Factors influencing acceptance of the COVID-19 vaccination in Thailand: The initiate phase of introducing COVID-19 vaccines

Awirut Singkun[1*], Hanifah Booraka[2], Ibteesan Che-u-bong[3], Kulaya Tohrayor[4], Jarmmaree Sornboot[5]

[1,2,3,4,5]Sirindhorn College of Public Health, Yala, Faculty of Public Health and Allied Health Sciences, Praboromarajchanok Institute, 95000 Thailand.

*Corresponding author: Awirut Singkun (Email: awirut@yala.ac.th)

ABSTRACT

Purpose: Coronavirus disease 2019 (COVID-19) was first reported in late 2019. The virus led to a severe acute respiratory syndrome. It rapidly and dramatically spread, causing a global pandemic. Vaccination may reduce the disease severity and rate of infection. However, controversy and uncertainty caused people to initially be hesitant about receiving the COVID-19 vaccines. The objectives of this study were to assess knowledge about COVID-19 vaccines, attitudes toward COVID-19 vaccination, and factors associated with acceptance of COVID-19 vaccination among Thai people.

Design/Methodology/Approach: A cross-sectional study was used to collect the data at the end of April 2021. Participants (n=756) completed an online, self-administered questionnaire. Descriptive statistics, including frequency and percentage, the Chi-square test, and the Fisher's exact test, were used for data analysis.

Findings: We found that approximately half of respondents had good knowledge about COVID-19 vaccines (50.8%) and attitudes toward COVID-19 vaccination (51.5%). We observed that age, religion, attitudes toward COVID-19 vaccination, observing respected people and colleagues being vaccinated, receiving a vaccination certificate, receiving vaccination free of charge, living in a community with high numbers of COVID-19 infections, not completely having self-protection against the infection, noticing other people did not have suitable self-protective practice, and having good self-esteem were statistically associated with the acceptance of the COVID-19 vaccination ($p < 0.05$).

Conclusion: The demographic and social factors influence acceptation and cooperation. In summary, we suggested that healthcare providers should consider demographic and social factors when promoting COVID-19 vaccination to increase the acceptance rate.

1. INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SAR-CoV-2) was a novel coronavirus discovered at the end of 2019 (Zhou et al., 2020). The new virus was named the coronavirus disease 2019 (COVID-19). The first official reported case was found in the city of Wuhan, China, in late November 2019. Then, the disease rapidly spread out to the rest of the world. In March 2020, the World Health Organization (WHO) stated that COVID-19 was a pandemic disease (World Health Organization, 2020).

COVID-19 patients' respiratory droplets spread the infection when they sneezed and coughed. Moreover, clothes, objects, or things that were contaminated with these droplets also caused the infection (Chowdhury, Hossain, Kashem, Shahid, & Alam, 2020). Most severe cases occurred in the elderly and patients with chronic diseases. Active young people and adults reported mild or asymptomatic cases, with their innate immune response playing a crucial role in mitigating the severity of the infection (Chowdhury et al., 2020; Prompetchara, Ketloy, & Palaga, 2020).

COVID-19 affected more than 218 countries, resulting in 14.8 million cases confirmed of infection. Of these infected patients, 110,946 were severe cases; more than 3 million deaths (as of 27 April 2021) resulted from COVID-19 (Hafeez, Ahmad, Siddqui, Ahmad, & Mishra, 2020; The Center for COVID-19 Situation Administration, 2021). All countries have control measures to restrict the disease spreading, including COVID-19 vaccination. Because the rate of COVID-19 infection was rapidly increasing, public health officials encouraged mass vaccination in order to reduce the severity of the disease and also prevent the infections from spreading so rapidly (Ella & Mohan, 2020; Prompetchara et al., 2020). It was also believed that vaccination was the best way to control the horrendous pandemic. Vaccination would confer some immunity against the disease (Ella & Mohan, 2020; Koff & Berkley, 2021; Poland, Ovsyannikova, Crooke, & Kennedy, 2020).

