Comparison of Disease Prevalence and Severity of SARS-CoV-2 Infection between Two Factory Accommodation Isolations in Southern Thailand

Kanruethai Tangsurased, M.D.[1], Chanon Kongkamol, M.D., M.H.S., Ph.D.[1], Phoomjai Sornsenee, M.D.[1], Thammasin Ingviya, M.D., M.H.S., Ph.D.[1,2]

[1]Department of Family Medicine and Preventive Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

[2]Department of Clinical Research and Medical Data Science, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

ABSTRACT

Objective: In 2021, the Thai Ministry of Public Health implemented policies known as "Factory Accommodation Isolation" (FAI) to provide care for confirmed patients with coronavirus disease-2019 (COVID-19). FAIs were established to alleviate strain on the healthcare system. However, the effectiveness of FAIs in alleviating COVID-19 remains unclear due to a lack of knowledge concerning the extent of the outbreak and the symptoms, severity, and management of the disease in workers' factories. This study aimed to describe and compare the characteristics, severity, and incidence of COVID-19 cases in two FAI facilities.

Material and Methods: This cross-sectional study was conducted in two factories related to concrete manufacturing and the production of rubber gloves in Songkhla, Thailand, between October 2021 and November 2021.

Results: The prevalence of COVID-19 infection in the concrete manufacturing factory, where prevention measures for COVID-19 were implemented early, and in the rubber glove factory was 38% and 21%, respectively. Patients from the concrete manufacturing factory reported a higher prevalence of symptoms, including cough, muscle pain, loss of sense of smell, and difficulty in breathing than did those from the rubber glove factory. Patients with incomplete vaccination had a higher prevalence of respiratory symptoms.

Conclusion: FAI design, number of workers, and crowded working spaces were associated with COVID-19 outbreaks in the workplace. This study showed that caring for patients with COVID-19 in FAI facilities can be performed safely while reducing the use of medical resources and personnel, which should be reserved for severe infections.

INTRODUCTION

Coronavirus disease-2019 (COVID-19) is an emerging respiratory disease caused by the SARS-CoV-2 virus[1]. The first outbreak of COVID-19 was reported in Wuhan, China, in December 2019. In 2020, the World Health Organization declared the COVID-19 pandemic a life-threatening disease and emphasized that countries should control, mitigate, and delay the outbreak in their populations[1-3].

The respiratory symptoms of patients infected with SARS-CoV-2 range from mild to severe, including pneumonia and respiratory failure. The probability of developing severe symptoms was relatively high in people aged ≥65 years, those who were immunocompromised, and those who had been diagnosed with chronic medical conditions, including cardiovascular diseases, chronic kidney diseases, diabetes, or chronic pulmonary diseases. The cumulative death rate was 243 per million people globally in 2020. In Thailand, the cumulative death rates were 0.85 per million people in 2020 and 303 per million people in 2021[4].

COVID-19 can be transmitted from infected individuals to others through respiratory droplets. In October 2020, based on Occupational Safety and Health Administration recommendations, US government agencies acted to protect worker health and safety through law enforcement and a COVID-19 prevention plan that included scheduling and workspace design to avoid crowding, physical distancing, using masks, enhancing ventilation, implementing hand sanitation, disinfecting contaminated surfaces, and screening workers with symptoms consistent with COVID-19 or who had had close contact with infected persons[5]. Nonetheless, the US still experienced many workplace COVID-19 outbreaks. The three most common sectors of outbreaks were manufacturing, retail trade, and transportation[6].

In Thailand, the first patient with COVID-19 was confirmed in March 2020. At the beginning of the COVID-19 outbreak, the Thai government implemented zero-COVID-19 policies by isolating confirmed patients and persons with a history of close contact in hospitals. After the number of patients increased in 2020, control measures moved from zero-COVID-19 to minimizing the number of patients by quarantining the confirmed patients or high-risk contacts at field hospitals, social distancing, and limiting the number of people in the same public space and/or transportation[7]. In early 2021, after its evolution to the delta variant, SARS-CoV-2 spread rapidly worldwide, causing a global public health crisis. In Thailand, almost 20,000 patients were confirmed per day, and the fatality rate reached 300 deaths per day in August 2021. The cumulative number of deaths in Thailand ranged from approximately 200 to 11,500 from April to August 2021[4].

