



## Risk Factor and Clinical Outcomes of Coronavirus Disease 2019 (COVID -19) Patients in TAK Province, Thailand

Dr. Thanyarat Sitthiwong<sup>1</sup>, Krit Sonkong, Dr.P.H.<sup>2</sup>

<sup>1</sup>Director of Bantak hospital, Provincial Public Health Office, Tak, Thailand

<sup>2</sup>Lecturer at Kamphaeng Phet Rajabhat University, Kamphaeng Phet, Thailand

### ABSTRACT

**Objective:** To describe the association of clinical characteristics, clinical progression, and outcome of COVID-19 patients in TAK province, Thailand

**Methods:** This retrospective cohort study included patients who were diagnosed with COVID-19 in Tak province, Thailand from June 1, 2021 to December 31, 2021.

**Results:** The statistical analysis was done on the records of 15,442 patients who underwent RT-PCR of SARS-CoV-2 detection at Tak province during the fourth wave of the outbreak. 53.9% of patients were diagnosed asymptomatic. The overall mortality rate among patients with COVID-19 in this study was 1.81%. Patients with ages over 60 years was associated with increased risk of pneumonia (aOR 5.16, 95% CI 4.52-5.89;  $P < 0.001$ ) and death (aOR 22.09, 95% CI 12.66-38.53,  $P < 0.001$ ). Myanmar were also significantly associated with pneumonia (aOR 1.15, 95% CI 1.00-1.33,  $P < 0.001$ ) and death (aOR 1.99, 95% CI 1.44-2.78,  $P < 0.001$ ). Chronic Kidney Disease (aOR 3.84, 95% CI 2.31-6.38,  $P < 0.001$ ) and dyspnea (aOR 4.54, 95% CI 3.27-6.31,  $P < 0.001$ ) were associated with increased odds of death as well as the presence of more than one comorbidity (aOR 2.87, 95% CI 1.99-4.14,  $P < 0.001$ ). The previous receipt of vaccination regardless of partially (aOR 0.14, 95% CI 0.08-0.27;  $P < 0.001$ ) or fully vaccination (aOR 0.08, 95% CI 0.03-0.19;  $P < 0.001$ ) was associated with lower odds of mortality.

**Conclusions:** Determining high-risk COVID-19 infected patients can help in the design of appropriate measures and proper management strategies. Ongoing mass vaccination efforts is still an absolutely priority for Thai and non-Thai citizens as a human right to health.

**KEYWORDS:** COVID-19, Comorbidity, Mortality, SARS-CoV-2, Vaccination

### 1. INTRODUCTION

Since the Coronavirus Disease 2019 (COVID-19) outbreak has started in early December 2019, it rapidly spread to the majority of countries worldwide in less than three months. The outbreak caused more than 1.1 million confirmed cases and caused nearly 63,000 deaths on April 5, 2020 (1). It was declared a Public Health Emergency of International Concern on January 30, 2020, and a pandemic on March 11, 2020, by the World Health Organization (WHO) (2). In Thailand, the first COVID-19 case was reported on January 13, 2020. The outbreak was under control and manageable as there were only 3,134 confirmed cases with a relatively death low case fatality rate of 2% on June 30, 2022 (3). In late March 2020, the first wave of COVID-19 hit Thailand with the peak of daily cases numbering about 188 confirmed cases. The second wave of the outbreak began in mid-December 2020 and lasted until late February 2021, with a total of 19,867 confirmed cases. In April 2021, the country was hit by the third wave of the outbreak, caused by the Alpha variant of COVID-19, and the cumulative number of cases had increased to 290,000 in early July 2021(4). The situation was worsened, by the fourth wave of the outbreak on July 6, 2021, The outbreak has been driven by the highly-contagious Delta variant and rapidly transmitted to both vaccinated and unvaccinated populations (5). At that time only about 6.1 percent of Thailand's 70 million people were fully vaccinated (6). Meanwhile, many hospitals in the capital Bangkok were reported as facing the unavailability of hospital beds. The Thai government has even started returning COVID-19 patients to their hometowns for further treatment.

Tak province is a province in Thailand located along the Moei River as a western border between Thailand and Myanmar which is approximately 500 km long. In preparation for the transferred patients from Bangkok, the Committee of Communicable Disease of Tak province established field hospitals and community isolation facilities for asymptomatic and mildly symptomatic patients.



There are many studies regarding the clinical characteristics, comorbid conditions, and clinical outcomes of COVID-19 (7)(8)(9). However, there remains limited information regarding the association between patients who acquired COVID-19 and clinical outcomes after vaccination compared to unvaccinated COVID-19 cases.

This study was conducted to evaluate the demographic, presenting characteristics, especially prior vaccination with COVID-19, and clinical outcome of all laboratory-confirmed patients, diagnosed during the fourth wave.