The Thai government imported four types of COVID-19 vaccines, including viral vector vaccines, mRNA vaccines, inactivated virus vaccines, and protein vaccines. However, the urgent need for the pandemic led to the WHO approving the COVID-19 vaccines for the emergency use; consequently, many people had some questions about the effectiveness, availability, accessibility, safety, side effects, and other adverse events of the vaccines (Sirikalyanpaiboon et al., 2021). From the literature reviewed, there were associated factors with COVID-19 vaccination, for example, knowledge of COVID-19, vaccine hesitancy, and having a good attitude toward COVID-19 (Boon-Itt, Rompho, Jiarnkamolchurn, & Skunkan, 2021; Elgendy & Abdelrahim, 2021). However, in Thailand, there was a limitation of study exploring the reason for the acceptance rate as well as factors associated with COVID-19 vaccination (Boon-Itt et al., 2021). The study objectives were to explore knowledge about COVID-19 vaccines, attitudes toward COVID-19 vaccination, and acceptance for COVID-19 vaccination among Thai people. Our goal was to better understand the associations between demographic factors and COVID-19 vaccination acceptance. Based on the participants' demographic and social factors, we could apply the outcomes to enhance community cooperation and acceptance of COVID-19 vaccination.

2. MATERIAL AND METHODS

2.1. Study Design and Population
An online cross-sectional survey was conducted. The study population was Thai people across the country. We aimed to assess the acceptance of COVID-19 vaccination. Our data analysis included all completed response questionnaires submitted within the survey period.

2.2. Research Tools
The research questionnaire was developed by researchers according to related literature reviewed (see references). It consisted of 4 parts:

Part I Demographic characteristics included 5 items (sex, age, marital status, religion, and education level) and an item of acceptance of COVID-19 vaccination. Acceptance for COVID-19 vaccination was categorized as: 1) "accepted," a group with people that had been vaccinated, and 2) "not accepted," a group including people that were not vaccinated.

Part II, Knowledge about COVID-19 vaccines; 7 items (4 right statements and 3 wrong statements). Possible answers for each statement were true, false, and not sure. The scoring: 1 for a correct answer and 0 for an incorrect answer as well as for "not sure," meaning that they did not know if the statement was true or false. Level of knowledge about COVID-19 vaccines was categorized into three levels using a sum score for good (6–7 points), moderate (5 points), and poor (0–4 points), according to the Bloom cut-off points.

Part III: Attitudes toward COVID-19 vaccination; 7 items (3 affirmative and 4 negative statements). On 5-Likert scale, the responses were rated as strongly agree, agree, neutral, disagree, and strongly disagree. For positive remark, the score was 5, 4, 3, 2, or 1-point; for every negative statement, the score was 1, 2, 3, 4, or 5 points. Three levels of attitudes regarding the COVID-19 vaccine were identified according to class level that were good (27 – 35 points), moderate (17–26 points), and poor (7–16 points).

Part IV: People, events, or things leading to acceptance of COVID-19 vaccination. A binary response was yes or no for each item.

2.3. Tools Measurement

Five experts in the field of health and disease control evaluated the content validity. The index of item objective congruence varied from 0.8 to 1.0. Reliability was tested using the first fifty completed questionnaires. The Kuder-Richardson 20 (KR-20) and the Cronbach's α coefficient were assigned for knowledge about COVID-19 vaccines and attitudes toward COVID-19 vaccination, respectively. The coefficients for sections of the questionnaire about the knowledge about COVID-19 vaccines and attitudes toward COVID-19 vaccination were 0.815 and 0.810, respectively.

2.4. Data Collection

During late April 2021, a network of fifty-four public health administration personnel from all twelve health regions was asked to distribute and share the link for research questionnaire with people in their health area. A total of 756 completed responses were returned within a week. The 756 responses excluded the first fifty responses submitted, which were used to test for reliability of the study questionnaire.

2.5. Ethics

The Ethics Committee for Human Research Subjects, Sirindhorn College of Public Health, Yala, approved this study's research protocol (Project number 049/2564).

2.6. Data Analysis

Descriptive statistics, frequency, and percentage were used to summarize the participants' demographic characteristics, knowledge about COVID-19 vaccines, attitudes toward COVID-19 vaccination, and people, events, or things leading to acceptance of COVID-19 vaccination. The associations between potential variables and COVID-19 vaccination acceptance were evaluated using chi-square and Fisher's exact test. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS V28 Statistics for Windows (a license of Sirindhorn College of Public Health, Yala).