In 2021, Thai enterprises, including medium-to-large factories, were impacted by the COVID-19 outbreak, particularly in crowded immigration worker camps. When an infection was confirmed, all workers at the campsite were likely to have been infected without proper isolation or quarantine. Limited healthcare resources and facilities could not accommodate the isolation of many migrant workers. Therefore, the Thai Ministry of Public Health implemented policies called "Factory Accommodation Isolation" (FAI), where each factory was to set up facilities for taking care of confirmed patients through collaboration between their safety personnel and public health officers. These policies were implemented from August 2021 and continued until the completion of the current study[8,9]. FAI was designed to manage and control the COVID-19 outbreak and to be run by human resources and safety personnel from the factory in collaboration with the healthcare isolation system of designated hospitals or healthcare facilities. Thus, FAI was designed to mimic a healthcare facility for patient care with COVID-19 and to isolate confirmed patients using factories' facilities to reduce the number of patients and burden on

the healthcare system. FAI has not yet been established outside of Thailand, and most people self-quarantine at home and use universal prevention measures. However, the status of COVID-19 in FAI remains unclear. This is due to a lack of knowledge regarding the scope of the outbreak, symptoms, severity, and management of the disease in workers' factories[10,11].

Thus, the objectives of this cross-sectional study were to describe and compare the severity of FAI and the prevalence of COVID-19 outbreaks between two factories with different FAI designs, numbers of workers, and job descriptions: a Thai concrete factory and a rubber glove factory. Concrete factories manufacture instant concrete, which consists of mixing components, forming concrete, and shipping. The glove factory manufactures and exports natural rubber (concentrated latex) gloves and involves various production processes. By understanding the different characteristics of FAI between the two factories, their outbreaks, and the severity of patients, we believe that our study can provide fundamental knowledge for using FAI to control and mitigate outbreaks of similar communicable diseases in the future.

MATERIAL AND METHODS

Study design and settings

The cross-sectional study was conducted in two industrial areas: a concrete manufacturing factory and a rubber glove factory in Songkhla, a business city in Southern Thailand. Data were collected from October 2021 to November 2021.

Study population

The study population consisted of workers who had been employed in either of the two factories for at least 6 months before the date of data collection. The inclusion criterion was age equal to or more than 18 years. No explicit exclusion criteria were applied.

Data collection

The data collection was performed using the "RH12 care," an application developed by the Division of Digital Innovation and Data Analytics, Faculty of Medicine, Prince of Songkla University, to track and monitor patients with COVID-19 at home or in FAI that was used by doctors and nurses of hospitals residing in Health Region 12 of Thailand, or the lower southern part of Thailand. Patients or the human resource team of each factory reported proof of positive COVID-19 results, including real-time polymerase chain reaction (RT-PCR) or rapid antigen test kit (ATK) results, to register confirmed patients on the application. Care was then provided, and monitoring was performed online by doctors and nurses. This included assessing the severity score, evaluating the indications for prescribing Favipiravir (an antiviral medication), and registering for social welfare, such as food and drink, and accommodations.

Data on workers were extracted from the application database, which included workers' characteristics, baseline symptoms, severity of patients with COVID-19 rated by doctors online through telecommunications, COVID-19 vaccination, and characteristics of the FAI.

Outcomes of interest

The outcome of interest was the prevalence and severity of COVID-19 infection in the two factories. Confirmed patients with COVID-19 were those with either positive RT-PCR and/or ATK. Severe patients included those with respiratory failure or a severe condition as diagnosed by a physician. The characteristics of the two FAI facilities were compared and associated with the prevalence and severity of COVID-19 to understand FAI-related factors associated with disease outbreaks and/or severity.

Factors of interest

Signs and symptoms of COVID-19 in the patients were self-reported and were recorded twice daily for FAI

applications. The signs reported included resting heart rate, resting SpO2, and body temperature. Symptoms reported included cough, sore throat, muscle pain, and headache. The number of inactivated vaccinations was obtained from the factory's human resource department records and was confirmed with government data called "MOPHIC." The number of patients with COVID-19-infection referrals from the FAI to the collaborating regional tertiary hospital was tracked from the establishment of these two FAI facilities. All referred patients were reported through the application.