## 2. MATERIAL AND METHODS

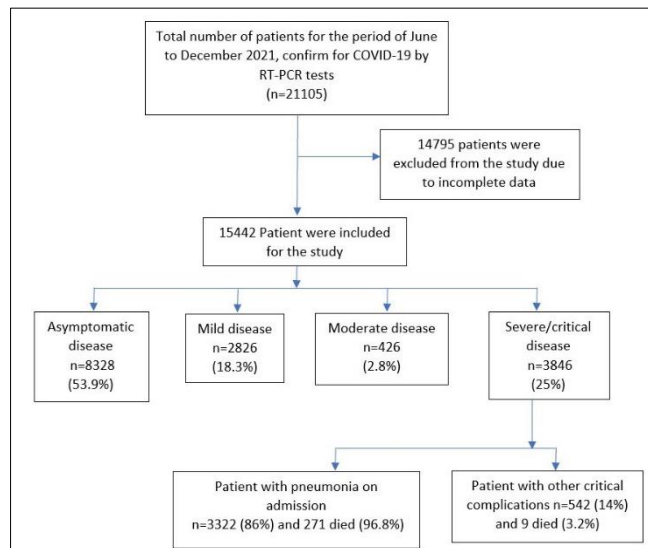
We conducted a retrospective study of all patients with a laboratory-confirmed diagnosis of COVID-19 who were admitted or quarantined in two provincial hospitals, seven district hospitals, four field hospitals, eleven community isolation facilities, and home isolation in Tak province, Thailand from June 1, 2021 to December 31, 2021. The data were identified via Tak Provincial Health Data Center of electrical medical record system and Situation Awareness Team. A confirmed COVID-19 case was defined as a positive result on a reverse transcriptase-polymerase chain reaction SARS-CoV-2 assay of a nasopharyngeal swab specimen. Patients were ineligible and excluded if they had insufficient clinical documentation available. The data was collected on the following patients' characteristics: age, sex, race, nationality, health coverage scheme, occupational status, exposure history, clinical symptoms, comorbidities, place of quarantine or admission, and history of COVID-19 vaccination. The primary outcomes of interest included severity of disease and discharged status. The disease severity of COVID-19 was classified as (1) asymptomatic (2) mild (defined as mild symptoms and no comorbidity), (3) moderate (defined as mild symptoms with at least one comorbidity or age more than 60 years old), and (4) severe (defined as the presence of pneumonia or critical complications)

Data are presented as numbers and percentages for categorical data and as mean  $\pm$  standard deviation for normal distribution data or median and range for non-normally distributed data. Categorical variables were presented as a number of patients and percentages. Continuous variables were summarized as median and interquartile range (IQR) values. Significant risk factors identified on univariate analyses with  $p$ -value  $< 0.20$  were further analyzed by multiple logistic regression to identify risk factors associated with clinical outcomes. All statistical analyses were performed via the STATA software package (Stata, version.12.0; StataCorp, College Station, Texas 77845 USA).

## 3. RESULTS

### Characteristics of study participants

A Total of 21,205 laboratory-confirmed COVID-19 patients by RT-PCR testing for SAR-CoV-2 were admitted or quarantined from Jun 1, 2021, to December 2021. The analysis was done on 15,442 patients' records since the other 14,795 patients' records were incomplete and excluded from our analysis. During the entire course of illness, most notably, 53.9% of patients were asymptomatic. The remaining patients had either mild symptoms (18.3%) or moderate symptoms (2.8%), while 25% of patients had severe/critical disease. Among patients who presented with severe/critical, the most common were pneumonia (86%), and the rest had other critical complications (14%). The number of deaths during hospital admission from these two cases were 271 and 9, respectively (Fig.1). The overall mortality rate among patients with COVID-19 in this study was 1.81%. The study population comprised slightly more females (53.78%) than males (46.22%). The median age was 31 years (IQR 17-49), and 5,374 patients (34.80%) were of age under 20 years. The proportion of elderly patients whose ages are over 60 years was 13.24%. Of all patients, 13,362 (86.53%), 1,428 (9.25%), 641(4.15%), and 11 (0.07%) were Thai, Myanmar, stateless, and another race, respectively (Table 1). Approximately 30% were students; 26% were unemployed; 21% were agriculture; and 23% had other occupations, whereas, healthcare workers represented only 1% of the infected population. Among possible health coverage schemes, around three quarters (87%) were covered under the Universal Coverage Scheme, which provides public health insurance coverage to those ineligible for Social Security Scheme or Civil Servant Medical Benefit Scheme. However, 570 (4%) stateless people were covered under Health Insurance for People with Citizenship Problems (HIPCP), 403 (3%) were covered under Health Insurance Card for migrant workers and 1,001 (6%) were uninsured people. Many of patients reported contact with COVID-19 patients (67%), going to high-risk places (28%), and very few (5%) could not identify source (Table 1).