3. RESULTS

Table 1 shows participants' demographic characteristics. Most respondents were female (70.1%). The largest percentage of participants were within the age range between 30-39 years old (31.6%). Over half of the participants (53.3%) had married. A majority of participants were Buddhist (70.5%) and had finished secondary school (63.9%). At the time of this survey, 71.8% of respondents accepted COVID-19 vaccination, while 28.2% still did not accept this vaccination.

Table 1. Demographic characteristics and association with the acceptance of COVID-19 vaccination (n=756).

Demographic characteristics		n	%	COVID-19 vaccination, n (%)		df	χ^2	*p*
				Accepted 543 (71.8)	Non-accepted 213 (28.2)			
Sex								
	Male	226	29.9	167 (73.9)	59 (26.1)	1	0.682	0.409
	Female	530	70.1	376 (70.9)	154 (29.1)			
Age								
	20-29 years old	177	23.4	127 (71.8)	50 (28.2)	3	7.912	0.048 [*]
	30-39 years old	239	31.6	159 (66.5)	80 (33.5)			
	40-49 years old	205	27.1	161 (78.5)	44 (21.5)			
	50-60 years old	135	17.9	96 (71.1)	39 (28.9)			
(Mean 38.5 years, max. 60.3 years, min.20.0 years)								
Marital status								
	Single	353	46.7	255 (72.2)	98 (27.8)	1	0.056	0.813
	Couple	403	53.3	288 (71.5)	115 (28.5)			
Religion								
	Islamic	219	29.0	138 (63.0)	81 (37.0)	2	11.830	0.003 [a, *]

Demographic characteristics		n	%	COVID-19 vaccination, n (%)		df	χ^2	p
				Accepted 543 (71.8)	Non-accepted 213 (28.2)			
	Buddhist	533	70.5	402 (75.4)	131 (24.6)			
	Christian	4	0.5	3 (75.0)	1 (25.0)			
Education level						3	1.263	0.738
	Primary school	73	9.7	52 (71.2)	21 (28.8)			
	Secondary school	483	63.9	350 (72.5)	133 (27.5)			
	Bachelor's degree	161	21.3	116 (72.0)	45 (28.0)			
	Graduated	39	5.2	25 (64.1)	14 (35.9)			

Note: ᵃ Fisher's exact test, *p<0.05.

The respondents' knowledge about COVID-19 vaccines: most participants (87.4%) correctly responded that they could still be infected by COVID-19, even though they were fully vaccinated for COVID-19. Most participants (86.9%) were also aware that obtaining a full COVID-19 vaccination in Thailand required multiple doses. Most respondents (83.9%) also correctly understood that immunity against COVID-19 immunization did not immediately occur after completing the COVID-19 vaccination. Overall, half of respondents (50.8%) had good knowledge level on COVID-19 vaccines (table was not shown).

The attitudes toward COVID-19 vaccination among the respondents were that most participants strongly disagreed that it was not necessary to get the COVID-19 vaccines. A majority of respondents (53.0%) disagreed that although other people have already had COVID-19 vaccination, it was not necessary for them to get vaccinated. Also, almost half of respondents (46.7%) strongly disagreed that the process of COVID-19 vaccination was a waste of the time. However, only 34.9% of respondents strongly agreed that getting COVID-19 vaccines could lower risk of COVID-19 infection. Overall, study respondents had a good attitude level toward COVID-19 vaccination (51.5%) (Table was not shown).

Table 2 shows participants' reported observations about people, events, or things that led them to accept COVID-19 vaccination. Participants reported that the top three factors leading to acceptance of the vaccine were seeing a statement of high prevalence and incidence rate of COVID-19 infection (81.7%), being surrounded by people who did not protect themselves against COVID-19 infection (79.9%), and receiving an approval document verifying their COVID-19 vaccination (68.7%).

Table 2. People, events, or things leading to acceptance of COVID-19 vaccination (n=756).

