COVID-19 Knowledge, Attitudes, and Vaccine Acceptance Among Students From Two Major Public Universities in Thailand: A Comparison Between Health Sciences and Non-Health Sciences Disciplines

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Abstract

Data on COVID-19 knowledge, attitudes, and vaccine acceptance among students is vital to inform appropriate COVID-19 preventive strategies. A survey was conducted online among students from 12 health sciences (HS) and 16 non-health sciences (NHS) faculties of two universities during 2021–2022. Of the 1,728 participating students, 613 (35%) were from the HS faculties, and 1,115 (65%) were from the NHS faculties. The HS students had a significantly higher median knowledge score about COVID-19 than the NHS students (15 vs. 14). Most students strongly agreed that people should have an equal chance to select and get the COVID-19 vaccines they want. The HS students were more likely than the NHS students to agree that wearing masks and social distancing can reduce the risk of acquiring COVID-19. At the same time, the NHS students were more likely to agree that the decision about vaccination is highly affected by the population's confidence in their government. The overall COVID-19 vaccine acceptance rate was 99.3%, similar for both student groups. Concerns about vaccine efficacy, safety, and availability of wanted vaccines were the main reasons for vaccination refusal. Improving COVID-19 prevention and vaccination should consider the differential knowledge gaps, attitudes toward COVID-19, and the reasons for refusing vaccination among students.

Keywords

Attitude; COVID-19; knowledge; university students; vaccine acceptance

Introduction

The coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), has become a pandemic and global health threat since early 2020. From March 2020 to May 2022, around 540 million world populations had developed COVID-19, resulting in approximately 6.3 million deaths or a 1.2% mortality rate (Worldometer, 2023). High morbidity and mortality were observed in particular risk groups, including older persons and those with underlying diabetes mellitus, cardiovascular conditions, chronic lung, kidney, and liver diseases, and immunosuppressed status (World Health Organization, 2022). Mass vaccination against COVID-19 is among the strategies to mitigate the ongoing pandemic, with scientific evidence supporting the effectiveness of COVID-19 vaccines in preventing symptomatic infection and reducing severity and related mortality (Zheng et al., 2022).

Vaccine availability, access, hesitancy, and refusal have significantly impacted adequate vaccination coverage worldwide. Hesitation and refusal of available vaccines is considered one of the global public health threats addressed by the World Health Organization in 2019 (World Health Organization, 2019). During the period when COVID-19 vaccines were not available, two survey studies conducted in general populations of 7 European countries and the United Kingdom indicated the rates of vaccine hesitancy of 17–19% and refusal of 7–12% (Freeman et al., 2020; Neumann-Böhme et al., 2020), while the rates of vaccine hesitancy and refusal were 46% and 19% respectively among medical students in an Egypt study (Saied et al., 2021).

The main reasons for hesitation or refusal of the vaccines were concerns about adverse reactions and safety issues (Neumann-Böhme et al., 2020). Aging, low level of education, female sex, black race, single or divorced status, and unemployment were associated with vaccine hesitancy (Freeman et al., 2020). Among the medical students, those who reported knowing COVID-19 were more likely to accept vaccination than those with less knowledge (Saied et al., 2021). In addition, COVID-19 risk perception, vaccine effectiveness, physicians' recommendations, the durability of immunity induced by the vaccines, and trust in political leaders or institutions were the reported factors associated with COVID-19 vaccine acceptance (Kreps et al., 2020; Lin et al., 2020). These study results suggest that knowledge and attitudes toward COVID-19 and COVID-19 vaccine could influence the decision to receive COVID-19 vaccines.

University students are at risk of acquiring COVID-19 and transmitting SARS-CoV-2 to others due to their activities, behaviors, socialization, and reluctance to follow COVID-19 preventive measures (Muto et al., 2020; Tavolacci et al., 2021). Asymptomatic infection is usually found in young students (< 20 years old), who can spread the virus to other people, especially high-risk populations (Tavolacci et al., 2021). In addition, a study demonstrated that many reopened colleges usually caused massive outbreaks or were sources of infection that were spread to the neighboring communities (Lu et al., 2021). University students are thus the target population for mass COVID-19 vaccination. Previous studies indicated that vaccine efficacy and safety, low complacency, and vaccine confidence were significant factors associated with immunization in university students (Mueangpoon et al., 2022; Tavolacci et al., 2021).

