นิพนธ์ต้นฉบับ **Original Article**

ภาระโรคไข้หวัดใหญ่ก่อนและระหว่างโควิด 19 ระบาดในประเทศไทย และปัจจัยที่เกี่ยวข้องกับอัตราการเสียชีวิตภายใน 30 วันของผู้ป่วยไข้หวัดใหญ่ ปี 2559-2563

Thailand's Influenza burden before and during COVID-19 pandemic and factors associated with 30-day mortality among influenza patients between 2016 and 2020

ศิโรรัตน์ เขียวบ้านยาง[1] Sirorat Khiewbanyang[1]
ชุติมน สินธุประมา[2] Chutimon Sindhuprama[2]
สุธรรม จิรพนากร[1] Sutham Jirapanakorn[1]
ระพีพงศ์ สุพรรณไชยมาตย์[1,3] Rapeepong Suphanchaimat[1,3]
ฐิติพร สุแก้ว[4] Thitiporn Sukaew[4]

[1]กองระบาดวิทยา กรมควบคุมโรค, กระทรวงสาธารณสุข *[1]Department of Disease Control, Ministry of Public Health, Thailand*
[2]นักวิจัยอิสระ *[2]Independent researcher*
[3]สำนักงานพัฒนานโยบายสุขภาพระหว่างประเทศ, กระทรวงสาธารณสุข *[3]International Health Policy Program, Ministry of Public Health, Thailand*
[4]สถาบันพระบรมราชชนก, กระทรวงสาธารณสุข *[4]Praboromarajchanok Institute, Ministry of Public Health, Thailand*

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บทคัดย่อ

ผลการศึกษาหลายฉบับระบุว่าการระบาดของโรคโควิด 19 มีผลต่อแนวโน้มของการติดเชื้อและความรุนแรงของไข้หวัดใหญ่ งานวิจัยนี้มีวัตถุประสงค์เพื่อวิเคราะห์แนวโน้มการติดเชื้อไวรัสไข้หวัดใหญ่ ความรุนแรง และปัจจัยที่เกี่ยวข้องกับอัตราการเสียชีวิตภายใน 30 วันของผู้ป่วยไข้หวัดใหญ่ก่อน (ปี 2559-2562) และระหว่างการระบาดของโรคโควิด 19 (ปี 2563) การศึกษานี้ใช้ฐานข้อมูลประกันสุขภาพแห่งชาติในปี 2559-2563 โดยวิเคราะห์จำนวนผู้ป่วยในที่ติดเชื้อไวรัสไข้หวัดใหญ่เป็นรายสัปดาห์ โดยประเมินอัตราป่วยและอัตราการเสียชีวิตไข้หวัดใหญ่ต่อ 100,000 ประชากร และศึกษาเชิงพรรณนาเกี่ยวกับข้อมูลเพศ อายุ ภูมิภาค การได้รับวัคซีนป้องกันไข้หวัดใหญ่ โรคประจำตัว จำนวนวันนอนโรงพยาบาล และค่าน้ำหนักสัมพัทธ์ที่ปรับด้วยวันนอน (adjusted RW) และศึกษาปัจจัยที่เกี่ยวข้องในการเสียชีวิตด้วยการวิเคราะห์การถดถอยลอจิสติกพหุคูณ ผลการศึกษาพบผู้ป่วยในที่ติดเชื้อไวรัสไข้หวัดใหญ่จำนวน 219,365 ราย ปี 2559-2662 ผู้ป่วยในที่ติดเชื้อไวรัสไข้หวัดใหญ่มักมีจำนวนมากในฤดูฝนและฤดูหนาว โดยมีอัตราป่วยมากที่สุดในปี 2562 และเริ่มลดลงในเดือนกุมภาพันธ์ 2563 ผู้ป่วยส่วนใหญ่อยู่ในกลุ่มเด็กอายุ 0-4 ปี โดยพบมากในภาคเหนือและตะวันออกเฉียงเหนือ อัตราการเสียชีวิตเพิ่มขึ้นหลังจากมีการระบาด