People, events, or things leading you to accept for COVID-19 vaccination	n (%)	
	Yes	No
You see Thai politicians had COVID-19 vaccination	80 (10.6)	676 (89.4)
Your favorite artists (Actors/Actress/Singers/Net idol) had COVID-19 vaccination	40 (5.3)	716 (94.7)
You see well known person had COVID-19 vaccination	62 (8.2)	694 (91.8)
People that you respect had COVID-19 vaccination	101 (13.4)	655 (86.6)
Your colleagues had COVID-19 vaccination	154 (20.4)	602 (79.6)
You will get approval document verifying your COVID-19 vaccination	519 (68.7)	237 (31.3)
It is free of charge to get COVID-19 vaccination	340 (45.0)	416 (55.0)
The statement of high prevalence and incidence rate of COVID-19 infection	618 (81.7)	138 (18.3)
You could not completely protect yourself using other measures of COVID-19 prevention	329 (43.5)	427 (56.5)
You see other people did not protect themselves from COVID-19 infection	604 (79.9)	152 (20.1)
You want to have COVID-19 vaccination in order to encourage others to do so	342 (45.2)	414 (54.8)

The results found that their age and religion were significantly associated with the acceptance of COVID-19 vaccination (p < 0.05) (Table 1). Other factors encouraged participants to have the COVID-19 vaccination. It was found that attitudes toward COVID-19 vaccination, seeing someone that they respected and their colleagues get the

vaccine, receiving an approval document verifying vaccination, no payment for vaccination, high prevalence and incidence rate of COVID-19 infection, realizing they could not practice COVID-19 prevention measures all the time, seeing people around them with improper behavior to prevent of COVID-19, and wanting to encourage other people to get the COVID-19 vaccination were significantly associated with the acceptance of COVID-19 vaccination (p < 0.05) (Table 3).

Table 3. Association between potential factors and the acceptance of COVID-19 vaccination (*n*=756).

Factors	COVID-19 vaccination, n (%)		df	χ^2	*p*
	Accepted	Non-accepted			
Knowledge about COVID-19 vaccines					
High	281 (73.2)	103 (26.8)	2	1.208	0.547
Moderate	103 (72.5)	39 (27.5)			
Poor	159 (69.1)	71 (30.9)			
Attitudes toward COVID-19 vaccination					
Good	336 (86.2)	54 (13.8)	2	85.075	< 0.001 [a], ***
Moderate	206 (57.1)	155 (42.9)			
Poor	1 (20.0)	4 (80.0)			
Politicians had COVID-19 vaccination					
Yes	62 (77.5)	18 (22.5)	1	1.424	0.233
No	481 (71.2)	195 (28.8)			
Your favorite artists had COVID-19 vaccination					
Yes	32 (80.0)	8 (20.0)	1	1.395	0.238
No	511 (71.4)	205 (28.6)			
You see a well-known person had COVID-19 vaccination					
Yes	50 (80.6)	12 (19.4)	1	2.596	0.107
No	493 (71.0)	201 (29.0)			
Person that you respected had COVID-19 vaccination					
Yes	84 (83.2)	17 (16.8)	1	7.412	0.006 **
No	459 (70.1)	196 (29.9)			
Your colleagues had COVID-19 vaccination					
Yes	123 (79.9)	31 (20.1)	1	6.185	0.013 *
No	420 (69.8)	182 (30.2)			
You will get approval document verifying you had COVID-19 vaccination					
Yes	439 (84.6)	80 (15.4)	1	133.208	< 0.001 ***
No	104 (43.9)	133 (56.1)			
It is free of charge to get vaccinated					
Yes	262 (77.1)	78 (22.9)	1	8.363	0.004 **
No	281 (67.5)	135 (32.5)			
The statement of high prevalence and incidence rate of COVID-19 infection					
Yes	493 (79.8)	125 (20.2)	1	105.686	< 0.001 ***
No	50 (36.2)	88 (63.8)			
You could not protect completely yourself according to other measures of COVID-19 prevention					
Yes	254 (77.2)	75 (22.8)	1	8.326	0.004 **
No	289 (67.7)	138 (32.3)			
You see other people did not protect themselves from COVID-19 infection					
Yes	473 (78.3)	131 (21.7)	1	62.447	< 0.001 ***
No	70 (46.1)	82 (53.9)			
You want to have COVID vaccination in order to encourage others to do so					
Yes	294 (86.0)	48 (14.0)	1	61.699	< 0.001 ***
No	249 (60.1)	165 (39.9)			

Note: [a] Fisher's exact test, *p<0.05, **p<0.01, ***p<0.001.