**Figure 1.** Flow diagram of patients and classification of clinical severity of coronavirus disease 2019 who underwent real-time reverse transcription-polymerase chain reaction (RT-PCR) test for SARS-CoV-2

**Comorbidities and other conditions**

In total, most patients (91.65%) had no comorbidity, only 4.24% of patients had at least one comorbidity, and common comorbidities observed were hypertension (3.96%) and diabetes mellitus (3.96%), and dyslipidemia (2.35%). The most common presenting symptoms were cough (24.38%), nasal congestion (17.2%), fever (12.92%), and sore throat (9.94%) (Table 1).

**Factors associated with pneumonia**

On univariate analysis, it was found that higher age, Myanmar, and other races, students, unemployed and other occupations, people with or without health insurance, and those having a history going to high-risk places either could not identify the source of infection were also significantly associated with pneumonia (Table 2). COVID patients who had pre-existing comorbidities including diabetes mellitus, followed by hypertension, dyslipidemia, Chronic Obstructive Lung Disease, cardiovascular disease, cerebrovascular disease, chronic kidney disease, and atrial fibrillation were also significantly associated with pneumonia, as well as presenting one or more than two comorbidities. Patients who presented with fever and cough were more like to develop pneumonia.

**Table 1.** Characteristic of all confirmed COVID-19 patients.

Characteristics	All patients (n=15442) N (%)
Age in year [median (IQR)]	31 (17-49)
Age groups, y	
< 20	5374 (34.80)
20 – 39	4374 (28.33)
40 – 59	3649 (23.63)
≥ 60	2,045 (13.24)
Sex	
Male	7138 (46.22)
Female	8304 (53.78)
Race	
Thai	13362 (86.53)
Myanmar	1428 (9.25)
Stateless	641 (4.15)



Characteristics	All patients (n=15442) N (%)
Other	11 (0.07)
Occupational status	
Employed	4003 (25.92)
Agriculture	3291 (21.31)
Student	4565 (29.56)
Government officer	80 (0.52)
Healthcare worker	370 (2.40)
Unemployed	1011 (6.55)
Other	2122 (13.74)
Health Coverage Scheme	
Civil Service Medical Benefit Scheme (CSMBS)	921 (5.96)
Social Security Scheme (SSS)	2095 (13.57)
Health Insurance for People with Citizenship Problems (HIPCP)	570 (3.69)
Health Insurance Card for migrant workers	403 (2.61)
Uninsured people	1001 (6.48)
Universal Coverage Scheme (UCS)	10452 (67.69)
Exposure history within the past 14 d	
Contact with a COVID-19 patient	10403 (67.37)
Going to high-risk places	4320 (27.98)
Could not identify source	719 (4.66)
Presence of comorbidities	
Diabetes mellitus	612 (3.96)
Hypertension	843 (5.45)
Dyslipidemia	363 (2.35)
Chronic Obstructive Lung Disease	33 (0.21)
Asthma	21 (0.14)
Epilepsy	19 (0.12)
Cardiovascular disease	14 (0.09)
Cerebrovascular disease	71 (0.46)
Chronic kidney disease	138 (0.89)
Atrial fibrillation	25 (0.16)
Congestive health failure	17 (0.11)
Malignancy	17 (0.11)
Cirrhosis	6 (0.04)
Autoimmune or inflammatory conditions	35 (0.23)
Dementia	4 (0.03)



Characteristics	All patients (n=15442) N (%)
Presenting symptoms	
Fever	1995 (12.92)
Cough	3765 (24.38)
Sore throat	1535 (9.94)
Myalgia	826 (5.35)
Nasal congestion	2656 (17.20)
Productive sputum	1293 (8.37)
Difficulty in breathing	611 (3.96)
Headache	946 (6.13)
Diarrhea	186 (1.2)
Anosmia	654 (4.24)
Ageusia	202 (1.31)
1 <sup>st</sup> Dose of COVID-19 Vaccination	
Inactivated Vaccines	2451 (67.34)
Viral Vector Vaccines	1050 (28.85)
mRNA vaccine	139 (3.82)
2 <sup>nd</sup> Dose of COVID-19 Vaccination	
Inactivated Vaccines	763 (54.04)
Viral Vector Vaccines	595 (42.14)
mRNA vaccine	54 (3.82)
COVID-19 Vaccination	
Unvaccinated	11802 (76.43)
Partially vaccinated	2228 (14.43)
Fully vaccinated	1412 (9.14)
Place of quarantine or admission	
Hospital	6155 (39.86)
Field hospital	3524 (22.82)
Community isolation	3045 (19.72)
Home isolation	2413 (15.63)
Factory isolation	305 (1.98)