In Thailand, the third epidemic wave of COVID-19 due to the delta variant lasted from June 2021 to October 2021. About the end of September 2021, nearly 30 million (about 71% of the total Thai population) had already received the first dose of the COVID-19 vaccine, and over 16 million (more than 23% of the total population) had already received the second dose of the vaccine (Department of Disease Control, 2021). The COVID-19 vaccines were not compulsory but were available for all Thai people, prioritizing at-risk populations. At that time, Thailand's available types of COVID-19 vaccines were inactivated (CoronaVac) and viral vector (ChAdOx1 nCoV). The study conducted among older persons in Chiang Mai, Thailand, demonstrated that they had sufficient knowledge, positive attitude, and good practice about COVID-19, and the rate of vaccine acceptance was as high as 100% if the vaccine efficacy was at least 80% (Wungrath et al., 2021).

Another Thai study among village health volunteers revealed that vaccine fear and hesitation were negatively associated with vaccine acceptance (Siewchaisakul et al., 2022). The survey among the general population in northern Thailand's community found that the majority had moderate COVID-19 knowledge (65.5%), and the knowledge score was significantly associated with getting the COVID-19 vaccine and practicing COVID-19 preventive behaviors (Pothisa et al., 2022). Among university personnel, research conducted among physicians in a university-based hospital demonstrated a high rate of COVID-19 vaccine acceptance (95.6%) and the association between vaccine hesitancy and concerns about uncertain vaccine efficacy and adverse events, low vaccine literacy and unavailability of wanted vaccine type (Sirikalyanpaiboon et al., 2021).

Only one study conducted among university students in Thailand reported a high prevalence of vaccine acceptance (95.6%) in this group, with 50% of students refusing vaccination due to not trusting the efficacy of the COVID-19 vaccine, concerns about serious side effects, and a lack of trust in public authorities (Kaewkrajang et al., 2023). Despite these studies' results, knowledge gaps in and negative attitudes toward COVID-19 and COVID-19 vaccines have not been described in detail, and such data are currently limited among Thai university students. Moreover, the differences in the vaccination timeline and availability of each type of COVID-19 vaccine in the country may impact vaccine acceptance and attitudes toward COVID-19 vaccines. This study assessed the rate of COVID-19 acceptance, knowledge, and attitudes toward COVID-19 and COVID-19 vaccines among Thai university students.

Materials and methods

Study population and setting

A cross-sectional survey study was conducted among university students from Thammasat University and Chulalongkorn University, which are large urban universities in Bangkok and its vicinities in Thailand. These two universities were chosen because they are the largest universities in Thailand, with diverse students from various backgrounds and diverse faculties. The study period was from 1 October 2021 to 31 January 2022.

Our target population was students aged 18 years and older from both universities, with approximately 36,300 students. These students were Health Sciences (HS) students from 12 health sciences faculties, including Medicine, Dentistry, Allied Health Sciences,

Pharmaceutical Science, Cardiothoracic Technology, Chinese Medicine, Veterinary Science, Psychology, Nursing, Thai Traditional Medicine, Public Health, and Sport and Exercise Science; students from five Sciences faculties including Science, Engineering, Sirindhorn International Institute of Technology, Architect, and Science and Technology; and students from 11 Social Sciences faculties, including Communication Arts, Law, Economics, Accounting, Liberal Art, Political Science, Arts, Fine Art, Social Work, Social and Humanity, and Education. The students from the Science and Social Sciences faculties were categorized as non-health sciences (NHS) students.

This study was conducted per the amended Declaration of Helsinki and approved by the Human Research Ethics Committee of Thammasat University (Medicine) (No. 190/2564) and the Research Ethics Review Committee for Research Involving Human Subjects of Chulalongkorn University (No. 048/2021). An informative statement was added at the beginning of the anonymous online survey, and a participant could consent to participate by doing the survey. Confidentiality and privacy of data were maintained during the whole study process. The investigators had no information to identify individual participants during or after data collection.

