	18.1		
		More than 3 times a day	17	5.5		
Q8	How often do you floss your teeth per week during the Covid-19 pandemic?	None	142	45.6	51 (16.4)	260 (83.6%)
		1-2 days/week	85	27.4		
		3-4 days/week	33	10.6		
		5-6 days/week	13	4.2		
		Everyday	38	12.2		
Q9	What type of toothpaste do you regularly use during the Covid-19 pandemic?	Never use toothpaste	10	3	257 (83)	54 (17%)
		Non-Herbal Fluoride Toothpaste	130	42		
		Herbal Non-Fluoride Toothpaste	44	14		
		Herbal and Fluoride Toothpaste	127	41		
Q10	During the Covid-19 pandemic if you have or doubt that you may have an oral problem, what would you like to do?	Make the appointment right away	95	30.5	135 (43.4%)	176 (57.6%)
		Check for the coverage by the insurance	40	12.8		
		No need to do if it has no symptom	121	39		
		Wait until you cannot stand for	55	17.7		
Q11	How often do you regularly visit the dentist? (Not in the pandemic period)	Never	42	13.5	51 (16.4%)	260 (83.6%)
		Whenever have a problem	175	56.3		
		Less frequent than every 6 months	43	13.8		
		Every 6 month	51	16.4		

**Table 4** and **figure 13** describe the distribution of the behavior of international students during the pandemic period of covid-19. 258 international students (83%) have good behavior about oral care after eating. More than half (around 50% in average) of them have the behavior to eat sugary food and added sugary drink or soft drink at least once a day between meal or before going to bed. 191 students (61.4%) have the negative behavior about eating high-fiber fruits where in general the students eat a few times a week or never. 61.3% (190) brush their



teeth twice a day. Only 2% of the students indicated they did not brush their teeth. Unfortunately, the data showed around 43% of students never do flossing, and 17.4% did not use fluoride toothpaste. In spite, from 311 of the students 18% of them chose to endure their oral health problem until they could not be able to stand for. 13.5% of the students indicated they never visited the dentist even before the pandemic and more than half of the students (56.3%) reported they visited the dentist only when they have oral problems.



**Figure 13 the percentage comparison proportion between proper and unpropped behavior of international students**

In conclusion, from this graph (**figure 13**) the data showed that the proportion of behavior both international students' behavior was improper at flossing, and regular dental visit, followed by the timing for eating sugary food and drinking added sugar or soft drink. In general, the student has proper oral care behavior after meals and frequency of brushing their teeth.

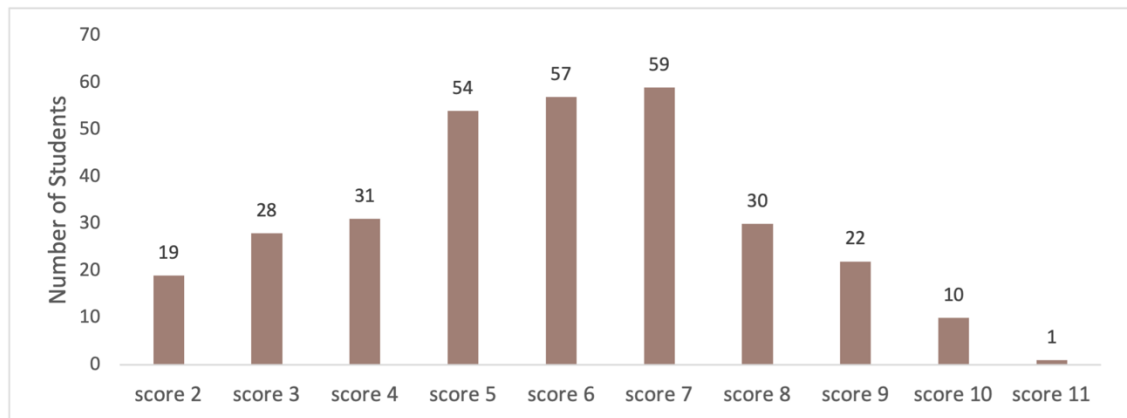


Figure 14 distribution of total scoring for behavior of oral health by international student

The **figure 14** shows that the average  $5.9 \pm 2.04$  of behavior of international students about oral health was in score 5 to 7 (54.6%). However, 25% of the students still have a lower score (2-4 score).

