Original Article

Factors Associated with the Incidence of COVID-19 Disease in Muang Pattani District, Thailand

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Abstract:

Objective: This study aimed to investigate the Coronavirus disease (COVID-19) incidence in Muang Pattani district; from April 2021 and September 2022, Specifically, the main objective was to study the varying distribution by demographic, area and period of COVID-19.

Material and Methods: COVID-19 data, with 15,807 reported cases was obtained from the Muang Pattani District Health Office. A descriptive analysis was used to describe the characteristics of the COVID-19 cases. A negative binomial model was used to investigate COVID-19 incidence.

Results: The overall incidence of COVID-19 was 1,188.9 cases per 100,000 of the population. Females had a higher incidence rate of COVID-19 infection than males. People aged from 20 to 39 years had significantly higher incidence rates than the average, with the highest rate being found in the Barohom sub-district. In 2021, the highest rates were in the month of October, followed by July and August; while March was reported as the highest rate in 2022.

Conclusion: The findings of this study can be used by the public health organizations and others involved in COVID-19 for direct prevention and control in those high-incidence areas. This study has also proven that its findings can be applied to cases related to the prevention programs of other infectious diseases in Thailand.

Keywords: COVID-19 incidence, demographic, negative binomial, Thailand, spatial-temporal

Introduction

Corona virus disease 19 (COVID-19) is a contagious disease of the respiratory system. It is brought about by an infection of a novel coronavirus strain that was eventually given the name Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) initially identified in Wuhan, China, in December 2019. Later in March 2020, the disease spread to over 200 countries, resulting in a total of almost 300 million cases and 5 million deaths[1]. The COVID-19 pandemic also caused the SARS-CoV-2 virus to mutate, resulting in the emergence of many new variants. Among Alpha them, Beta, Gamma, Delta, and Omicron were included in the list of variants of concern. The increased rates of transmission, pathogenicity and immune evasion by Omicron set it apart from the initial Wuhan's variant. These variants have triggered a new wave of epidemics worldwide[2].

The distribution of COVID-19 varies depending on spatial and temporal factors. The population density and distance between each city were found to be highly linked with the number of infected people in a prior study.[3,4] Furthermore, as new SARS-CoV-2 variants emerged, the characteristics of the disease distribution changed over time. According to the study by Lak et al. (2021)[5], the demographic composition and physical characteristics (living space and public transport) were key factors explaining the rates of infection and deaths. From previous studies, it was found that demographic factors affecting infection include age groups and gender. Those between the ages of 20 and 49, as well as those 50 and older, were at a comparatively higher risk of infection[6,7]. Although, the risks for males and females are similar, males had a higher in hospitals mortality rate[8]. Additionally, while COVID-19 vaccination still cannot completely prevent infection, it can reduce the risk of hospitalization and death from infection[9].

The COVID-19 outbreak in Thailand can be divided into five phases[10]. Each wave caused an increase in COVID-19 patients as a result from the emergence of new variants[10]. The spread of disease was also due to social activities. In a previous study, the provinces with higher economic status and number of visitors, including Bangkok and Phuket, had a higher number of infected cases[11]. A study conducted in Thung Yang Daeng district, where the first cluster of COVID-19 was discovered in Pattani province, revealed that contact related to the Islamic missionary (Dawah Tabligh) activities, were at a significantly higher risk of COVID-19 infection than other community members[12]. This cluster was the first outbreak in the lower south of Thailand.

COVID-19 studies have been reported in Thailand. However, most of the studies in the southernmost were based on preliminary results. In consequence, the study findings based on the adjusted rate are crucial and more accurate results. Therefore, this research took one crucial step further by applying statistical modeling to the COVID-19 data in order to obtain a more accurate incidence rate for this study. This research aimed to investigate factors associated with the incidence of COVID-19 in the Muang Pattani district.

Material and Methods

Data source and management

The infected patients in this study were Thai people from Pattani that tested positive by RT-PCR. The Muang Pattani District Public Health Office collected all reported cases from April 2021, when the first cases in the district were discovered, until September 2022; the last month before the outbreak was declared endemic. There were 16,997 reported cases. The exclusion criteria were as follows: 1) Patients with other nationalities were not counted, because their population numbers are not reported. Although the population number of migrant workers was variables, it cannot be used due to the number being lower than the reported COVID-19 cases. 2) Patients whose were not fully available study variable. As a result, the total number of infected people stood at 15,807.