Study protocol

The researchers created the online survey, which included two infectious diseases specialists and two medical students after an extensive literature review. The survey was divided into four parts, including demographics (four questions), knowledge about COVID-19 and COVID-19 vaccines (16 questions), attitude toward COVID-19 and COVID-19 vaccines (11 questions), and vaccine acceptance (four questions). Collected data in the survey included personal and study characteristics, responses to statements about COVID-19 and COVID-19 vaccines which could be true, false, or do not know, attitudes toward the disease and the vaccine assessed by the responses to the specific statements which the students could grade their responses into five levels (1 = strongly disagree, 2 = disagree, 3 neither agree nor disagree, 4 = agree and 5 = strongly agree), the rate of vaccine acceptance, reasons for refusing vaccination and factors influencing the decision to receive the vaccination. These data were collected through the online Google form. The survey was pretested on 20 students to evaluate for its internal consistency, and the calculating Cronbach's alpha was 0.77. All of the responses in the survey were assigned to be mandatory to minimize data missing.

The researchers contacted each university faculty's student affairs departments to ask for their help in distributing the inviting electronic poster and the link for the online survey form through their social media, such as LINE, Facebook, and Instagram. This approach was considered to be most appropriate during the time of the COVID-19 pandemic. Convenience sampling was used for this study with an anticipated good distribution of the participating HS, Sciences, and Social Sciences students.

Based on the expected vaccine acceptance rate among the students of 65%, an acceptable margin of error of 2.5%, and a confidence level of 95%, the minimum required sample size was 1,400. We anticipated at least 700 students enrolled from each university and at least 470 students from HS, Sciences, and Social Sciences faculties to represent all students from both universities well.

Statistical analyses

Statistical analysis was performed using IBM SPSS Statistics 22.0. Descriptive data were present in number (percent), median, and interquartile range (IQR). Categorical variables of the two faculty groups were compared using the Chi-square test, while continuous variables were compared using the Kruskal–Wallis test. A p value less than 0.05 was considered statistically significant.

Results

Characteristics of the participating students

As shown in Table 1, of 1,728 participating students, 901 (52.1%) and 827 (47.9%) were from Thammasat University and Chulalongkorn University, respectively. There were 613 HS (35.5%) and 1,115 NHS (64.5%) students. Of the 1,115 NHS students, 486 and 629 were from the Science and Social Sciences faculties, respectively. Most participants were female (66.1%) and first-year students (30.4%) with a median age of 20. A higher proportion of the Thammasat University students were from HS faculties, while a higher proportion of the students from Chulalongkorn University were from NHS faculties.

Table 1: Characteristics of the Participating University Students Stratified by Faculty

Characteristic	All (N = 1,728)	Health Sciences Faculties (N = 613)	Non-Health Sciences Faculties (N = 1,115)	p value[a]
University				< 0.001
Thammasat	901 (52.1)	375 (61.2)	526 (47.2)	
Chulalongkorn	827 (47.9)	238 (38.8)	589 (52.8)	
Gender				0.37
Female	1,143 (66.1)	397 (64.8)	746 (66.9)	
Male	585 (33.9)	216 (35.2)	369 (33.1)	
Age (years, median, IQR)	20 (19–21)	20 (19–21)	20 (19–21)	1.00
Year of Study				< 0.001
Year 1	526 (30.4)	203 (33.1)	323 (29.0)	
Year 2	362 (20.9)	95 (15.5)	267 (23.9)	
Year 3	404 (23.4)	139 (22.7)	265 (23.8)	
Year 4	375 (21.7)	131 (21.4)	244 (21.9)	
Year 5	37 (2.1)	26 (4.2)	11 (1)	
Year 6	19 (1.1)	18 (2.9)	1 (0.1)	
Others[b]	5 (0.3)	1 (0.4)	4 (0.2)	

Note: Data are in numbers (%) unless indicated otherwise; [a] Comparison between two groups; [b] Included Year 7 and graduate student; IQR = interquartile range

Knowledge about COVID-19 and COVID-19 vaccines

As seen in Table 2, the median knowledge score concerning COVID-19 and COVID-19 vaccines is 14 (out of 16) for all participating students. The HS students had a significantly

higher median knowledge score than the NHS students (15 vs. 14; $p < .001$). Most of the students (more than 95%) correctly responded to the statements about transmission, common symptoms, and prevention of COVID-19, typical side effects of COVID-19 vaccines, and herd immunity, while less proportion of the students (less than 70%) correctly responded to the statements about oral medicine for COVID-19 prevention, efficacy of COVID-19 vaccines, onset of the side effects of the vaccines, and vaccination in older persons or a person with a medical condition. A lower proportion of NHS students, compared to HS students, correctly responded to the statements about oral medicine for COVID-19 prevention, the efficacy of COVID-19 vaccines, and the onset of the side effects of the vaccines.