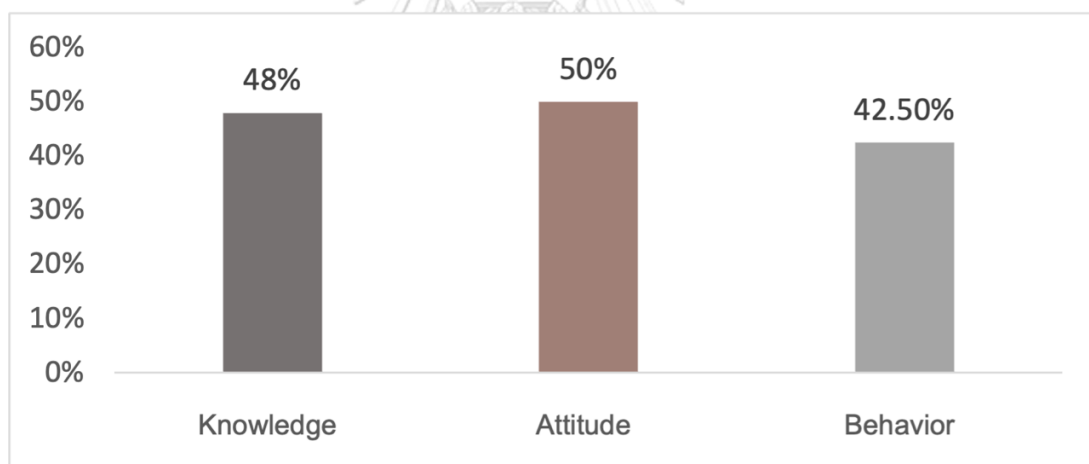


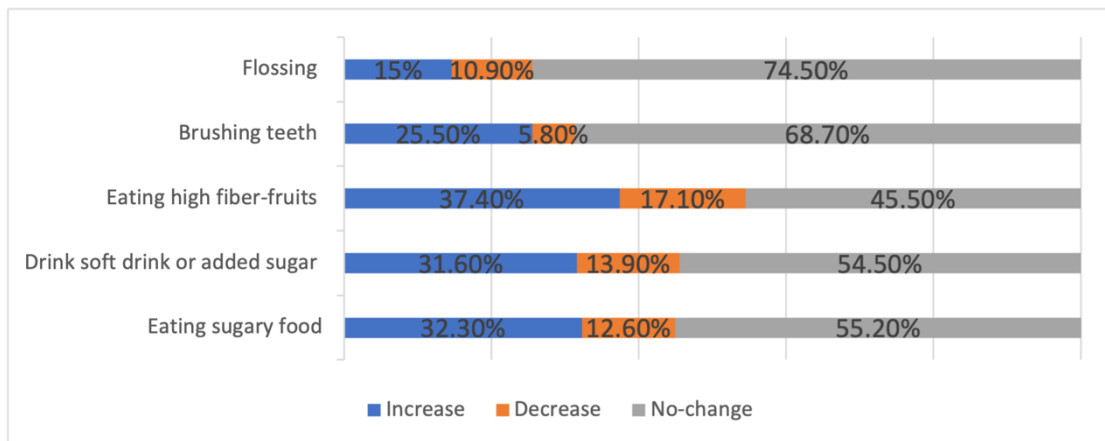
Figure 15 proportion of overseas students who had scored of knowledge, attitude, and behavior below the average.

**Figure 15** showed that almost half of the overseas students had scored knowledge (48%), attitude (50%), and behavior (42.5%) below the average. The average scores of the knowledge, attitude, and behavior of overseas students are  $8.33 \pm 2.84$  from 13 (64.1%),  $6.33 \pm 2.01$  from 14 (45.2%), and  $5.85 \pm 2.04$  from 11 (53.2%), respectively. When looking

further at the proportion of the respondents with incorrect answers, negative attitudes, and improper behaviors, the results demonstrate that 48%, 50%, and 42.5% had knowledge, attitude, and behavior scores below the averages, respectively.

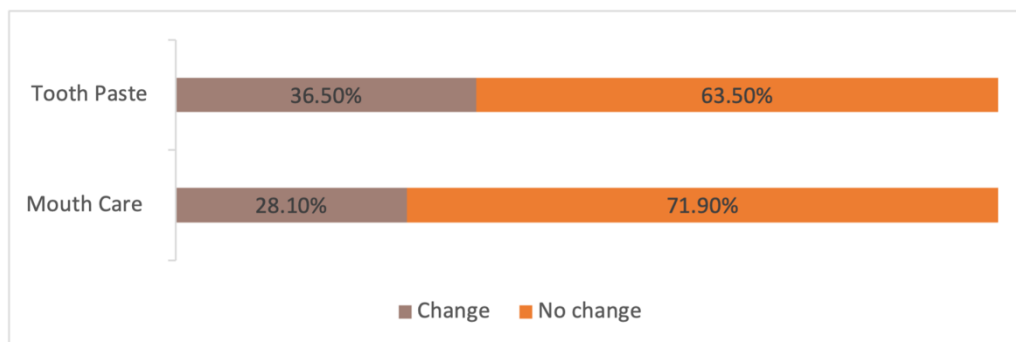
#### 5. Comparison behavior before and during pandemic and consideration about adoption of behavior

Compared to before pandemic in general, students' behaviors remain the same even if there are some changes in them (**figure 16**). During the pandemic, the behavior of eating high-fiber fruit increased by 37%, 17% decrease (59 students), while the rest remained unchanged. 26 out of 59 international students who decreased their high-fiber fruit consumption want to adopt their behavior, while the rest (33) want to change their habits. 25% of the students increased the frequency of brushing their teeth, 68% unchanged, and decreased around 5.8%. However, the frequency of increased flossing went up by 15%, while the frequency of reduced flossing increased by 10.9% (34 students), while most of the population remained the same. 26 out of 34 who decreased their flossing behavior likely was not wanting to change their behavior.