4. DISCUSSION

Apart from self-protection and state control measures, passive immunization through mass vaccination is an important strategy to increase community immunity against COVID-19 and stop the global COVID-19 pandemic (Sunthornwat & Areepong, 2021). However, in our study, approximately 28% of study participants did not accept the COVID-19 vaccination (Table 1). This finding contrasts with the results of a study in Northern Thailand (Pothisa et al., 2022). People who have not accepted the vaccine may be hesitant about the vaccine's effectiveness against the infection (Harapan et al., 2020) or the possible side effects after vaccination (Alwi et al., 2021; Boon-Itt et al., 2021; Kitro et al., 2022; Troiano & Nardi, 2021). In addition, the rapid process of vaccine production and approval for emergency use during the pandemic period might cause people to have hesitancy and concerns about its safety (Koff & Berkley, 2021).

Participants in the 40–49 years old age group had the highest proportion of participants that accepted the COVID-19 vaccination. The lowest proportion of participants that accepted the COVID-19 vaccination was in the 30–39 years old age group. Approximately half of participants had knowledge about COVID-19 vaccines at a high level. However, in our study, the level of knowledge about COVID-19 vaccines was not associated with acceptance of vaccination. Slightly more than half of participants (51.5%) had good attitudes towards COVID-19 vaccination. We observed that participants with good attitudes toward COVID-19 vaccination were more likely to accept the COVID-19 vaccination. This finding is consistent with several studies in Thailand (Kittipimpanon, Maneesriwongul, Butsing, Janepanish Visudtibhan, & Leelacharas, 2022).

Religiosity was one factor that was negatively associated with getting the COVID-19 vaccination (Troiano & Nardi, 2021). According to some reports, there was low acceptance of vaccination among Thai Muslims and some Muslim communities (Ahmed et al., 2018; World Health Organization, 1967). However, this finding differed from results of a study in Malaysia in which most Muslims accepted the vaccination (Alwi et al., 2021). These findings suggest the implementation of religiously sensitive health communication (Elgendy & Abdelrahim, 2021; Hange et al., 2022; Romah, 2023). Religious leaders, as well as Muslim health professionals, should have more active roles in providing correct information about the vaccine, as well as in campaigning and promoting vaccination.

The study participants were inspired to get the vaccination after witnessing individuals they respected and their colleagues receiving the vaccination. A study indicated that when people trust their health providers, they would follow their recommendations, and their health compliance was enhanced (El-Elimat, AbuAlSamen, Almomani, Al-Sawalha, & Alali, 2021). This aligns with the theory of planned behavior, which suggests that individuals often align their behavior with a group they identify with and feel a genuine connection to. Another factor that induced people to get the vaccination was observing people that did not protect themselves from COVID-19 infection. Being nearby people who placed themselves at risk for the infection may have led people to recognize that they were at a greater risk of infection and therefore may have led them to get vaccinated.

Other supportive measures that encouraged study participants to have the vaccination were providing an approval document verifying vaccination after people received the vaccines, providing vaccinations free of charge, and seeing statements about high prevalence and incidence rate of COVID-19 (Saito, Komasawa, Aung, & Khin, 2022). The provision of a document confirming COVID-19 vaccination was a significant predictor of vaccination acceptance. Prevention and control measures, especially lockdowns and quarantines, made people feel stressed. The vaccination certificate was valuable because it would enable people to freely travel, which resulted in relaxation and stress reduction.

The pandemic not only affected one individual but also the whole population. A full, comprehensive, supportive budget to remedy the COVID-19 situation was implemented according to the universal health coverage policy to provide health equity for all (Tangcharoensathien et al., 2022). The severity and shading of infection situation affected the vaccination rate. Studies reported that falling numbers of infections resulted in reductions in the rate of vaccination (Boon-Itt et al., 2021). But when the rate of COVID-19 infections increased, people practiced preventive behavior according to COVID-19 prevention and control measures. Thus, there was also greater acceptance of vaccination.

Lastly, we found that the acceptance of COVID-19 vaccination was associated with oneself and one's own perception of their role in their community (Kitro et al., 2022). For some people, they felt increased self-esteem after they got vaccinated; they were proud to be a good role model on health for others.