Table 2: Knowledge About Coronavirus Disease 2019 (COVID-19) and COVID-19 Vaccine Among the Participating University Students Stratified by Faculty

Statement	All (N = 1,728)	Health Sciences Faculties (N = 613)	Non-Health Science Faculties (N = 1,115)	p value[a]
COVID-19 is a respiratory tract infectious disease caused by bacteria. (False)	1,286 (74.4)	472 (77.0)	814 (73.0)	0.07
COVID-19 can be transmitted from person to person via contact with the respiratory secretion of patients and passing through the respiratory, oral, and eye mucosa of exposed persons. (True)	1,650 (95.5)	576 (94.0)	1,074 (96.3)	0.02
The common symptoms found in COVID-19 patients are fever, cough, loss of taste and smell, rashes, difficulty breathing, and eye redness. (True)	1,654 (95.7)	578 (94.3)	1,076 (96.5)	0.03
Severe lung infection and respiratory failure are the main reasons for death in COVID-19 patients. (True)	1,635 (94.6)	574 (93.6)	1,061 (95.2)	0.18
Young persons or those without a medical condition are considered at higher risk than older persons or those with medical conditions for developing severe COVID-19. (False)	1,523 (88.1)	552 (90.0)	971 (87.1)	0.07
Transmitting COVID-19 viruses can occur even if the COVID-19 patients do not have any symptoms. (True)	1,662 (96.2)	587 (95.8)	1,075 (96.4)	0.50
There is no need to do COVID-19 diagnostic tests for those with no symptoms but have been in close contact with persons with COVID-19. (False)	1,488 (86.1)	533 (86.9)	955 (85.7)	0.46
Frequently washing your hands, wearing a mask, and social distancing for 1–2 meters can reduce the risk of getting COVID-19. (True)	1,648 (95.4)	586 (95.6)	1,062 (95.2)	0.74
Going to community places such as markets shopping malls, or using public transportation has a low risk of contracting COVID-19. (False)	1,508 (87.3)	543 (88.6)	965 (86.5)	0.23
Nowadays, there is an oral medicine that can protect us from getting COVID-19. (False)	1,029 (59.5)	385 (62.8)	644 (57.8)	0.04

Statement	All (N = 1,728)	Health Sciences Faculties (N = 613)	Non-Health Science Faculties (N = 1,115)	p value[a]
Every COVID-19 vaccine certified by the Thai FDA can reduce hospitalization, severity, and mortality rate of COVID-19. (True)	1,084 (62.7)	413 (67.4)	671 (60.2)	0.003
Side effects of the COVID-19 vaccine commonly seen are muscle aches, low-grade fever, fatigue, and dizziness. (True)	1,690 (97.8)	607 (99.0)	1,083 (97.1)	0.01
Severe side effects of the COVID-19 vaccine usually occur after getting the vaccine for about a couple of months. (False)	1,136 (65.7)	422 (68.8)	714 (64.0)	0.04
The COVID-19 vaccination can prevent 100% infection if the vaccination is completed as scheduled. (False)	1,625 (94.0)	587 (95.8)	1,038 (93.1)	0.03
Older adults or people with a medical condition should not get the vaccine because they may develop or die of severe side effects. (False)	1,204 (69.7)	440 (71.8)	764 (68.5)	0.17
Even though vaccinated, we should frequently wash our hands, wear masks, and maintain social distancing until herd immunity develops in our country. (True)	1,699 (98.3)	604 (98.5)	1,095 (98.2)	0.61
Median knowledge score (IQR)	14 (13–15)	15 (13–16)	14 (12–15)	< 0.001

Note: Data are in the number of participants who responded to each statement correctly (proportion to the whole participants in percentage) unless indicated otherwise.

The correct response to each statement is shown in a parenthesis after each statement. The knowledge score equals the number of correct responses (the full score is 16).

[a] Comparison between two groups.