**Figure 16 Comparison of international students' behavior before and during the pandemic**

For sugary food, 32.30% (100 students) of international students increase their sugar intake, while 55% of them remain unchanged and only 13% decline. Of 100 students who increased the number of sweets, 69 of them would like to continue this habit while 31 would like to change it. Regarding sugary drinks, 31.6% of the students (98 students) increased the consumption of sugary drinks during the pandemic. 13.9% of students decreased their consumption of sugary drinks while most of them (54.5%) did not change their consumption habits. Of 98 students who increased the frequency of sugary drinks, 62 of them would like to continue this habit and 36 of them would like to change that behavior. In general, we can conclude that the behavior of international students before and during the pandemic remains the same even if there are some changes but only in small population compared to the population who remain un-changed.



**Figure 17** the change of mouth care and type of toothpaste of international students

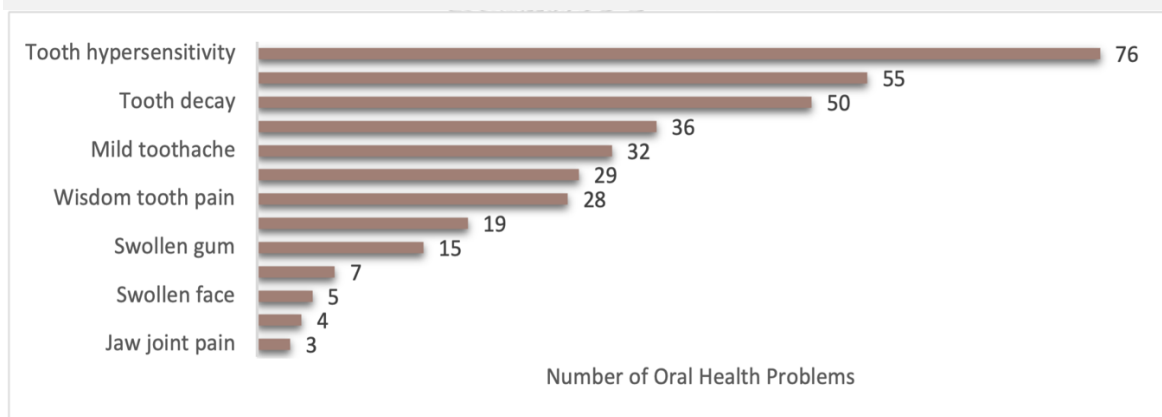
Meanwhile, **figure 17** shows that during the pandemic, 28.10 % of international students changed the way they treat their mouth after finishing their meal, 71.9% of them then to remain no change. In the other hand, 36.5% of the international students also changed the type of the toothpaste, while 36.5% still used the same type of the toothpaste. However, this trend is positive because 83% of international students (table 5, Q1 and Q9) had proper behavior.

## 6. Oral Health Problems Experienced by International Students

From the **table 6** the data show that around 174 (60%) international students worried about the infection of covid-19 during the dental procedure, it's possible even if they have oral health problem and even after lockdown the students still afraid and hesitate to go to visit dentist (137).

**Table 6** the distribution answer of international students regarding the covid-19 infection and oral health problems experiences

No	Questions	Responses	N	Percentage (%)
1	Did you worry about the risk of corona virus infection during dental procedures?	Yes	174	60
		No	91	29.2
		Not Sure	46	14.8
2	Did you experience any oral health problems during the Covid-19 pandemic?	Yes	136	43.8
		No	175	56.2
3	Was it difficult to find an open clinic during the Covid- 19 pandemic?	Yes	27	19.9
		No	109	80.1



**Figure 18** Oral Health Problems Experiences by International Students during the pandemic of Covid-19, N = 136, Total Cases =359

In addition, **figure 18** showed in total there are 359 cases for oral health disease that were experienced by 136 international students. 76 students had tooth sensitivity, 55 of them had the bleeding gum, 50 of them experienced tooth decay, 36 experienced the cracked or jaw joint pain, 32 and 29 of them had mild toothache and filling fell out, 28 case had a problem with their wisdom tooth, 15 students had swollen gum etc. From this result, one student at least experiences more than one oral health disease during their study.