The dependent variable of this study was the incidence of COVID-19. This study used the population data from the Pattani Provincial Public Health Office, which divides the population by year, gender, age group, and sub-district.

Statistical analysis

In this study, data analysis utilized descriptive statistics analysis tools; such as frequency and percentage, to describe the sample's characteristics. A poisson regression model was later fitted for investigating factors associated with COVID-19 incidence. This model is considered appropriate for modeling count data. However, Poisson models for disease counts are frequently over-dispersed; whereby, in such case the negative binomial model is more appropriate. The negative binomial model for incidence rates is an extension of the Poisson model for disease counts that provides for the over-dispersion, which is typical in disease counts.

The plot of residuals against normal quantiles is then used to assess how well a model fits with the data. For the Negative binomial model deviance residuals based on the likelihood are recommended. The plotted residuals should correspond to the normal quantiles by following a straight line on the plot.

The sum contrasts were used to generate confidence intervals for comparing the adjusted incidence rates within each factor in the overall incidence rate. The R program was used for statistical analysis and graphical displays.

Results

Descriptive statistics

Table 1 shows that 16,065 cases of COVID-19 were mostly female (58.5%), within the age groups of 20–29 years (18.49%). Most of them were from the area of Sabarang (20.47%), followed by Bana (19.63%), and Ru Samilae (16.82%), respectively. The highest rates in 2021 were found in the month of October (17.12%), followed by July

(13.31%) and August (13.38%); while in 2022 the highest rates were found in March (17.09%).

Table 1 Characteristics of infected patients (N=16,065 cases)

Variables	Frequency	Percentage
Gender		
Female	9,401	58.52
Male	6,664	41.48
Age group (years)		
0–9	1,861	11.58
10–19	2,120	13.2
20–29	2,971	18.49
30–39	2,931	18.24
40–49	2,309	14.37
50–59	1,949	12.13
60+	1,924	11.98
Sub-district		
Anoru	1,080	6.72
Bana	3,154	19.63
Baraho	756	4.71
Barahom	245	1.53
Chabang Tiko	976	6.08
Kamiyo	355	2.21
Khlong Maning	278	1.73
Paka Harang	563	3.50
Puyut	804	5.00
Ru Samilae	2,702	16.82
Sabarang	3,289	20.47
Talubo	1,050	6.54
Tanyong Lulo	813	5.06
Month-year		
April 2021	53	0.33
May 2021	91	0.57
June 2021	710	4.42
July 2021	2,138	13.31
August 2021	2,134	13.28
September 2021	1,298	8.08
October 2021	2,751	17.12
November 2021	1,813	11.29
December 2021	667	4.15
January 2022	156	0.97
February 2022	937	5.83
March 2022	2,745	17.09
April 2022	329	2.05
May 2022	84	0.52
June2022	30	0.19
July 2022	31	0.19
August 2022	62	0.39
September 2022	36	0.22

Statistical modeling

Figure 1(a) depicts the residual plot for the Poisson model. The model fails due to the appearance of over-dispersion, and the chi-square test confirmed that the model is unfit. However, Figure 1(b) shows that the negative binomial model fitted the data well, and the chi-square test indicates the fit is statistically acceptable. The results based on this model are shown in Figure 2.

Figure 2 shows the adjusted COVID-19 incidence rates per 100,000 of the population, with 95% confidence intervals. These confidence intervals used sum contrasts

to compare the COVID-19 incidence rate with the overall mean. This is represented by a red horizontal line, which equals to 1188.9 per 100,000. Females had a higher incidence rate than males in addition to the highest incidence rate being found in people aged 20–29, followed by people aged 30–39. Barahom was the sub-district with the significantly highest incidence rate. while the incidence rates below the average were found in Baraho, Chabang Tiko, Klong Maning, and Kamiyo, respectively. The highest incidence rates in 2021 occurred in the month of October, followed by July and August; whereas, in 2022, they occurred in March.
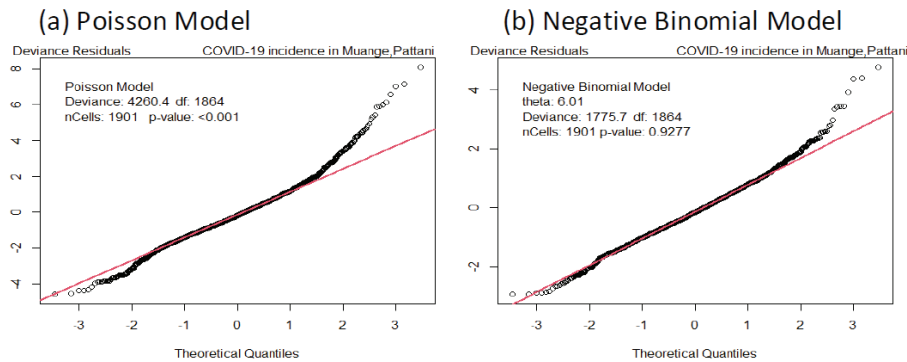