Abbreviations: IQR interquartile range

On multivariate analysis (Table 2), patients with ages between 40-59 years (aOR 2.38, 95% CI 2.12-2.68;  $P < 0.001$ ) and more than 60 years (aOR 5.16, 95% CI 4.52-5.89;  $P < 0.001$ ) more likely to develop pneumonia compared with younger patients whose ages less than 20 years. When stratified by race, Myanmar (aOR 1.15, 95% CI 1.00-1.33);  $P < 0.001$ ) patients were more likely to increase risk of pneumonia compared with Thai patients. The following presenting symptoms were more likely to develop pneumonia: fever (aOR 1.81, 95% CI 1.61-2.04;  $P < 0.001$ ) dyspnea (aOR 2.50, 95% CI 2.06-3.03;  $P < 0.001$ ) and productive sputum (aOR 1.28, 95% CI 1.09-1.51;  $P < 0.001$ ). While, sore throat (aOR 0.84, 95% CI 0.72-0.98;  $P 0.032$ ) nasal congestion (aOR 0.75, 95% CI 0.88-0.85;  $P < 0.001$ ) and headache (aOR 0.80, 95% CI 0.66-0.97;  $P 0.025$ ) were less likely to progress to pneumonia. The comorbidities of one (aOR 3.32, 95% CI 2.73-4.04;  $P < 0.001$ ), two (aOR 3.09, 95% CI 2.34-4.01;  $P < 0.001$ ), or more than two (aOR 2.14, 95% CI 1.45-3.20;  $P < 0.001$ ) were associated with increased risk of developing pneumonia compared with no comorbidities. Among patients who received partial vaccination (aOR 0.36, 95% CI 0.31-0.42;  $P < 0.001$ ) and full vaccination (aOR 0.48, 95% CI 0.41-.56;  $P < 0.001$ ) were less likely to develop pneumonia compared with unvaccinated patients.



**Table 2.** Univariate and multivariable analysis of factors associated with COVID-19 pneumonia

Characteristics	Patient without pneumonia (n= 12,120) N (%)	Patient with pneumonia (n= 3,322) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
Age in year [median (IQR)]	47 (23 - 63)	25 (12 - 43)	1.03 (1.028 - 1.032)	<0.001		
Age groups, y						
< 20	4,635 (38.24)	739 (22.25)	Ref	<0.001	Ref	
20 – 39	3,784 (31.22)	590 (17.76)	0.98 (0.87-1.10)		1.12 (0.99-1.26)	0.068
40 – 59	2,646 (21.83)	1,003 (30.19)	2.38 (2.13-2.64)		2.38 (2.12-2.68)	< 0.001
≥ 60	1,055 (8.70)	990 (29.80)	5.86 (5.24 6.61)		5.16 (4.52-5.89)	< 0.001
Sex						
Male	5,655 (46.66)	1,483 (44.64)	Ref	0.039		
Female	6,465 (53.34)	1,839 (55.36)	1.08 (1.00-1.17)			
Race						
Thai	10,565 (87.17)	2,797 (84.20)	Ref	<0.001	Ref	
Myanmar	1,033 (8.52)	395 (11.89)	1.44 (1.28-1.63)		1.15 (1.00-1.33)	< 0.001
Stateless	517 (4.27)	124 (3.73)	0.91 (0.74-1.11)		0.69 (0.55-0.86)	0.001
Other	5 (0.04)	6 (0.18)	4.53 (1.38-14.86)		3.68 (0.99-13.73)	0.051
Occupational status						
Employed	3,219 (26.56)	784 (23.60)	Ref	<0.001		
Agriculture	2,943 (24.28)	348 (10.48)	0.49 (0.42 - 0.57)			
Student	3,563 (29.40)	1,002 (30.16)	1.15 (1.04 - 1.28)			
Government officer	69 (0.57)	11 (0.33)	0.65 (0.34- 1.24)			
Healthcare worker	300 (2.48)	70 (2.11)	0.96 (0.73 - 1.26)			
Unemployed	628 (5.18)	383 (11.53)	2.50 (2.16 - 2.91)			
Other	1,398 (11.53)	724 (21.79)	2.13 (1.89 - 2.39)			
Exposure history within the past 14 d						