Statistical analysis

Descriptive analyses were performed to describe the characteristics of the study population as either continuous or categorical data, where appropriate. The prevalence of COVID-19 infection in the rubber glove and concrete manufacturing factories was compared using a chi-square test, and the corresponding 95% confidence intervals of the prevalence were calculated assuming a binomial distribution using the bootstrap method. Fisher's exact test was used to compare the severity of COVID-19 in the two factories. All analyses were performed using R software version 4.2.0 (R Core Team, Vienna, Austria).

RESULTS

Important control measures were similar between the FAI facilities of the two factories. Similar important measures included collaborations with a regional tertiary hospital, enforcement of wearing medical and personal protective equipment, and daily patient monitoring. However, the FAI of the rubber glove factory implemented early preventive and control measures. Other distinctive measures were implemented for all workers, including random screening with ATK tests, establishing explicit boundaries for the FAI area within factory premises, and wastewater disposal through the factory's treatment plant. Further measures included the separation of workspaces for migrant and

Thai workers and using table partition shields in cafeterias to promote social distancing (Table 1).

During the study period in 2021, 57 (38%) and 159 (21%) confirmed patients with COVID-19 among the 150 and 757 employees of the concrete manufacturing and rubber glove factory were accommodated at the respective FAI facilities. Patient characteristics are shown in Table 2. Most patients were migrant workers, and more than half were Burmese workers. The mean age was 31.2 years, while the average body mass index was 21.2 kg/m². Most of the workers reported no underlying diseases.

Table 3 shows the prevalence of symptoms and their severity in patients in the two FAI facilities. Patients from the rubber glove factory had a slightly higher median resting SpO2 (99%) than those from the concrete manufacturing factory (98%). Body temperature and heart rate were not significantly different between the two groups. Patients from the concrete manufacturing factory reported a higher prevalence of cough, muscle pain, loss of sense of smell, and difficulty breathing than did those from the rubber glove factory.

Of the total number of 216 patients in both FAI facilities, only 57 patients had completed vaccination (i.e., received at least two doses of vaccine by the time of confirmed COVID-19 infection). At the time of the study, 30% and 16% of the employees were in FAI rubber glove and concrete manufacturing factories, respectively. The prevalence of self-reported symptoms and the severity of COVID-19 are compared between those with and without complete vaccination in Table 4. Although not statistically significant, patients with incomplete vaccination reported a higher prevalence of symptoms, including cough, sore throat, loss of sense of smell, and difficulty breathing. None of the patients in either FAI facility reported a rash, red eyes, chest pain, or diarrhea. None of the patients developed severe respiratory distress or were referred to the hospitals associated with the FAI facilities.

Table 1 Comparison of control measures in FAI facilities between the concrete manufacturing and rubber glove factories

FAI of concrete manufacturing factory	FAI of rubber glove factory
• Random ATK test in employees since August 2021. • Arranging working zones; as a result, healthy workers with negative ATK tests worked in a designated area separated from positive or close-contact workers. • FAI was run in collaboration with a regional tertiary hospital and the city municipality for monitoring and referral systems. • Twice daily continuous patient monitoring for 10 days. • Accommodation for isolation was near the factory and was sufficient for at least 10% of employees. • Accommodation was a three-story building with a balcony, with five rooms per floor. Four toilets were there on each floor of the building. • Accommodation had appropriate ventilation, such as windows and fans for ventilation. • Required medical equipment, such as a thermometer, pulse oximeter, and sphygmomanometer, was obtained. • Personal protective equipment for attendants and employees, such as surgical masks and medical gloves, was prepared. • Infectious waste was disposed of by municipal garbage truck once per week. • Wastewater from the FAI was treated at the municipal wastewater treatment site. • Inactivated COVID-19 vaccination for all employees.	• Early random ATK test in employees by nurses since March 2021. • Arranging the working zone; as a result, healthy workers with a negative ATK test worked in a designated area separated from positive or close-contact workers. • FAI was run in collaboration with a regional tertiary hospital and the city municipality for monitoring and referral systems. • Twice daily continuous patient monitoring for 10 days. • Accommodation for isolation was near the factory and was sufficient for at least 10% of employees. • For females, accommodation was a three-story building with ensuite bathrooms. For males, the accommodation was a camp with knockdown bathrooms. • Accommodation had appropriate ventilation, such as windows and fans for ventilation. • Marking the explicit boundary of the FAI in the factory area. • Required medical equipment, such as a thermometer, pulse oximeter, and sphygmomanometer, was obtained. • Personal protective equipment for attendants and employees, such as surgical masks and medical gloves, was prepared. • Separation of migrant and Thai workers. • Infectious waste was incinerated by the factory incinerator. • Wastewater treatment was done by the wastewater treatment plant at the factory. • Inactivated COVID-19 vaccination for all employees.