Figure 1 Residual plot for the Poisson model (a) and Negative binomial
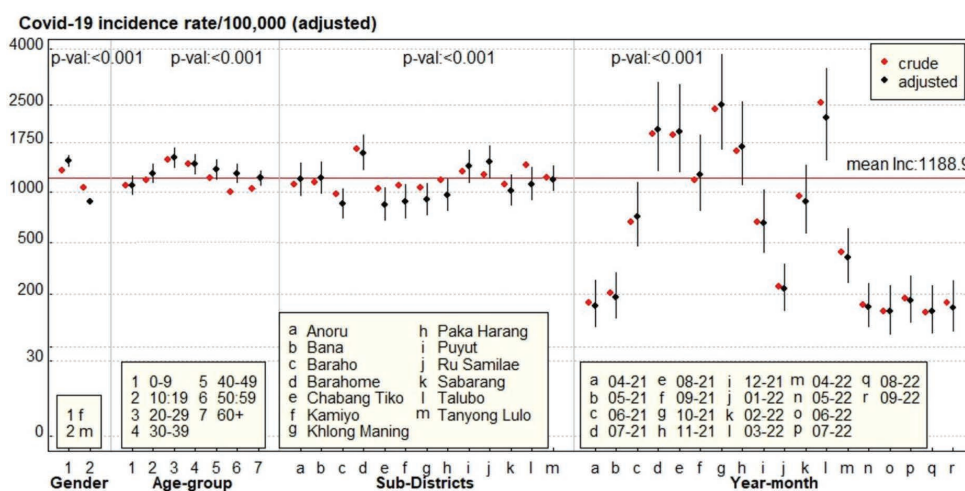

Figure 2 95% confidence interval plot of factors associated with COVID-19 incidence rate

Discussion

The findings in this study demonstrated that the four factors; namely: age, district, month, and year, were all associated with the rate of COVID-19 incidence. This study found that females had a higher infection rate than males. This is in contrast to earlier studies, which concluded that there was no difference between the sexes as to the chance of infection[13]. In a study, it was found that females were less susceptible to infection than males, because of the two sexes' different immune responses and between sexes the higher proportion of Angiotensin Converting Enzyme 2 (ACE-2) in males.9 ACE-2 is a receptor protein for the spike protein for the pathogen COVID-19, and infection is brought on by both proteins[14]. Hence, this may explain why females have higher infection rates. However, women were more likely than men to visit a doctor[15], which would probably have the same impact on the likelihood to undergo RT-PCR or ATK testing.

This study found that the age groups of 20 and 39 had a higher incidence rate than other groups; especially in children. This is found to be consistent with the results of the study during the first wave by Jakhmola et al.[6], which found that those aged 20–49 and those aged 50 and over are at higher risk of contracting COVID-19. This is due to the presence of the ACE-2 gene in the nasal epithelium being the lowest in children under 10 years of age, which then increases with age. However, during the outbreak of the Omicron variants, younger children were more likely to become severely ill than older children16; especially those aged 0–4, most likely due to their ineligibility for vaccination against COVID-19[17].