Characteristics	Patient without pneumonia (n= 12,120) N (%)	Patient with pneumonia (n= 3,322) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
Contact with a COVID-19 patient	8,563 (70.65)	1,840 (55.39)	Ref	<0.001		
Going to high-risk places	3,113 (25.68)	1,207 (36.33)	1.80 (1.66 - 1.96)	-		
Could not identify source	444 (3.66)	275 (8.28)	2.88 (2.46 - 3.38)	-		
Presence of comorbidities						
Diabetes mellitus	218 (1.80)	394 (11.86)	7.34 (6.20- 8.71)	<0.001	1.6 (1.22- 2.12)	0.001
Hypertension	336 (2.77)	507 (15.26)	6.31 (5.47- 7.29)	<0.001		
Dyslipidemia	152 (1.25)	211 (6.35)	6.32 (5.47 - 7.29)	<0.001		
Chronic Obstructive Lung Disease	14 (0.12)	19 (0.57)	4.97 (2.49 - 9.93)	<0.001		
Asthma	11 (0.09)	10 (0.30)	3.32 (1.41 - 7.83)	0.008		
Epilepsy	10 (0.08)	9 (0.27)	3.29 (1.34 - 8.10)	0.013		
Cardiovascular disease	4 (0.03)	10 (0.3)	9.14 (2.87 - 29.18)	<0.001		
Cerebrovascular disease	25 (0.21)	46 (1.38)	6.79 (4.17 - 11.07)	<0.001		
Chronic kidney disease	41 (0.34)	97 (2.92)	8.86 (6.14 - 12.79)	<0.001	1.57 (1.02- 2.40)	0.037
Atrial fibrillation	8 (0.07)	17 (0.51)	7.79 (3.36 - 18.06)	<0.001		
Congestive health failure	7 (0.06)	10 (0.3)	5.22 (1.99 - 13.74)	0.001		
Malignancy	8 (0.07)	9 (0.27)	4.11 (1.59 - 10.67)	0.005		
Cirrhosis	3 (0.02)	3 (0.09)	3.65 (0.74 - 18.10)	0.005		
Autoimmune inflammatory conditions	20 (0.17)	15 (0.45)	2.74 (1.40- 5.36)	0.005		
Dementia	2 (0.02)	2 (0.06)	3.65 (0.51 - 25.92)	0.210		
Number of comorbidities						
0	11603 (95.73)	2549 (76.73)	Ref	<0.001		



Characteristics	Patient without pneumonia (n= 12,120) N (%)	Patient with pneumonia (n= 3,322) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
1	278 (2.29)	376 (11.32)	6.16 (5.24 - 7.23)	-	3.32 (2.73- 4.04)	< 0.001
2	144 (1.19)	238 (7.16)	7.52 (6.09 - 9.29)	-	3.09 (2.34- 4.01)	< 0.001
>2	95 (0.78)	159 (4.79)	7.62 (5.89 - 9.86)	-	2.14 (1.45- 3.20)	< 0.001
<b>Presenting symptoms</b>						
Fever	1310 (10.81)	685 (20.62)	2.14 (1.93 - 2.37)	<0.001	1.81 (1.61- 2.04)	< 0.001
Cough	2838 (23.42)	927 (27.9)	1.27 (1.16 - 1.38)	<0.001		
Sore throat	1237 (10.21)	298 (8.97)	0.86 (0.75 - 0.99)	0.033	0.84 (0.72- 0.98)	0.032
Myalgia	622 (5.13)	204 (6.14)	1.21 (1.02- 1.42)	0.024		
Nasal congestion	2178 (17.97)	478 (14.39)	0.77 (0.69 - 0.85)	<0.001	0.75 (0.88- 0.85)	< 0.001
Productive sputum	967 (7.98)	326 (9.81)	1.25 (1.10- 1.43)	0.001	1.28 (1.09- 1.51)	0.002
Dyspnea	302 (2.49)	309 (9.3)	0.25 (0.21 - 0.29)	<0.001	2.50 (2.06- 3.03)	< 0.001
Headache	772 (6.37)	174 (5.24)	0.81 (0.69 - 0.96)	0.014	0.80 (0.66- 0.97)	0.025
Diarrhea	132 (1.09)	54 (1.63)	1.50 (1.09 - 2.06)	0.016		
Anosmia	535 (4.41)	119 (3.58)	0.84 (0.66 - 0.99)	0.032		
Ageusia	157 (1.3)	45 (1.35)	1.05 (0.75 - 1.46)	0.791		
<b>Vaccination</b>						
Unvaccinated	9077 (74.89)	2725 (82.03)	Ref	<0.001	Ref	
Partially vaccinated	1915 (15.80)	313 (9.42)	0.54 (0.48 - 0.61)	-	0.36 (0.31- 0.42)	< 0.001
Fully vaccinated	1128 (9.31)	284 (8.55)	0.83 (0.73 - 0.96)	-	0.48 (0.41- 0.56)	< 0.001

$p < 0.05$  indicates significant association

Abbreviations: aOR adjusted odds ratio; CI Confidence interval; IQR interquartile range

**Factors associated with mortality**

The univariate analysis (Table 3) showed that higher age, race, particularly, Myanmar, stateless and others, occupation, particularly, healthcare worker, unemployed and others, individuals covered with health coverage scheme, exposure history, comorbidity particularly Diabetes mellitus, hypertension, dyslipidemia, epilepsy, cerebrovascular disease, chronic kidney disease, atrial fibrillation, malignancy, and cirrhosis were significantly associated with pneumonia. Also, an increasing number of





comorbidities were significantly associated with pneumonia as well as COVID-19 with presenting symptoms such as fever, cough, nasal congestion, productive sputum, dyspnea, diarrhea, and anosmia. Furthermore, even a single dose of vaccine was also significantly associated with a decrease in developing pneumonia.