ของโรคโควิด 19 จาก 0.38 เป็น 0.74 ต่อ 100,000 ประชากร จากการวิเคราะห์การถดถอยลอจิสติกพหุคูณ พบว่าปัจจัยอายุ โดยเฉพาะผู้ป่วยที่มีอายุ 50 ปีขึ้นไป ในช่วงก่อนโควิด 19 ระบาด และอายุตั้งแต่ 65 ปีขึ้นไป ในช่วงโควิด 19 ระบาด ค่า adjusted RW และการมีโรคประจำตัว เป็นปัจจัยที่เกี่ยวข้องกับการเสียชีวิต นอกจากนี้ พบว่ากลุ่มที่ได้รับวัคซีนป้องกันไข้หวัดใหญ่เกี่ยวข้องกับการเสียชีวิตน้อยกว่ากลุ่มที่ไม่ได้รับวัคซีนในช่วงก่อน โควิด 19 ระบาด ข้อเสนอแนะจากผลการศึกษาสนับสนุนการเพิ่มความตระหนักให้แก่กลุ่มเปราะบางโดยเฉพาะผู้สูงอายุและผู้ที่มีโรคประจำตัวเพื่อป้องกันการเสียชีวิตจากการติดเชื้อไข้หวัดใหญ่ การศึกษานี้พบการสวนทางกันระหว่างอัตราการป่วยและอัตราการเสียชีวิต ควรมีการศึกษาเพิ่มเติมเกี่ยวกับคุณภาพการดูแลผู้ป่วยในที่ติดเชื้อไวรัสไข้หวัดใหญ่ขณะโรคโควิด 19 ระบาดและประสิทธิผลของมาตรการการป้องกันโรคโควิด 19 ในการป้องกันการติดเชื้อไวรัสไข้หวัดใหญ่ในประเทศไทย

ติดต่อผู้นิพนธ์ : ศิโรรัตน์ เขียวบ้านยาง อีเมล : hiew20.sirorat@gmail.com

Abstract

Various studies have reported that the COVID-19 pandemic affected influenza infection trends and severity. This study aimed to analyze influenza infection patterns, severity, and factors associated with 30-day mortality among influenza patients before (2016-2019) and during the COVID-19 pandemic (2020). Using National Health Security Office data, we included weekly influenza admissions. We estimated morbidity and mortality per 100,000 persons and performed descriptive study in sex, age, geographic, influenza vaccination, underlying diseases, length of stay, and adjusted related weight (adjusted RW). Multiple logistic regression was used in inferential study. Our analysis, based on 219,365 inpatients, revealed 2 peaks in influenza admissions during rainy and winter seasons. The highest morbidity rate was found in 2019 then suddenly decreased in February 2020. Most cases were found in young children (0-4 years) in the northern and northeastern regions. The mortality rate increased from 0.38 to 0.74 per 100,000 persons during the COVID-19 period. Factors significantly correlated with mortality were described as being aged 50 years and over at pre-COVID-19 period, being aged 65 years and over during COVID-19 period, adjusted related weight, and comorbidities. Moreover, vaccination was less associated with death during pre-COVID-19 period. We suggest targeted risk awareness campaigns by public health agencies, especially for vulnerable groups, to prevent influenza-related deaths, notably among the elderly and those with multiple comorbidities. Despite reduced influenza morbidity during the COVID-19 pandemic, the mortality rates surged. Further studies should explore the quality of care for influenza patients during COVID-19 period and evaluated non-pharmaceutical interventions in preventing COVID-19, which likely played a role in reducing influenza.

Correspondence: Sirorat Khiewbanyang E-mail: hiew20.sirorat@gmail.com

คำสำคัญ
ไข้หวัดใหญ่, โรคโควิด 19, ประเทศไทย, อัตราการเสียชีวิตของไข้หวัดใหญ่, การเสียชีวิตภายใน 30 วัน

Keywords
influenza, COVID-19, Thailand, influenza mortality rate, 30-day mortality

Introduction

Influenza is a contagious respiratory illness caused by influenza viruses mainly belonging to influenza A (genus influenzavirus A) and influenza B (genus influenzavirus B)(1). The average incubation period is approximately 2 days. Influenza typically presents with respiratory symptoms, and the severity of the illness can range from mild to severe conditions, sometimes resulting in death. The duration of the illness is usually around 2 weeks or more(2). The vulnerable group to severe influenza infection includes children under the age of 5, adults over the age of 60, and people with chronic conditions(3). The influenza vaccine has the potential to prevent millions of cases of influenza infection each year, as well as reduce the severity of symptoms and the need for hospitalization(4).