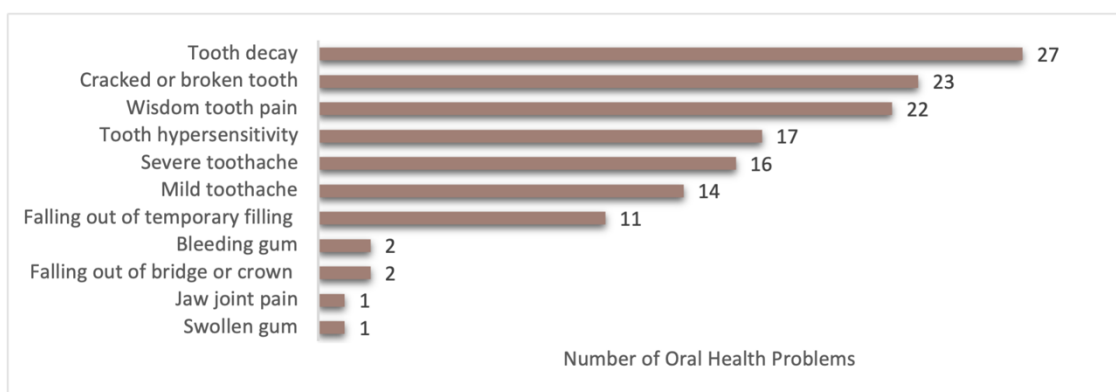


Figure 19. The Worst Oral Health problems Experienced Chosen by International students during the Covid-19 (N=136)



Figure 20. oral health solution chosen by international students N = 136

The worst oral health experience that the international students experience was shown in **figure 19**. Three of the worst oral health problems chosen by the international students are tooth decay (27), cracked or broken teeth (23) and wisdom tooth pain (22).

A multiple-answer question was used to explore how they solved their problems. Of those students who had oral health problems, 55% (75) of them went to visit the dentist, 27 could not be able to find an open clinic and 8 of them did nothing because it did not disturb their daily life. Moreover, 30% of international students do online searching for and consulted their friend or relative for the relieving methods. Only 5.8% (8) did the online

consultation to the dentist. 50.7% of them (69 students) took the medicine, whereas 15.4% (21 students) endured the pain until it relieved by themselves (described in figure 20).

## 7. The Association of Sociodemographic of international students toward Knowledge, Attitude, and Behavior

Table 7 Association of Demographic characteristic with M + SD of Knowledge, Attitude and Behavior

Sociodemographic Characteristics	Total (N=311)		Knowledge Score (13 questions)		p-value	Attitude Score (14 statements)		p-value	Behavior Score (11 questions)		p-value
	N	%	Mean	SD		Mean	SD		Mean	SD	
<b>Gender</b>					0.927			0.987			0.517
Male	173	55.6	8.32	2.86		6.33	2.05		5.92	2.09	
Female	138	44.4	8.35	2.82		6.33	1.96		5.77	1.97	
<b>Country</b>					0.269			0.298			0.327
ASEAN	214	68.8	8.22	3.07		6.41	2.08		5.78	2.0	
NON-ASEAN	97	31.2	8.57	2.23		6.15	1.82		6.02	2.1	
<b>Level of Study</b>					0.146			0.204			0.020*
Undergraduate	29	9.3	7.45	3.40		5.73	2.13		6.97	1.86	
Master	180	57.9	8.25	2.81		6.28	2.02		5.70	1.96	
Doctoral	89	28.6	8.65	2.71		6.58	1.91		5.79	2.18	
Postdoctoral	13	4.2	9.23	2.42		6.69	1.97		5.92	1.80	
<b>Field of Study</b>					<0.001*			0.004**			0.604
Health Program	83	26.7	9.55	2.67		6.88	2.18		5.95	2.06	
non-Health Program	228	73.3	7.89	2.77		6.13	1.91		5.82	2.03	
<b>Monthly Allowance (Baht)</b>					0.516			0.448			0.193
<10,000	20	6.4	8.70	3.24		6.05	2.43		6.25	1.55	
10,000-12,500	23	7.4	7.83	3.15		6.30	1.86		6.04	1.36	
12,501-15,000	20	6.4	7.55	2.37		6.05	1.82		6.25	1.58	
15,001-17,500	173	55.6	8.31	2.81		6.23	2.06		5.59	2.00	
17,501-20,000	22	7.1	9.09	2.04		6.41	1.59		5.86	2.83	
>20,000	53	17.1	8.45	3.07		6.85	1.94		6.32	2.26	
<b>Health Insurance</b>					0.262			0.082			<0.014*
None	69	22.2	8.01	3.25		5.96	2.27		5.48	2.09	
General Health	198	63.7	8.31	2.75		6.35	1.90		5.81	2.06	
General & Oral Health	44	14.1	8.91	2.50		6.82	1.96		6.61	1.64	

\*\* . significant at the 0.01 level (2-tailed). \* . is significant at the 0.05 level (2-tailed). The test was performed by T-test and ANOVA Test.