**Table 3.** Univariate and multivariable analysis of factors associated with COVID-19 mortality

Characteristics	Survivor (n= 15,162) N (%)	Non-survivor (n= 280) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
Age in year [median (IQR)]	30 (14 - 48)	66 (52 - 76)	1.067 (1.06 - 1.074)	<0.001		
Age groups, y						
< 20	5,359 (35.34)	15 (5.36)	Ref	<0.001	Ref	
20 – 39	4,359 (28.75)	15 (5.36)	1.23 (0.60-2.52)		1.38 (0.67-2.85)	0.371
40 – 59	3,568 (23.53)	81 (28.93)	8.11 (4.67-14.09)		7.53 (4.27-13.27)	< 0.001
≥ 60	1,876 (12.37)	169 (60.36)	32.18 (18.93-54.71)		22.09 (12.66-38.53)	< 0.001
Sex						
Male	6,997 (46.15)	141 (50.36)	Ref	0.162		
Female	8,165 (53.85)	139 (49.64)	0.84 (0.67- 1.07)			
Race						
Thai	13,155 (86.76)	207 (73.93)	Ref	<0.001	Ref	
Myanmar	1,368 (9.02)	60 (21.43)	2.79 (2.08-3.74)		1.99 (1.44-2.78)	< 0.001
Stateless	630 (4.16)	11 (3.93)	1.10 (0.60-2.05)		0.71 (0.37-1.34)	0.293
Other	9 (0.06)	2 (0.71)	14.12 (3.03-65.76)		9.79 (1.60-59.5)	0.013
Occupational status						
Employed	3,219 (26.56)	784 (23.60)	Ref	<0.001		
Agriculture	2,943 (24.28)	348 (10.48)	0.49 (0.42 - 0.57)			
Student	3,563 (29.40)	1,002 (30.16)	1.15 (1.04 - 1.28)			
Government officer	69 (0.57)	11 (0.33)	0.65 (0.34- 1.24)			
Healthcare worker	300 (2.48)	70 (2.11)	0.96 (0.73 - 1.26)			
Unemployed	628 (5.18)	383 (11.53)	2.50 (2.16 - 2.91)			
Other	1,398 (11.53)	724 (21.79)	2.13 (1.89 - 2.39)			
Exposure history within the past 14 d						
Contact with a COVID-19 patient	3,942 (26.00)	61 (21.79)	Ref	<0.001		
Going to high-risk places	3,283 (21.65)	8 (2.86)	0.16 (0.08 - 0.32)			
Could not identify source	4,516 (29.78)	49 (17.50)	0.70 (0.48 - 1.02)			
Presence of comorbidities						
Diabetes mellitus	537 (3.54)	75 (26.79)	9.96 (7.54- 13.16)	< 0.001		
Hypertension	762 (5.03)	81 (28.93)	7.69 (5.88- 10.06)	< 0.001		