FDA = Food and Drug Administration; IQR = interquartile range

Attitude toward COVID-19 and COVID-19 vaccine

Overall, as displayed in Table 3, most of the students strongly agreed that "Getting the COVID-19 vaccine can reduce the severity of the symptoms and hospitalization", "People should have an equal chance to get the COVID-19 vaccine," and "People should have an opportunity to choose the vaccine they want and are confident to receive." The HS students were more likely than NHS students to agree that wearing a mask and social distancing can reduce the risk of getting COVID-19 even if they are unvaccinated, and side effects of the COVID-19 vaccine, for example, muscle aches and fatigue, are common. On the contrary, NHS students were more likely than HS students to agree that the population's confidence in their government highly affects the decision to get vaccinated and that COVID-19 should be considered an economic problem rather than a public health problem.

Table 3: Mean Attitude Scores Toward Coronavirus Disease 2019 (COVID-19) and COVID-19 Vaccine Among the Participating University Students Stratified by Faculty

Statement	All (N=1,728)	Health Sciences Faculties (N= 613)	Non-Health Sciences Faculties (N=1,115)	p value[a]
Healthcare workers should be role models for getting the COVID-19 vaccination.	4.25 (0.83)	4.26 (0.83)	4.25 (0.84)	0.89
Wearing a mask and social distancing can reduce the risk of getting COVID-19, even if we are unvaccinated.	3.56 (1.13)	3.69 (1.12)	3.48 (1.13)	< 0.001
Getting the COVID-19 vaccination is a duty that people should take into consideration.	4.47 (0.75)	4.47 (0.73)	4.46 (0.77)	0.84
People's confidence in their government significantly impacts their decision to get vaccinated.	4.44 (0.93)	4.38 (0.95)	4.48 (0.93)	0.04
COVID-19 is a life-threatening condition.	4.05 (0.88)	3.99 (0.89)	4.01 (0.88)	0.07
Getting the COVID-19 vaccine can reduce the severity of the symptoms and hospitalization.	4.51 (0.64)	4.53 (0.63)	4.50 (0.65)	0.25
People should have an equal chance to get the COVID-19 vaccine.	4.84 (0.58)	4.84 (0.56)	4.84 (0.60)	0.93
People should be able to choose the vaccine they want and are confident to receive.	4.88 (0.43)	4.86 (0.43)	4.89 (0.42)	0.26
Side effects of the COVID-19 vaccine, for example, muscle aches and fatigue, are common.	4.38 (0.72)	4.45 (0.67)	4.35 (0.75)	0.007
COVID-19 should be considered as an economic problem rather than a public health problem	3.37 (1.06)	3.25 (1.03)	3.43 (1.06)	< 0.001
Getting the COVID-19 vaccine is a social responsibility for everyone.	4.36 (0.83)	4.37 (0.81)	4.35 (0.84)	0.61

Note: Data are in mean scores (standard deviation).
Score ranges from 1 to 5; 1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree, and 5 = strongly agree with the provided statements.
[a] Comparison between two groups

Vaccine acceptance among the participating students

As shown in Table 4, the vaccine acceptance rate in the participating students was 99.3%. Of the 1566 students who received the vaccines, the majority (91.9%) had already received two doses. A higher proportion of HS students than NHS students had already received the COVID-19 vaccines at the time of the survey. However, the vaccine acceptance rates were not significantly different between the two groups. Among the 12 students who refused COVID-19 vaccination, the most commonly reported reasons were that their wanted vaccines were unavailable (75%) and they were not confident in a vaccine (58.3%). They feared the vaccine's side effects (50%). The reported reasons for refusing the COVID-19 vaccination differed between HS and NHS students. Among the 1,716 students who accepted COVID-19 vaccination, the three most common factors influencing the decision

were their safety, family safety, and being at risk of getting COVID-19. A higher proportion of HS students compared to NHS students reported that factors influencing their decision to receive the vaccines were vaccine efficacy, being a healthcare professional, and wanting to return to everyday life. In contrast, other factors influencing the decision were not different between the two groups.