**Table 7** shows the association of knowledge ( $p < 0.001$ ) and attitude ( $p = 0.018$ ) with the field of study and, while the behavior is associated with the level of education ( $p = 0.02$ ) and insurance coverage ( $p < 0.014$ ). Data was further split by the field of study. After analysis, the result demonstrated an association between knowledge and the countries only within the non-health science programs ( $p = 0.013$ ). Meanwhile, it also showed associations of attitude and behavior with insurance coverage in the health science program students ( $p = 0.43$  and  $p = 0.32$ , respectively). While the rest of the sociodemographic remains non-statistically significant associations. Next, after getting the statistically significant from the data we further investigate the resulted split by the gender as shown in **table 8**.

**Table 8** The association of faculty of study toward knowledge and attitude split by gender.

Gender		Faculty	N	Mean	SD	P value
Male	knowledge	Health science	36	9.69	2.796	<0.001**
		Non-health Science	137	7.96	2.784	
Female	knowledge	Health Science	47	9.45	2.603	<0.001**
		Non-Health Science	91	7.78	2.772	
Male	attitude	Health Science	36	6.92	2.601	0.054
		Non-health Science	137	6.18	1.866	
Female	attitude	Health Science	47	6.85	1.829	0.025
		Non-Health Science	91	6.07	1.982	

\*\* . Correlation is significant at the 0.01 level (2-tailed). Test was performed using T-test.

Among the same gender, the result showed the statistically significant different mean knowledge score and mean attitude score between different study program (health science and non-health science) ( $p$  value  $< 0.001$ ). However, the attitude showed different result, male students of health science and non-health science showed no statistical

different attitude scores while the female showed statistically significant different attitude mean scores ( $p=0.025$ ). For the education level and insurance (**table 9**), the result showed non-significant different behavior scores in both male and female. ( $p=0.380$  and  $p=0.054$  and  $p=0.116$  and  $p=0.069$ ).

**Table 9** The Association of behavior toward education level and insurance split by gender

Gender	Education level	N	Mean	SD	P value
Male	undergraduate	14	6.86	1.916	0.380
	Master	102	5.81	1.964	
	Doctoral	49	5.88	2.421	
	Postdoctoral	8	5.88	1.727	
Female	undergraduate	15	7.07	1.870	0.054
	Master	78	5.55	1.972	
	Doctoral	40	5.68	1.886	
	Postdoctoral	5	6.00	2.121	
<b>Insurance</b>					
Male	No insurance	40	5.70	1.856	0.116
	General insurance	111	5.83	2.190	
	Both dental and general	22	6.77	1.850	
Female	No insurance	29	5.17	2.391	0.069
	General insurance	87	5.79	1.899	
	Both dental and general	22	6.45	1.438	

The test was performed using ANOVA Test.

## 8. Correlation between knowledge, attitude, and behavior of international students

**Table 10 Correlation between knowledge, attitude, and behavior of international students**

Variable	p-value	Coefficient correlation (r)	Interpretation
Knowledge-behavior	<0.001	0.198**	Very low positive correlation
Attitude-behavior	<0.001	0.212**	Very low positive correlation

\*\* Correlation is significant at the 0.01 level (2-tailed). Correlation performed using Pearson Correlation.

Table 10 shows the correlation of variables using Pearson correlation (r) between the knowledge score and the behavior score is 0.198. where the Pearson correlation for attitude score and the behavior score is 0.153. All the p-values show the significant relationship between variables. Overall, the range of Pearson correlations among the variables is 0.1 to 0.3 which means the correlation between variables is very low in positive correlation.

## 9. Correlation between questions regarding the cause, symptom, and oral health prevention.

**Table 11 Correlation between knowledge, attitude, and behavior for each category**

Categories	Variable	Correlation Coefficient	p-value	Interpretation
Cause of disease	K-A	0.062	0.273	No correlation
	K-B	0.038	0.499	No correlation
	A-B	0.076	0.183	No correlation
Plaque deposit	K-A	0.147**	0.009	Very low positive correlation
	K-B	0.075	0.189	No correlation
	A-B	0.216**	<0.001	Very low positive correlation
Symptom of disease	K-A	0.132*	0.019	Very low positive correlation
	K-B	0.130*	0.022	Very low positive correlation
	A-B	0.056	0.328	No correlation
Prevention of disease				
Fluoride	K-A	0.226**	<0.001	Very low association

Categories	Variable	Correlation Coefficient	p-value	Interpretation
	K-B	0.022	0.926	No association
	A-B	0.163	0.007	No association
	K-A	0.152**	0.009	Very low association
Flossing	K-B	0.170**	0.004	Very low association
	A-B	0.108	0.069	No association
	K-A	0.212**	<0.001	Very low association
High-fiber fruits	K-B	0.106	0.067	No association
	A-B	0.293	0.064	No association
	K-A	0.212**	<0.001	Very low association
Tooth brushing	A-B	0.068	0.487	No association

\*\* significant at the 0.01 level (2-tailed). \* is significant at the 0.05 level (2-tailed). K = knowledge, A = attitude, B = behavior, Correlation was performed using Pearson correlation and Association using chi-square.