FAI=factory accommodation isolation; COVID-19=coronavirus disease-2019; ATK=rapid antigen test kit

DISCUSSION

In this study, the prevalence of COVID-19 among employees of the concrete manufacturing factory was higher than that among rubber glove factory employees (38% vs. 21%). No severe infections or hospitalizations occurred at either factory. Only differences in the prevalence of mild symptoms, including cough, muscle pain, loss of smell, and difficulty in breathing, were observed between the two FAI facilities.

Limited research exists on COVID-19 outbreaks and control measures in factory settings during the COVID-19 pandemic in the delta variant phase. Only one Canadian study, performed in factory settings during the delta variant outbreak, reported lower infection rates in the manufacturing (16%) and construction (4%) industries[12]. Differences in factory type, workplace space, preventive measures, vaccination rates, and job roles likely contributed to the disparities observed between the FAI facilities in our study.

We compared control measures implemented in the FAI facilities of the concrete manufacturing and rubber glove factories. The rubber glove factory implemented various primary prevention measures to control COVID-19. In the rubber glove factory, these control measures included universal prevention and strict physical distancing, immediate isolation of high-risk contact migrant workers to control the spread of COVID-19, and designation of separate working areas for individual workers. Facility zoning has been shown to be an effective measure against airborne infections in

Table 2 Participant's characteristics between FAI concrete manufacturing factory and FAI rubber glove factory

	Overall (N=216)	FAI of concrete manufacturing factory (N=57)	FAI of the rubber glove factory (N=159)	p-value
Sex				<0.001[c]*
Male	106.0 (49.1%)	41.0 (71.9%)	65.0 (40.9%)	
Female	110.0 (50.9%)	16.0 (28.1%)	94.0 (59.1%)	
Age				<0.001[b]*
Mean (S.D.), years	31.2 (7.1)	35.5 (7.0)	29.6 (6.4)	
Body weight				0.749[c]
Mean (S.D.), kg	55.6 (7.9)	56.2 (10.3)	55.4 (6.8)	
Height				0.058[a]
Mean (S.D.), cm	162.0 (7.0)	160.0 (5.8)	162.0 (7.3)	
BMI				0.176[b]
Mean (S.D.), kg/m^2	21.2 (2.99)	21.8 (3.75)	21.0 (2.65)	
Underlying disease				
Yes	2.0 (0.9%)	0.0 (0.0%)	2.0 (1.3%)	
No	214.0 (99.1%)	57.0 (100%)	157.0 (98.7%)	
Race				<0.001[d]*
Burmese	188.0 (87.0%)	39.0 (68.4%)	149.0 (93.7%)	
Thai	1.0 (0.5%)	0.0 (0.0%)	1.0 (0.6%)	
Others	27.0 (12.5%)	18.0 (31.6%)	9.0 (5.7%)	
Incidence of COVID-19 infection				<0.001[c]*
n (%)	216 (23.8%)	57 (38.0%)	159 (21.0%)	

*significant at p-value<0.05; [a]*t*-test; [b]Wilcoxon's rank-sum test; [c]chi-square test; [d]Fisher's exact test; FAI=factory accommodation isolation; S.D.=standard deviation; COVID-19=coronavirus disease-2019

Table 3 Prevalence of self-reported symptoms and severity of COVID-19 between patients in FAI of concrete manufacturing factory and rubber glove factory