5. CONCLUSION

About half of the participants had good knowledge about COVID-19 and attitudes toward COVID-19 vaccination. About 72% of participants accepted the COVID-19 vaccination. In our study, the factors associated with the acceptance of COVID-19 vaccination included age, religion, level of health care services/workplace, duration of work, attitudes toward COVID-19 vaccination, seeing that respected people and colleagues were vaccinated, receiving a certificate verifying their vaccination, getting the vaccine for no charge, seeing statements about high prevalence and incidence rates of COVID-19 cases, not having complete self-protection from COVID-19, and getting vaccinated to encourage other people to get the COVID-19 vaccination. These findings could be used for devising a strategy and future policies to enhance cooperation and compliance in getting vaccinations. Comprehensive information should be integrated into a communication strategy to encourage people to get vaccinated.

INSTITUTIONAL REVIEW BOARD STATEMENT
The Ethical Committee of the Sirindhorn College of Public Health, Yala, Thailand has granted approval for this study on 9 April 2021 (Ref. No. 049/2564).

TRANSPARENCY
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

COMPETING INTERESTS
The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS
Designed conceptual framework, conducted all methods, resources, and wrote the original draft, A.S.; collected the data and review and editing manuscript, H.B., IC-u-b, K.T. and J.S. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Ahmed, A., Lee, K. S., Bukhsh, A., Al-Worafi, Y. M., Sarker, M. M. R., Ming, L. C., & Khan, T. M. (2018). Outbreak of vaccine-preventable diseases in Muslim majority countries. *Journal of Infection and Public Health, 11*(2), 153-155. https://doi.org/10.1016/j.jiph.2017.09.007

Alwi, S. S., Rafidah, E., Zurraini, A., Juslina, O., Brohi, I. B., & Lukas, S. (2021). A survey on COVID-19 vaccine acceptance and concern among Malaysians. *BMC Public Health, 21*(1), 1129. https://doi.org/10.1186/s12889-021-11071-6

Boon-Itt, S., Rompho, N., Jiarnkamolchurn, S., & Skunkan, Y. (2021). Interaction between age and health conditions in the intention to be vaccinated against COVID-19 in Thailand. *Human Vaccines & Immunotherapeutics, 17*(12), 4816-4822. https://doi.org/10.1080/21645515.2021.1979378

Chowdhury, M. A., Hossain, N., Kashem, M. A., Shahid, M. A., & Alam, A. (2020). Immune response in COVID-19: A review. *Journal of Infection and Public Health, 13*(11), 1619-1629. https://doi.org/10.1016/j.jiph.2020.07.001

El-Elimat, T., AbuAlSamen, M. M., Almomani, B. A., Al-Sawalha, N. A., & Alali, F. Q. (2021). Acceptance and attitudes toward COVID-19 vaccines: A cross-sectional study from Jordan. *Plos One, 16*(4), e0250555. https://doi.org/10.1371/journal.pone.0250555

Elgendy, M. O., & Abdelrahim, M. E. (2021). Public awareness about coronavirus vaccine, vaccine acceptance, and hesitancy. *Journal of Medical Virology, 93*(12), 6535-6543. https://doi.org/10.1002/jmv.27199

Ella, K. M., & Mohan, V. K. (2020). Coronavirus vaccine: Light at the end of the tunnel. *Indian Pediatrics, 57*, 407-410. https://doi.org/10.1007/s13312-020-1812-z

Hafeez, A., Ahmad, S., Siddqui, S. A., Ahmad, M., & Mishra, S. (2020). A review of COVID-19 (Coronavirus Disease-2019) diagnosis, treatments and prevention. *Ejmo, 4*(2), 116-125. https://doi.org/10.14744/ejmo.2020.90853

Hange, N., Agoli, A. M., Pormento, M. K. L., Sharma, A., Somagutta, M. R., Paikkattil, N., . . . Pisude, P. (2022). Impact of COVID-19 response on public health literacy and communication. *Health Promotion Perspectives, 12*(1), 1. https://doi.org/10.34172/hpp.2022.01

Harapan, H., Wagner, A. L., Yufika, A., Winardi, W., Anwar, S., Gan, A. K., . . . Mudatsir, M. (2020). Acceptance of a COVID-19 vaccine in Southeast Asia: A cross-sectional study in Indonesia. *Frontiers in Public Health, 8*, 381. https://doi.org/10.3389/fpubh.2020.00381

Kitro, A., Sirikul, W., Dilokkhamaruk, E., Sumitmoh, G., Pasirayut, S., Wongcharoen, A., . . . Sapbamrer, R. (2022). COVID-19 vaccine hesitancy and influential factors among Thai parents and guardians to vaccinate their children. *Vaccine: X, 11*, 100182. https://doi.org/10.1016/j.jvacx.2022.100182