Characteristics	Survivor (n= 15,162) N (%)	Non- survivor (n= 280) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
Dyslipidemia	323 (2.13)	40 (14.29)	7.66 (5.38 - 10.89)	< 0.001		
Chronic Obstructive Lung Disease	30 (0.20)	3 (1.07)	5.46 (1.65- 18.00)	0.005		
Asthma	20 (0.13)	1 (0.38)	2.71 (0.36- 20-29)	0.331		
Epilepsy	17 (0.11)	2 (0.71)	6.40 (1.47 - 27.87)	0.013		
Cardiovascular disease	13 (0.09)	1 (0.36)	4.34 (0.544 - 32.04)	0.169		
Cerebrovascular disease	58 (0.38)	13 (4.64)	12.67 (6.87 - 23.42)	< 0.001		
Chronic kidney disease	100 (0.66)	38 (13.57)	23.65 (15.94 - 35.09)	< 0.001	3.84 (2.31-6.38)	< 0.001
Atrial fibrillation	18 (0.21)	7 (2.50)	21.57 (8.94 - 52.07)	< 0.001		
Congestive heart failure	16 (0.11)	1 (0.36)	3.39 (0.45 - 25.67)	0.237		
Malignancy	15 (0.10)	2 (0.71)	7.26 (1.65 - 31.91)	0.009		
Cirrhosis	4 (0.03)	2 (0.71)	27.26 (4.97 - 149.46)	< 0.001		
Autoimmune or inflammatory conditions	33 (0.22)	2 (0.71)	3.29 (0.79- 13.81)	0.102		
Dementia	4 (0.03)	0 (0.00)	0.43 (0.06 - 3.25)	0.380		
Number of comorbidities						
0	14008 (92.39)	144 (51.43)	Ref	<0.001		
1	601 (3.96)	53 (18.93)	8.58 (6.2 - 11.88)		2.87 (1.99-4.14)	< 0.001
2	338 (2.23)	44 (15.71)	12.66 (8.88 - 18.05)		3.18 (2.09-4.82)	< 0.001
>2	215 (1.42)	39 (13.93)	17.65 (12.08 - 25.77)		3.3 (2.07-5.36)	< 0.001
Presenting symptoms						
Fever	1917 (12.64)	78 (27.86)	2.6 (2.04 - 3.48)	<0.001		
Cough	3675 (24.24)	90 (32.14)	1.48 (1.14- 1.90)	0.002		
Sore throat	1512 (9.97)	23 (8.21)	0.80 (0.53- 1.24)	0.331		
Myalgia	816 (5.38)	10 (3.57)	0.65 (0.35- 1.23)	0.186		
Nasal congestion	2628 (17.33)	28 (10.00)	0.53 (0.35 - 0.78)	0.002		
Productive sputum	1258 (8.30)	35 (12.50)	1.57 (1.10- 2.26)	0.013		
Dyspnea	542 (3.57)	69 (24.64)	8.82 (6.63 - 11.73)	<0.001	4.54 (3.27-6.31)	< 0.001
Headache	934 (6.16)	12 (4.29)	0.68 (0.38 - 1.22)	0.198		

Characteristics	Survivor (n= 15,162) N (%)	Non- survivor (n= 280) N (%)	OR (95%CI)	p-value	aOR (95%CI)	p-value
Diarrhea	178 (1.17)	8 (2.86)	2.48 (1.21 – 5.09)	0.013		
Anosmia	649 (4.28)	5 (1.79)	0.41 (0.18 - 0.99)	0.047		
Ageusia	200 (1.32)	2 (0.71)	0.54 (0.13 – 2.18)	0.385		
Vaccination						
Unvaccinated	11538 (76.10)	264 (94.29)	Ref	<0.001	Ref	
Partially vaccinated	2217 (14.62)	11 (3.93)	0.21 (0.12 - 0.39)		0.14 (0.08-0.27)	< 0.001
Fully vaccinated	1407 (9.28)	5 (1.79)	0.15 (0.064 - 0.38)		0.08 (0.03-0.19)	< 0.001

$p < 0.05$  indicates significant association

Abbreviations: aOR adjusted odds ratio; CI Confidence interval; IQR interquartile range

#### Factors associated with mortality (continued)

The multiple logistic regression (Table 3) indicated that higher age was a strong predictor of mortality in hospital, as the ages higher than 60 years was significantly associated with increased odds of death by 22 times compared to the younger age groups (aOR 22.09, 95% CI 12.66-38.53;  $P < 0.001$ ). In addition, there was significantly increasing of mortality for Myanmar (aOR 1.99, 95% CI 1.44-2.7;  $P < 0.001$ ) and other race compared with Thai people (aOR 9.79, 95% CI 1.44-2.7;  $P = 0.013$ ). Of comorbidities, chronic kidney disease (aOR 3.84, 95% CI 2.31-6.38;  $P < 0.001$ ) and dyspnea (aOR 4.54, 95% CI 2.31-6.38;  $P < 0.001$ ) were also significantly associated with increased odds of mortality compared with no comorbidities. Meanwhile, patients who presented with one, two, and more than two pre-existing comorbid diseases had approximately 2-3 times higher mortality, with an aOR of 2.87 (95% CI 1.99-4.14;  $P < 0.001$ ), 3.18 (95% CI 2.09-4.82;  $P < 0.001$ ), and 3.3 (95% CI 2.07-5.36;  $P < 0.001$ ), respectively. The previous receipt of vaccination regardless of partially (aOR 0.14, 95% CI 0.08-0.27;  $P < 0.001$ ) or fully vaccination (aOR 0.08, 95% CI 0.03-0.19;  $P < 0.001$ ), was associated with decreased mortality when compared with unvaccinated individuals.