	FAI of the concrete manufacturing factory (N=57)	FAI of the rubber glove factory (N=159)	p-value
Vital signs			
Resting Heart Rate			
Mean (S.D.)	85.8 (14.2)	89.7 (12.6)	0.055[a]
Resting SpO2			
Median (IQR)	98.0 (97.0, 99.0)	99.0 (98.0, 99.0)	<0.001[b]*
Body temperature			
Median (IQR)	35.8 (35.2, 36.4)	35.9 (35.3, 36.3)	0.418[b]
Present of symptoms, n (%)			
Cough	34.0 (59.6)	56.0 (35.2)	0.001[c]*
Muscle pain	8.0 (14.0)	1.0 (0.6)	<0.001[d]*
Sore throat	10.0 (17.5)	19.0 (11.9)	0.288[c]
Loss of smell	5.0 (8.8)	3.0 (1.9)	0.032[d]*
Headache	9.0 (15.8)	12.0 (7.5)	0.072[c]
Difficult breathing	5.0 (8.8)	0.0 (0.0)	0.001[d]*

*significant at p-value<0.05; [a]*t*-test; [b]Wilcoxon's rank-sum test; [c]chi-square test; [d]Fisher's exact test; FAI=factory accommodation isolation; S.D.=standard deviation; COVID-19=coronavirus disease-2019

Table 4 Prevalence of self-reported symptoms and severity of patients with COVID-19 by COVID-19 vaccination status

	Incomplete vaccination (N=159)	Complete vaccination (N=57)	p-value
Signs and symptoms, n (%)			
Resting heart rate			
Mean (S.D.)	88.0 (13.2)	90.6 (12.9)	0.198[a]
Resting SpO2			
Mean (S.D.)	97.8 (3.3)	98.1 (3.4)	0.560[b]
Temperature			
Median (IQR)	35.8 (35.3–36.3)	35.9 (35.5–36.4)	0.381[b]
Cough	69.0 (43.4)	21.0 (36.8)	0.389[c]
Muscle pain	7.0 (4.4)	2.0 (3.5)	1.000[d]
Sore throat	21.0 (13.2)	8.0 (14.0)	0.875[c]
Loss of smell	7.0 (4.4)	1.0 (1.8)	0.684[d]
Headache	14.0 (8.8)	7.0 (12.3)	0.447[c]
Respiratory problems	4.0 (2.5)	1.0 (1.8)	1.000[d]
COVID-19 vaccination			<0.001[d*]
Single Sinopharm	3.0 (100)	0.0 (0)	
Both Sinopharm	0.0 (0.0)	51.0 (89.5)	
Single Sinovac life sciences, single AstraZeneca	0.0 (0.0)	6.0 (10.5)	
No data	156 (72)		

*significant at p-value<0.05, [a]*t*-test; [b]Wilcoxon's rank-sum test; [c]chi-square test; [d]Fisher's exact test; S.D.=standard deviation; COVID-19= coronavirus disease-2019

several settings, such as hospital settings and nursing home residences[13]. Comprehensive COVID-19 prevention and control measures that incorporate contact tracing, patient isolation, PPE use, and facility zoning can effectively prevent workplace outbreaks. Masking alone should not be considered sufficient for protection against outbreaks in the workplace[14].

The job descriptions of workers may have affected the prevalence of COVID-19. In a concrete manufacturing factory, where instant concrete is made by mixing rock, soil, and sand, the major production steps require workers to gather and perform close-contact work. This hampered the implementation of a zoning policy. In a rubber glove factory, workers generally perform separate tasks independently. A study in Ontario, Canada, reported that the COVID-19 outbreak in the manufacturing industry was associated with a high-density work setting, close proximity between worker stations, and long duration of contact during work[15].

The COVID-19 pandemic affected a significantly lower proportion of young individuals. Age disparities among the observed patients could be explained by the fact that younger people had a lower susceptibility to infection, a lower propensity to display clinical symptoms, or both[16–18]. These factors may explain the higher prevalence of disease and symptoms observed in infected patients in the concrete manufacturing factory, as the workforce tended to be older than those in the rubber glove factory.