Kittipimpanon, K., Maneesriwongul, W., Butsing, N., Janepanish Visudtibhan, P., & Leelacharas, S. (2022). COVID-19 vaccine literacy, attitudes, and vaccination intention against COVID-19 among Thai older adults. *Patient Preference and Adherence*, 2365-2374. https://doi.org/10.2147/PPA.S376311

Koff, W. C., & Berkley, S. F. (2021). A universal coronavirus vaccine. *American Association for the Advancement of Science, 371*, 759. https://doi.org/10.1126/science.abh0447

Poland, G. A., Ovsyannikova, I. G., Crooke, S. N., & Kennedy, R. B. (2020). SARS-CoV-2 vaccine development: Current status. *Mayo Clinic Proceedings, 95*(10), 2172-2188. https://doi.org/10.1016/j.mayocp.2020.07.021

Pothisa, T., Ong-Artborirak, P., Seangpraw, K., Tonchoy, P., Kantow, S., Auttama, N., . . . Panta, P. (2022). Knowledge of COVID-19 and its relationship with preventive behaviors and vaccination among adults in northern Thailand's community. *International Journal of Environmental Research and Public Health, 19*(3), 1521. https://doi.org/10.3390/ijerph19031521

Prompetchara, E., Ketloy, C., & Palaga, T. (2020). Immune responses in COVID-19 and potential vaccines: Lessons learned from SARS and MERS epidemic. *Asian Pacific Journal of Allergy and Immunology, 38*(1), 1–9. https://doi.org/10.12932/AP-200220-0772

Romah, N. (2023). Situations and factors related to the arrangement of dental services in public health facilities under COVID-19 in 3 Southern border provinces. *Journal of Education and Research in Public Health, 1*(2), 65-79. https://so12.tci-thaijo.org/index.php/JERPH_Yala/article/view/441/347

Saito, K., Komasawa, M., Aung, M. N., & Khin, E. T. (2022). COVID-19 vaccination willingness in four Asian countries: A comparative study including Thailand, Indonesia, the Philippines, and Vietnam. *International Journal of Environmental Research and Public Health, 19*(19), 12284.

Sirikalyanpaiboon, M., Ousirimaneechai, K., Phannajit, J., Pitisuttithum, P., Jantarabenjakul, W., Chaiteerakij, R., & Paitoonpong, L. (2021). COVID-19 vaccine acceptance, hesitancy, and determinants among physicians in a university-based teaching hospital in Thailand. *BMC Infectious Diseases, 21*, 1-12. https://doi.org/10.1186/s12879-021-06863-5

Sunthornwat, R., & Areepong, Y. (2021). Predictive model for the total daily COVID-19 cases with herd immunity policy. *Natural and Life Sciences Communications, 20*(1), e2021016. https://doi.org/10.12982/CMUJNS.2021.016

Tangcharoensathien, V., Sachdev, S., Viriyathorn, S., Sriprasert, K., Kongkam, L., Srichomphu, K., & Patcharanarumol, W. (2022). Universal access to comprehensive COVID-19 services for everyone in Thailand. *BMJ Global Health, 7*(6), e009281. https://doi.org/10.1136/bmjgh-2022-009281

The Center for COVID-19 Situation Administration. (2021). *Coronavirus disease 2019 (COVID-19) [in Thai]*. Retrieved from https://media.thaigov.go.th/uploads/public_img/source/270464.pdf

Troiano, G., & Nardi, A. (2021). Vaccine hesitancy in the era of COVID-19. *Public Health, 194*, 245-251. https://doi.org/10.1016/j.puhe.2021.02.025

World Health Organization. (1967). *Smallpox eradication in Thailand. WHO/SE/78.113*. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/68243/WHO_SE_78.113.pdf?sequence=1&isAllowed=y

World Health Organization. (2020). *Listings of WHO's response to COVID-19*. Retrieved from https://www.who.int/news/item/29-06-2020-covidtimeline

Zhou, P., Yang, X.-L., Wang, X.-G., Hu, B., Zhang, L., Zhang, W., . . . Huang, C.-L. (2020). A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature, 579*(7798), 270-273.