#### 4. DISCUSSION

This was one of the initial studies which included a population of the first and largest COVID-19 epicenter on Thailand's western border with Myanmar. The study included adequate follow-up time to evaluate the risk factors associated with developing pneumonia and mortality of COVID-19 in all laboratory-confirmed patients, diagnosed during the period of the fourth wave which Delta variant predominance, in Tak province, Thailand. Approximately half (53.9%) of COVID-19 patients in our study were asymptomatic. This finding was similar to a recent report of asymptomatic patients from India, Washington, and Japan with 57.1%, 56.5%, and 49.5%, respectively (10)(11)(12). Many studies had shown evidence of asymptomatic patients, who can transmit the virus to others. Early recognition of these asymptomatic patients, thereby, can prevent further transmission (13). Among the symptomatic patients, the most common symptoms associated with pneumonia were fever, productive sputum, and dyspnea. This was similar to the finding of a previous study in a university-based referral hospital in Thailand (14). Our study also identified increased age as a risk factor prone to pneumonia and death in both univariate and in the final variate models. This analysis was similar to many studies which had identified old age as high severity of COVID-19 (15).

In addition, the study had demonstrated an association between race/ethnicity and clinical outcomes of pneumonia and death. Although only 9% of patients were Myanmar, they were found to be an independent and significant risk factor for developed pneumonia and increased mortality. This could be explained by three main reasons. Firstly, there were more than 80,000 Myanmar migrant workers in Thai- Myanmar border towns of Mae Sot, Tak province. They were either both undocumented or documented migrant workers. Since the COVID-19 epidemic broke out, many factories and agriculture sectors that employed Myanmar migrant workers had closed, causing most of them to be unemployed or live with insufficient daily wages. With these unsafe living conditions, they had insufficient protective equipment for combating COVID-19 (16). Secondly, smuggling across borders had been continuously happening since the severe COVID-19 situation in Myanmar in the middle of 2021. Lastly, during the early stage



of the pandemic, migrant workers were not able to access the vaccination due to insufficient supplies of vaccines. The vaccination campaign was launched for migrant workers at the end of July 2021, including those without legal documents (17). Future studies investigating the role of race/ethnicity in hospital admission and COVID-19 related outcomes after vaccination are needed.

The present finding showed that an increased number of pre-existing comorbidities was associated with an increased risk of developing pneumonia and mortality compared with no comorbidities. This finding was similar to a recent report from New York City, where investigators reported that the presence of more than two comorbidities was associated with an increased risk of hospitalization and odds of death compared with no comorbidities (18). The report also indicated that diabetes mellitus was independently associated with mechanical ventilation, indicating more severe disease. Contrary, our study showed that diabetes mellitus was found to be risk factor of pneumonia, it was not associated with increased risk of death. Also, chronic kidney disease was associated with increased risk of either developed pneumonia or death. Recent studies also reveal that chronic kidney disease increased the risk of mortality among hospitalized patients was 111% higher compared to the patients without chronic kidney disease (19) and associated with higher odds for severe COVID-19 outcomes (20).

Thailand has started COVID-19 vaccination in February 2021. During the first phase, two million doses of CoronaVac, inactivated Vaccines, had been distributed throughout the country and the remaining from AstraZeneca PLC would deliver by end of 2021. Healthcare-related individuals were the priority, followed by those with high risks for severe COVID-19 outcomes. As of, August 9, 2021, 21.1 million doses had been administered. Approximately, 16.3 million (22.7%) people were partially vaccinated and 4.6 million (6.3%) people were fully vaccinated (4). Our study showed that being partial and fully vaccinated was associated with lower develop pneumonia and mortality. This was consistent with the previous studies that even partial vaccination was strongly associated with decreased risk of death (21) and fully vaccinated individuals had 70% lower odds of mortality than unvaccinated persons among hospitalized severe cases (22). Nonetheless, many studies reported that the risk of a severe COVID-19 outcome after primary vaccination was high among persons aged more than 65 years, were immunosuppressed, or had one of six other comorbid conditions (20).

There were limitations to this study. First, in our study, the study population only included patients from a single geographic region, therefore, potentially limiting the generalizability of the result to other regions. Second, our study was a retrospective study using secondary data of COVID-19 positive patients. The rapid surge of cases during Delta variant predominance resulted in missing data including BMI and smoking status.

## CONCLUSION

This finding can help the healthcare providers or physicians to determine high-risk COVID-19 infected patients so that the healthcare providers can come up with appropriate measures and proper management strategies in the health care and community sectors. Thus, the complication and mortality rate from COVID-19 can be reduced, and the COVID-19 pandemic can be prevented to become an endemic disease. However, ongoing mass vaccination efforts for migrant workers or stateless individuals who are at risk of suffering severe symptoms are still an absolutely priority as a human right to health.

## Conflict of interest

The authors have no conflicts of interest to declare

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## Ethical Approval

This study was approved by the Ethics Review Board of Tak Provincial Health Office (PHO), Thailand. (Ethical clearance No001/the Year 2022)

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