Rubber glove factory employees reported higher percentages of complete COVID-19 vaccination (at least two doses) than did those of the concrete manufacturing factory. Nevertheless, no significant difference was observed in the prevalence or severity of symptoms between patients with and without complete vaccination. Unlike this study, other studies have reported protective effects of vaccination against symptom severity in patients infected with the SARS-CoV-2 delta variant, which was

the most common variant found during the study period[19–22]. These negative findings may be ascribed to the overall health of the workers, who reported no underlying diseases, or the small sample size of this study.

No severe infections or hospital referrals were reported for the 216 study patients. This may be due to the overall health status of the workers, as individuals with no underlying disease were at a relatively lower risk of developing severe symptoms. Patients with underlying conditions, such as obesity, asthma, cardiovascular disease, and diabetes, were reported to develop severe respiratory symptoms[23]. Younger patients with COVID-19 have been reported to require hospitalization less than twice as frequently as those in their 40s and 50s[24]. In our study, no patients in the FAI facilities were severely ill or required referral for hospitalization.

Besides the potential selection bias described above, the relatively small sample size and cross-sectional design limit the interpretation of the results of this study in terms of causal relationships. Moreover, the prevalence of symptoms was based on a self-reported questionnaire, which might have been overestimated due to the fear of COVID-19 at the time of the study. Nonetheless, this study is one of the few to assess the characteristics and effectiveness of factories' responses to communicable outbreaks in settings with limited healthcare resources. The characteristics of these self-sustaining facilities for employees can be applied to related industries.

CONCLUSION

The prevalence of COVID-19 outbreaks differed between the two factories, with different FAI designs, numbers of workers, and job descriptions. These factors affected COVID-19 prevalence and disease control. Our findings indicate that, in times of resource constraint or high burdens on healthcare, such as during the COVID-19 pandemic or outbreaks of similar airborne diseases, effectively establishing facilities to take care of workers in their own work environment, such as the FAI facilities described in this study, can reduce the burden on medical resources while taking care of infected but relatively healthy workers safely. This will preserve the limited resources for severe infections that require intensive medical attention. Additionally, it will help decrease hospital overcrowding, which in turn lowers the risk of infection among healthcare workers and other patients.

REFERENCES

1. World Health Organization. Coronavirus disease (COVID-19). [homepage on the Internet]. Geneva: WHO; 2023 [cited 2023 Jan 7]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019

2. COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines [monograph on the Internet]. National Institutes of Health; 2019 [cited 2023 May 02]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK570371/pdf/Bookshelf_NBK570371.pdf

3. World Health Organization. Coronavirus disease (COVID-19) Symptom. [homepage on the Internet] Geneva: WHO; 2021 [cited 2022 Jan 12]. Available from: https://www.who.int/westernpacific/health-topics/coronavirus

4. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Giattino C, Hasell J, et al. Coronavirus Pandemic (COVID-19) [homepage on the Internet]. Our World Data; 2020 [cited 2023 Oct 1]. Available from: https://ourworldindata.org/coronavirus/country/thailand

5. Michaels D, Wagner GR. Occupational Safety and Health Administration (OSHA) and worker safety during the COVID-19 pandemic. JAMA 2020;324:1389.

6. Contreras Z, Ngo V, Pulido M, Washburn F, Meschyan G, Gluck F, et al. Industry sectors highly affected by worksite outbreaks of coronavirus disease, Los Angeles County, California, USA, March 19–September 30, 2020. Emerg Infect Dis 2021;27:1769–75.

7. Department of disease control. Ministry of Public Health. Situation of coronavirus disease 2019 (COVID-19) public health measures and obstacles to disease prevention and control in travelers. [monograph on the nternet]. Ministry of Public Health; 2021 [cited 2022 Jan 29]. Available from: https://ddc.moph.go.th/uploads/files/2017420210820025238.pdf

8. Ministry of Labor. Ministry of Labor Announcement. Providing welfare of business establishments for provide accommodation for employees to protect against the risk of coronavirus disease 2019 [monograph on the Internet]. 2021 [cited 2022 Jan 12]. Available from: http://www.oic.go.th/FILEWEB/CABINFOCENTER3/DRAWER005/GENERAL/DATA0002/00002908.PDF