The map of 13 sub-districts in Muang Pattani district is shown in Figure 3. The map also presents the adjusted COVID-19 incidence rate when compared with the mean incidence; which equals to 1188.9 per 100,000 population. Barahom had a significantly highest incidence rate, while, Baraho, Chabang Tiko, Khlong Maning, and Kamiyo sub-districts had incidence rates around the mean incidence. This might be due to certain commonalities between these sub-districts; for example, their population and housing
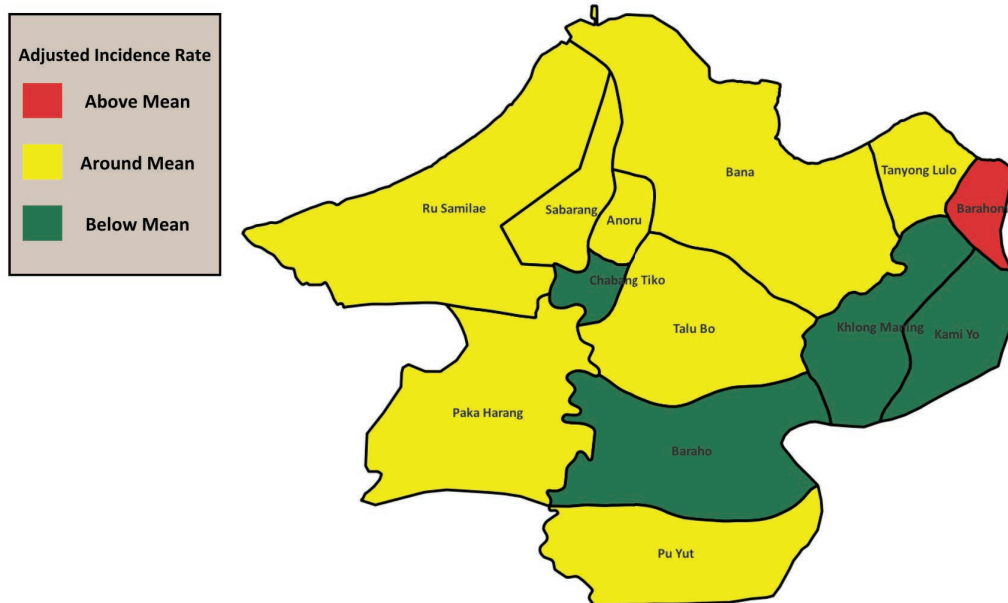

Figure 3 A map of sub-district in muang Pattani district with adjusted incidence rate

densities are higher than others. Similarly, to a study by Lak (2021)[5], the findings revealed that factors contributing to the high number of infected people in urban society in Tehran, Iran, consisted of population density, the density of houses the number of neighborhood shopping and retail centers, and so forth. In addition, a study in China found that the two key factors explaining the spread of the pandemic were human movement and population density[18].

In 2021, the months with the high incidence rates were July–November, which was during the country's fourth wave10. In this study the peak of the incidence was found in October, similarly to neighboring provinces; such as Yala, Narathiwat, and Songkhla. This incidence was found to be contradicting to the overall trend of the country, where a peak of COVID-19 cases was found in August and gradually decreased in October[19]. The predominant variant of SARS-CoV 2 in this wave was Delta[10]; whereby, it was found that Delta can transmit more efficiently than Alpha and Beta: the dominant variants of the previous waves20. The Delta variant has also been reported to have immune escape capability, reducing the effectiveness of AstraZeneca and Pfizer–BionTech vaccines against infection and hospitalization when compared to the alpha variant[21-22]. In 2022, the month with the highest incidence rate in this area was March. This incidence is consistent with the trend of the country; wherein, the peak of COVID-19 cases occurred throughout the outbreak and during the country's fifth wave, January–May 2022, with Omicron as the predominant variant10. A study by Tian et al. (2022)[23] found that the Omicron variant had 1.4–3.1 times more infectivity than the Delta variant. This was because of the following reasons: i) the majority were asymptomatic or mild[24], and ii) two doses of the AstraZeneca and Pfizer–BionTech vaccines were insufficient to provide adequate protection[25] compared to other strains, and more likely to result in re-infection23. The policy of not confirming all possible cases with PCR testing, as well as the widespread use of antigen test kits

(ATK)[26], may have resulted in a lower incidence rate during the fifth wave than in the fourth wave.

Conclusion

This study revealed that demographic, area, and period are all factors associated with COVID-19 incidence. However, suggestions for further studies, in order to get more specific detailed results; especially in other specific areas, should include other potential factors; such as economic status and COVID-19 vaccination. Additionally, advanced infectious models incorporating with spatiotemporal dimensions could be used in further, subsequent research for explanation of the virus mutation and transmission characteristics. The findings of this study can be used by public health organizations and others involved in prevention of COVID-19 and other infectious diseases. Moreover, the statistical methods utilized in this study can be applied to other regions in Thailand and other countries to investigate factors associated with the incidence of COVID-19 or other diseases.

Acknowledgement

Conflict of interest

The authors declare no conflicts of interest.

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