**Table 11** describes the correlation between knowledge score, attitude score and knowledge score. For each category related to the cause of oral disease, sugary intake showed no correlation. For disease caused by plaque, the correlation for knowledge to attitude (K-A) and attitude to behavior (A-B) were statistically significant compared to knowledge to behavior (K-B) ( $r=0.1\pm 0.3$ ). The correlation between the K-A and K-B also showed very low positive correlation ( $r=0.1\pm 0.3$ ) where there is no correlation between attitude about oral health symptom to the behavior. Regarding the prevention, including fluoride, flossing, high-fiber food, and tooth brushing, the association shows no association except for the association between K-A for fluoride, high fiber fruits. also, the K-A, for flossing that showed no correlation.

Table 12 the comparison of the correlation of knowledge, attitude, and behavior divided by faculty of study.

Categories	Variable	Health Science		Interpretation	Non-Health Science		Interpretation
		p-value	Correlation Coefficient		p-value	Correlation Coefficient	
Cause of disease							
Sugary intake	K-A	0.761	0.034	No correlation	0.295	0.070	No correlation
	A-B	0.332	0.108	No correlation	0.492	-0.046	No correlation
	K-B	<0.001**	0.357	low positive correlation	0.328	0.065	No correlation
Plaque deposit	K-A	0.099	0.183	No correlation	0.100	0.109	No correlation
	A-B	0.023*	0.250	Very low positive correlation	0.002**	0.204	Very low positive correlation
	K-B	<0.001**	0.418	low positive correlation	0.462	0.049	No correlation
Symptom	K-A	0.006**	0.297	Very low positive correlation	0.860	0.012	No correlation
	K-B	0.110	0.177	No correlation	0.638	0.031	No correlation
	A-B	0.077	0.195	No correlation	0.274	0.073	No correlation
Prevention							
Fluoride	K-A	0.067	0.255	No association	0.010	0.201	No association
	K-B	0.197	0.198	No association	0.471	0.081	No association
	A-B	0.051	0.239	No association	0.051	0.132	No association
Flossing	K-A	0.096	0.196	No association	0.078	0.124	No association
	K-B	0.323	0.133	No association	0.008**	0.183	Very low association
	A-B	0.004**	0.329	low positive association	0.762	0.026	No association
High-fiber fruits	K-A	0.168	0.162	No association	<0.001	0.230	Very low association
	K-B	0.096	0.199	No association	0.319	0.073	No association
	A-B	0.025*	0.257	Very low positive association	0.009**	0.182	Very low association
Tooth brushing	A-B	0.652	0.101	No association	0.499	0.078	No association

\*\* . significant at the 0.01 level (2-tailed). \* . is significant at the 0.05 level (2-tailed). Correlation using Pearson correlation and Association using chi-square.

Table 12 shows the comparison of the international students by their study program (the health science and non-science). For diseases caused by sugary foods, the data shows correlation between knowledge score and behavior score for health science students while the

non-health science shows no correlation. For the plaque deposit, both health science and non-health science students showed the correlation between the attitude score to the behavior score in very low positive correlation. However, for the symptom of disease, there is only a correlation between the knowledge score to the behavior score of health science students where the others are no correlation. For the prevention of disease, the data showed no association for both group except for the attitude toward behavior of high fiber fruits for both group ( $r= 0.257$  and  $r=0.182$ ) and flossing for health science students in low association as well ( $r=0.329$ ).

#### 10. Insurance, behavior, and the oral health problem by international students

**Table 13** illustrates the association of the insurance and how it affects the decision making of the students to visit the dentist. Out of 69 students who do not have insurance, only 6 decided to visit a dentist compared to 32 from 198 students who only have general insurance and 13 from 44 students who had both insurances. However, the result showed significant differences between the three groups, where the p value showed significant differences among this group with p value=0.014.

**Table 13 Association of Insurance and Dental Visit**

		Dental visit behavior		Total	P value (chi-square)
		Others	Visit dentist		
Insurance	No	63	6	69	0.014
	General	166	32	198	
	General and Dental	31	13	44	

From **table 14**, the data showed statistically significant differences, where the mean of international students who had the oral health problems is lower compared to them who is not (p-value <0.001).

**Table 14 Association between Behavior score toward oral health problems**

Oral Health Problems	N	Behavior's Mean	SD	P-Value (T-test)
No	175	6.24	1.745	<0.001**
Yes	136	5.35	2.276	

\*\* Significant at the 0.01 level (2-tailed).

**Table 15 Correlation between behavior score toward total number of oral health problems.**

		Total case	behavior
Total case	Pearson Correlation	1	-.204**
	Sig. (2-tailed)		<.001

\*\* Correlation is significant at the 0.01 level (2-tailed).

There is a negative correlation ( $p < 0,001$   $r = -0,204$ ) between the behavior scores and the total number of the oral health problems (**Table 15**). This indicated the international students who had low oral health behavior had high case of oral health problems compared to students who had high oral health behavior score.