9. Department of Disease Control, Ministry of Public Health. Guide to disease prevention and control measures in specific areas (Bubble and Seal) for business establishments [monograph on the Internet]. Ministry of Publc Health; 2021 [cited 2022 Jan 12]. Available from: https://ddc.moph.go.th/uploads/publish/1183620211001030623.pdf

10. Health Center 5, Ratchaburi, Department of Health, Ministry of Public Health. Guidelines for establishing isolation centers for infected people with COVID-19 in factories or establishments [monograph of the Internet]. Ratchaburi: Ministry of Public Health; [cited 2022 Jan 12]. Available from: https://apps.hpc.go.th/dl/web/upFile/2021/08-10077-20210826164051/d0c7fa5f844061111bad4a26f8492056.pdf

11. Nopparat Ratchathani Hospital, Occupational and Environmental Medicine Center. Guidelines for practice in the COVID-19 outbreak situation for establishments. Bangkok: Nopparat Ratchathani Hospital; 2021.

12. Buchan SA, Smith PM, Warren C, Murti M, Mustard C, Kim JH, et al. Incidence of outbreak-associated COVID-19 cases by industry in Ontario, Canada, 1 April 2020–31 March 2021. Occup Environ Med 2022;79:403-11.

13. Ingram C, Downey V, Roe M, Chen Y, Archibald M, Kallas KA, et al. COVID-19 prevention and control measures in workplace settings: a rapid review and meta-analysis. Int J Environ Res Public Health 2021;18:7847.

14. Ingram C, Downey V, Roe M, Chen Y, Archibald M, Kallas KA, et al. COVID-19 prevention and control measures in workplace settings: a rapid review and meta-analysis. Int J Environ Res Public Health 2021;18:7847.

15. Murti M, Achonu C, Smith BT, Brown KA, Kim JH, Johnson J, et al. COVID-19 workplace outbreaks by industry sector and their associated household transmission, Ontario, Canada, January – June, 2020. J Occup Environ Med 2021;63:574-80.

16. Davies NG, Klepac P, Liu Y, Prem K, Jit M, CMMID COVID-19 working group, et al. Age-dependent effects in the transmission and control of COVID-19 epidemics. Nat Med 2020;26:1205-11.

17. Schneiderman M, Rumain B, Kaganovskiy L, Geliebter A. Incidence and relative risk of COVID-19 in adolescents and youth compared with older adults in 19 US States, Fall 2020. JAMA Netw Open 2022;5:e2222126.

18. Kalantari H, Tabrizi AHH, Foroohi F. Determination of COVID-19 prevalence with regards to age range of patients referring to the hospitals located in western Tehran, Iran. Gene Rep 2020;21:100910.

19. Al Kaabi N, Zhang Y, Xia S, Yang Y, Al Qahtani MM, Abdulrazzaq N, et al. Effect of 2 inactivated SARS-CoV-2 vaccines on symptomatic COVID-19 infection in adults: a randomized clinical trial. JAMA 2021;326:35.

20. Hu Z, Tao B, Li Z, Song Y, Yi C, Li J, et al. Effectiveness of inactivated COVID-19 vaccines against severe illness in B.1.617.2 (Delta) variant-infected patients in Jiangsu, China. Int J Infect Dis 2022;116:204-9.

21. Wu D, Zhang Y, Tang L, Wang F, Ye Y, Ma C, et al. Effectiveness of inactivated COVID-19 vaccines against symptomatic, pneumonia, and severe disease caused by the delta variant: real world study and evidence—China, 2021. China CDC Wkly 2022;4:57-65.

22. Palacios R, Batista AP, Albuquerque CSN, Patiño EG, Santos J do P, Tilli Reis Pessoa Conde M, et al. Efficacy and safety of a COVID-19 inactivated vaccine in healthcare professionals in Brazil: the PROFISCOV study. Rochester, NY; 2021 [cited 2023 Feb 28]. Available from: https://papers.ssrn.com/abstract=3822780

23. COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines [homepage on the Internet]. National Institutes of Health; 2019 [cited 2023 May 02]. Available from: https://www.covid19treatmentguidelines.nih.gov/

24. Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. Estimates of the severity of coronavirus disease 2019: a model-based analysis. Lancet Infect Dis 2020;20:669-77.