Table 4: Coronavirus Disease 2019 (COVID-19) Vaccination Acceptance Among the Participating University Students Stratified by Faculty

Characteristic	All (N = 1,728)	Health Sciences Faculties (N = 613)	Non-Health Sciences Faculties (N = 1,115)	p value[a]
COVID-19 vaccination status				0.01
Received	1,566 (90.6)	573 (93.5)	993 (89.1)	
Not received, but want to receive	150 (8.7)	37 (6.0)	113 (10.1)	
Declined	12 (0.7)	3 (0.5)	9 (0.8)	
Reason for refusing vaccination[b]				0.51
Wanted vaccine was not available	9/12 (75.0)	3/3 (100.0)	6/9 (66.7)	
Not confident in a vaccine	7/12 (58.3)	2/3 (66.7)	5/9 (55.6)	1.00
Afraid of the side effects	6/12 (50.0)	1/3 (33.3)	5/9 (55.6)	1.00
Vaccine is not safe	6/12 (50.0)	2/3 (66.7)	4/9 (44.4)	1.00
Waiting for more data about vaccine	4/12 (40.0)	0/3 (0)	4/9 (44.4)	0.49
Waiting for herd immunity	3/12 (25.0)	1/3 (33.3)	2/9 (22.2)	1.00
Low risk of getting COVID-19	2/12 (16.7)	0/3 (0)	2/9 (22.2)	1.00
Family and friends did not want to be vaccinated	1/12 (8.3)	0/2 (0)	1/10 (10.0)	1.00
Others[c]	2/12 (16.7)	0/3 (0)	2/9 (22.2)	1.00
Factors influencing the decision to receive vaccination[b]				
Own safety	1,429/1,716 (83.3)	501/610 (82.1)	928/1,106 (84.9)	0.35
Family safety	1,362/1,716 (79.4)	473/610 (77.5)	889/1,106 (80.4)	0.16
Risk of getting COVID-19	845/1,716 (49.2)	285/610 (46.7)	560/1,106 (50.6)	0.12
Vaccine efficacy	790/1,716 (46.0)	319/610 (52.3)	471/1,106 (42.6)	< 0.001
Vaccine safety	713/1,716 (41.6)	251/610 (41.1)	463/1,106 (41.9)	0.77
Brand of vaccine	626/1,716 (36.5)	209/610 (34.3)	417/1,106 (37.7)	0.16
Type of vaccine	594/1,716 (34.6)	212/610 (34.8)	382/1,106 (34.5)	0.93
Being a healthcare professional	252/1,716 (14.7)	212/610 (34.8)	40/1,106 (3.6)	< .001
Rule and regulation	99/1,716 (5.8)	32/610 (5.3)	67/1,106 (6.1)	0.49
Vaccine access	81/1,716 (4.7)	24/610 (3.9)	57/1,106 (5.2)	0.25
To travel across provinces and aboard	32/1,716 (1.9)	11/610 (1.8)	21/1,106 (1.9)	0.89
Social pressure	30/1,716 (1.8)	10/610 (1.6)	20/1,10 (1.8)	0.80
To return to normal life	16/1,716 (0.9)	1/610 (0.2)	15/1,106 (1.4)	0.02
Social responsibility	10/1,716 (0.6)	5/610 (0.8)	5/1,106 (0.5)	0.34
Others[d]	15/1,716 (0.9)	4/610 (0.7)	11/1,106 (1.0)	0.59
Number of doses of vaccine received				0.38
1 dose	127/1,566 (8.1)	51/573 (8.9)	76/993 (7.7)	
2 doses	1,439/1,566 (91.9)	522/573 (91.1)	917/993 (92.3)	

Note: [a] Comparison between two groups.

Discussion

Our study is the first to assess Thai university students' knowledge and attitude towards COVID-19 and COVID-19 vaccines and determine the vaccine acceptance rate. The study was conducted when the delta variant of SARS-CoV-2 was dominant and caused widespread infections in the country, while the availability and access to more options for COVID-19 vaccines were limited. Our study demonstrates that the vaccine acceptance rate was very high (99%) in both HS and NHS students, with no significant difference between these two groups. This increased acceptance rate fell in line with a previous Thai study conducted during the same period, which revealed a rate of vaccine acceptance of 90% among participants with a high school education and a bachelor's degree or above (Mueangpoon et al., 2022).