## Discussion

The present study demonstrated that oral healthcare behaviors score of overseas university students have a positive correlation with their knowledge score and attitude score, even if the correlations are low. The COVID-19 pandemic seems not to enhance appropriate behaviors in a regular manner. Dental caries and gingivitis were the first major oral health problems experienced by overseas students, like those in normal situations worldwide. As predictable, there was a negative correlation between the behavior score and the number of oral health problems. Interestingly, the spectrum of insurance coverage contributes to the decision to appoint a dental visit.

In the current study, students' attitude score about sugary intake positively related to the number of oral health problems where over 50% of the students indulge in sugar-laden food and beverages more frequently and at inappropriate times.

It is widely accepted that what we eat significantly impacts our health. Unhealthy eating habits significantly contribute to the disease burden (138). One of the main culprits is excessive sugar intake which has been linked to various non-communicable diseases, including oral health issues(139, 140).

Recent research reveals that university students have been consuming more sugary foods and drinks since the start of the pandemic, a trend that is observed worldwide(21, 141). The students studied online from home, so they could easily



access sugary treats while attending classes. As a result, their intake of sweets and sugary drinks could increase, and they might even consume these items during study time. Additionally, previous research has shown that students experienced increasing stress during the COVID-19 lockdown due to heavy workloads and long hours spent in front of their computers(142, 143, 144). This stress may also contribute to unhealthy eating habits, such as snacking on sweets and consuming sugary drinks while studying late at night.

When living abroad and away from their families, overseas students can choose the type of food they like without parental supervision. A systematic review indicates that people living alone have a lower diversity of food intake, insufficient essential core nutrition, especially protein, vegetables, and fruits, and a higher likelihood of unhealthy dietary patterns(145). These behaviors occur even without pandemic.

The university's environment and regulations may hinder efforts to reduce sugar intake on campus, with factors such as limited time for food availability and strict policies on sugar. For creating a healthy environment, the university should take steps to address the issue of high sugar consumption and create a healthier campus canteen. These findings could bring about future interventions to promote healthier habits among university students.

Dental plaque accumulation is a significant risk factor for the development of dental caries and periodontal disease(146). The effective removal of dental plaque is

essential for maintaining periodontal health and dental caries prevention. The ADA guideline recommends crucial effective self-care by mechanical control, brushing twice daily with fluoride toothpaste, and flossing once a day. Meanwhile, chemical control is an adjunct measure that may facilitate the removal and prevent the accumulation of microbial plaque.

Even though, in normal circumstances, most individuals brush their teeth at least twice a day as recommended, the prevalence of gingivitis remains high in most populations worldwide. Our result demonstrates an increase in frequency of daily toothbrushing during the COVID-19 pandemic, consistent with several studies(147). This might be the awareness of oral health, including limited dental clinic access, fear of viral contagiousness by the dental procedure, and hesitation to go out during the lockdown.

Also, more than half of the respondents believed the brushing technique was unimportant if they brushed their teeth more frequently. Wrong brushing techniques are considered harmful because vigorous scrubbing can lead to gingival recession, and abrasives in toothpaste can cause tooth abrasions(148, 149), which leads to tooth hypersensitivity(150). Modified Bass' method is the recommended tooth brushing technique(9, 151).

Regarding attitude, most students believe using herbal toothpaste strengthens the gum, although 83% of the students used fluoride toothpaste. The meta-analyses

reveal that fluoride toothpaste is more efficient in reducing dental plaque than herbal, non-herbal, and non-fluoride toothpaste, which appear equally effective(9). One of the potential shared mechanisms of action of herbal toothpaste is that their active ingredients can penetrate biofilm and prevent plaque accumulation, and preventing bacterial colonization on the tooth surfaces(152). Herbal extracts have increased attraction because they are natural, not chemical, giving a sense of safety, though a plurality of effects in herbal extracts makes their action non-specific. Moreover, there were periodic reports of allergy or hypersensitivity reactions(153, 154, 155).

As previously stated, mouth rinse is an adjunct for dental plaque control. A meta-analysis found that chlorhexidine was superior to essential oil mouth rinses regarding plaque reduction, despite the adverse effect in long-term use. At the same time, there were no significant differences in reducing gingivitis. Hence, there were low recommendations for using herbal preparations to substitute conventional oral hygiene products(156).

A recent meta-analysis showed that flossing, in addition to toothbrushing, reduced gingivitis compared to toothbrushing alone. However, there was not enough evidence to support the effectiveness of flossing in preventing dental caries(157). The study by Broadbent JM. and colleagues demonstrated that 49% of adolescents

thought flossing was unimportant, whereas almost 83% routinely brushed(158). Our result showed a similar direction, with only 16% of the ones who do flossing.

The overseas student had no significant difference in knowledge, attitude, and behavior score in the present study. However, compared to non-health science programs, overseas students who studied in health science programs had higher knowledge scores and more positive attitudes, like previous studies(159, 160, 161). It is worth noting that having a background in health science provides a better understanding of general health, including oral health. However, it is disappointing that there is not a significant difference in behavior between these two groups. The behavior score was, instead, associated with the level of education and insurance coverage. Our research revealed a slight but positive correlation between knowledge/attitude score and behavior score. However, the outcomes of similar studies varied depending on factors such as sample size, region, duration, and when the research was performed. Theoretically, possessing knowledge or attitude should lead to appropriate behavior(162, 163). Several studies suggested that knowledge must be given as early as possible to promote the development and retention of positive attitudes and good behavior(164, 165, 166), which need several steps and take time(167, 168); however, various factors can influence the outcome. People's oral health attitudes are not necessarily fixed. One study reported that a substantial proportion of the population will likely change their beliefs about oral health

practices between adolescence and young adulthood(158). To prevent oral health issues such as gingivitis, high plaque score, and tooth loss from caries, it is necessary to implement interventions that encourage sustainable positive attitudes towards oral hygiene.

Education is an essential tool for maintaining oral health. Our result indicated that the field of study affected overseas students' knowledge and attitude. To implement and retain proper knowledge and attitudes, the university may provide free elective courses in essential health, especially for the non-health science program students. In addition, undergraduate students had significantly higher mean behavior scores than master, doctoral, and postdoctoral students. These might be affected by workloads regarding their study levels which might cause them to neglect themselves unintentionally.

Further analyses were performed for the association between behavior scores and oral problems in overseas students. The results showed that students who had proper behavior had a lower number of oral health problems. Around 43.7% of the overseas students in the current study had at least one kind of oral health problem.

Besides clinics closing during the lockdown period, it is concerning that 60% of overseas students hesitate to visit a dentist due to COVID-19 infection risks associated with dental procedures. This fear could prevent them from addressing any oral health issues they may have. Some students turned to online searches and

consulted friends for advice, but it is essential to be cautious as there is a risk of misinformation(169, 170, 171). Students may benefit from using a health web engine instead of a general search engine like Google to reduce this risk. Despite the potential for false or misleading information, this trend showed that overseas students were taking proactive measures to safeguard their health. Consulting with the dentist must be the best; however, before the pandemic, telehealth or tele-dentistry had the primary purpose for remote healthcare. Then overseas students and most people in the cities are unfamiliar with tele-dentistry. During the pandemic, limited tele-dentistry services were provided, mainly by the university dental hospitals. Thus, there was no surprise that few students chose this solving method.

After the pandemic, tele-dentistry may be added into everyday practice for the benefit of decongesting clinics, improving patient flow, and reducing travel and associated costs for patients. A barrier to implementation is difficulty in providing accurate diagnoses based on videos or static images without essential diagnostic maneuvers such as percussion, palpation, and radiographic investigation that might limit dental professionals' ability to establish the correct diagnosis, causing mismanagement and litigation was also identified as issues that may jeopardize widespread acceptance(172, 173, 174, 175). Language barriers might be another additional concern for overseas students. Regarding the limitation of telediagnosis, some aspects of tele-dentistry may be applied. Tele-triage prioritizes patients needing urgent care, nonprocedural care, hygiene assessments, specialist

consultations, and telemonitoring can follow up on treatment. Tele-dentistry can also prescribe temporary medications such as antibiotics, painkillers, and anti-inflammatory mouth rinses, which could temporarily address conditions such as swelling and pain until further treatment can be arranged(176, 177).

Our data shows that the type of health insurance coverage available plays a role in whether overseas students choose to schedule a dental appointment. Healthcare is one of the many expenses that overseas students must worry about, along with the high cost of living. Preventive dental treatment can be expensive, even for those with dental insurance, which few students have(178, 179, 180). As a result, money is a significant consideration for overseas students who have to use scholarships to cover living expenses and may have to forego dental treatment even if they need it. Language can also be a barrier for overseas students seeking dental care(181, 182). Misunderstandings can arise, making it difficult for students to feel satisfied with the treatments.

To effectively address these issues, it would be highly advantageous for the university to provide a comprehensive welfare support to all first-year students by implementing oral health check-ups and early lesion detection screenings on top of their personnel general or dental health insurance. This proactive approach will significantly enhance student awareness and encourage them to prioritize their oral health care needs.

Moreover, as a post-pandemic, universities can fully leverage tele-dentistry for the benefit of their students. By incorporating teleconsultation, tele-triage, and telemonitoring into their established policies, the universities can maintain optimal oral health for all students, not only those overseas, throughout their academic journey, regardless of their locations, while reducing dental visit expenses.

A current study revealed that the oral healthcare habits of overseas university students have a positive correlation with knowledge and attitude, even at a low level. Unfortunately, the COVID-19 pandemic seems not to enhance dental hygiene practices. Dental caries and gingivitis continue to be the most common oral health issues among these students. A negative correlation was observed between behavior and the number of oral health problems experienced. Additionally, the field of study impacts the knowledge and attitude of overseas students toward oral health. It is also important to note that insurance coverage can affect decisions to seek dental care.



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