The rate of vaccine acceptance in this study was significantly higher than the rates of 71%–77% reported by medical students in the previous studies, which were conducted during the period when there were no COVID-19 vaccines available yet (Grochowska et al., 2021; Lucia et al., 2021). The higher rate in our study may be explained by the availability of the vaccines' clinical data, the high burden of COVID-19 at the time of the survey, the provision of free vaccines (but a limited number of doses) to the students from the universities and the country's regulations that required proof of vaccination to enter public places such as restaurants and shopping malls. These findings and effective measures could be used to improve vaccine acceptance among students during the ongoing and future pandemics of COVID-19 and other infectious diseases.

Most students reported that their safety, family safety, risk of getting COVID-19, vaccine efficacy, and vaccine safety were the significant factors influencing the decision to receive vaccination. In contrast, a minority of the students refused vaccination due to the unavailability of their wanted vaccines, safety concerns, and lack of adequate information about them. These findings were consistent with the previous studies (Mueangpoon et al., 2022; Tavolacci et al., 2021) and emphasized the importance of providing adequate vaccine information and availability in future COVID-19 vaccination programs.

In this study, the university students were knowledgeable about COVID-19 and COVID-19 vaccines. The HS students were more knowledgeable than the NHS students, which was most likely since COVID-19-related topics had been added to the current curriculum of HS students, and they had more fundamental knowledge of infectious diseases than the NHS students. However, there were some knowledge gaps among the students regarding constantly updated topics, including oral medicine for COVID-19 prevention, the efficacy of COVID-19 vaccines, and the onset of the side effects of the vaccines. Education on these issues should be provided to the students to improve their knowledge, which could enhance their COVID-19 vaccine acceptance (Saied et al., 2021; Tavolacci et al., 2021).

Our study students had positive attitudes toward COVID-19 vaccination regarding vaccine effectiveness and safety, their responsibility to be vaccinated, and health care workers as role

models for COVID-19 prevention. These positive attitudes correlated with the high vaccine acceptance rate, consistent with those reported in previous studies (Kecojevic et al., 2021; Lucia et al., 2021). Most of the HS and NHS students had positive attitudes toward the efficacy of the vaccines and equal opportunity for everyone to receive and choose the COVID-19 vaccines they want. The HS students were more likely than the NHS students to agree about the need for preventive measures among unvaccinated persons and the common and expected side effects of the COVID-19 vaccines. At the same time, the NHS students were more likely than HS students to agree that COVID-19 should be considered an economic problem rather than a public health problem. This is the first study to describe the differences in attitude between HS and NHS students. The reasons for the differences were likely due to the differences in their fields of research and perspectives. These differences in attitudes and ideas toward COVID-19 and COVID-19 vaccines should be considered for implementing local and national policies tailored to each population group.

The strengths of this study include the large sample size and adequate distribution of the students that could represent the HS and NHS students from these urban and public universities. However, some limitations should be noted. First, since the study was conducted during the COVID-19 pandemic surge in the country, the results may not be generalizable to other students in different settings and during different COVID-19 situations. The results may be applied only to the students from the leading universities in Thailand. Second, an anonymous and self-administered design may be subject to misunderstanding and misinterpreting questions and statements in the survey. Third, the study was not designed to evaluate the students' socioeconomic status, which might affect vaccine acceptance. Lastly, the survey was conducted in a short period, and the respondents may be affected by time limitations and other recent social media and/or news.

In conclusion, the vaccine acceptance rate was high among all groups of university students in this study, correlating with a high level of knowledge about COVID-19 and COVID-19 vaccines and the COVID-19 situation in the country. However, some knowledge gaps and negative attitudes toward COVID-19 vaccines would require education and interventions tailored for each group of students. At the national level, evidence-based information about vaccine safety, vaccine efficacy, and the benefits of vaccination, such as the reduced risk of transmission, hospitalization, and mortality, should be provided to the public promptly. Further studies are needed to evaluate the effectiveness of education or interventions based on the findings in improving university students' acceptance of, knowledge, and attitudes toward COVID-19 vaccination. Although the situation of COVID-19 and the COVID-19 vaccine in Thailand has changed, the principles of our study results remain applicable to the future vaccination program. These principles include evaluating knowledge about vaccines and filling up the knowledge gaps, assessing attitudes toward vaccines and improving negative attitudes, and exploring the reasons behind vaccine refusal to increase vaccine acceptance among target populations.

Acknowledgments

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