Before the COVID-19 pandemic, respiratory viruses like influenza A/B, human rhinovirus, and respiratory syncytial virus were major public health concerns, posing a significant global health burden. These viruses presented an urgent public health problem worldwide(5). Globally, an annual influenza infection can cause up to 1 billion infections, with 3-5 million of severe cases(1). In addition, influenza can cause between 99,000 and 650,000 deaths annually(1-2). During the COVID-19 pandemic, the cumulative incidence of influenza-associated hospitalizations drastically decreased in the United States, from a range of 62-102 per 100,000 persons to only 0.8 per 100,000 persons(6). Similarly, the 2020/21 seasonal epidemics of influenza in Asia were delayed, shorter, and less severe than expected(7-8).

In Thailand, during the COVID-19 pandemic, the center of excellence in clinical virology of Chulalongkorn university and hospital conducted a study which revealed there were 40% decline in the total number of influenza-like illnesses and laboratory-confirmed influenza cases in 2020. Moreover, influenza hospitalization rates also decreased during the same period(9-11). Information on the influenza burden, as reflected by hospitalization and mortality data prior and during the pandemic in Thailand, was limited. This study aimed to examine patterns of influenza infection and severity (morbidity, seasonal variation, and mortality) before and during COVID-19 pandemic using National Health Security Office (NHSO) data from 2016 to 2020 in order to characterize the changes in hospitalized influenza burden, utilization pattern, and mortality outcome in Thailand, as well as to identify factors associated with influenza-related mortality.

Materials and Methods

The Universal Coverage Scheme (UCS) data by NHSO was used in the study. The UCS covered health care for approximately 71% of the Thai population(12). The database includes demographic information, primary and secondary medical diagnoses based on International Classification of Disease (ICD) codes, along with date of hospital admission and date of discharge from hospital, date of death (either in the hospital or after discharge), and adjusted related weight (adjusted RW), which estimate resources used in the hospital admission, implying severity of illness. Adjusted RW was the numerical factor calculated by associated factors of admission: principle diagnosis, comorbidity, complication, age, sex, admission weight, procedure, operation, and discharge status, finally adjusted with length of stay(13).

We used the UCS data during 2016-2020. We extracted the weekly number of influenza hospital admissions (number of inpatients) and analyzed for the seasonal pattern of influenza. Based on ICD tabulation list, 10th edition (ICD-10), the ICD-10 codes for influenza were added to the analysis including J09-avian influenza, J10-other influenza virus, and J11-influenza virus not identified. In addition, the history of influenza vaccination variable was assigned to a patient with ICD-10 code Z251 and a vaccination date within 365 days of the patient's latest visit.

We analyzed the patterns of influenza patients by sex, geography, and age, dividing population into subgroups classified by age groups: 0-4, 5-14, 15-49, 50-64, and 65 years and over. The admission rate and the mortality rate were calculated using midyear population estimates for specific population groups obtained from the Ministry of Public Health. We define "pre-COVID-19 period" as a period from 1 January 2016 to 31 December 2019 and "COVID-19 period" as a period from 1 January to 31 December 2020. We calculated characteristic descriptions of inpatients for the pre-COVID-19 period and during the COVID-19 period. We further calculated the 30-day mortality of inpatients, which meant inpatients with influenza who died within 30 days of influenza admission, both in-hospital and out-hospital. We utilized the Charlson Comorbidity Index (CCI), which is a weighted measure designed to predict the likelihood of mortality for patients with specific comorbid diseases during a one-year hospitalization period. The CCI incorporates 19 different conditions, each assigned a weight ranging from 1 to 6 based on their impact on mortality risk. These comorbidities were identified using the ICD-10 codes. The conditions included in our analysis were myocardial infarction, congestive heart failure (CHF), peripheral vascular disease, stroke, dementia, chronic obstructive pulmonary disease, rheumatoid arthritis, peptic ulcer disease, liver disease, diabetes, hemiplegia, renal disease, cancer, and acquired immune deficiency syndrome (AIDS)(14).

Statistical analysis was performed in the R program version 4.1.0. We assessed the influenza pattern by comparing the morbidity rate per 100,000 population. Numerical variables were summarized as median and percentiles, and categorical variables as frequencies and percentages. The prevalence ratio was used to compare the prevalence before and during the COVID-19 period. The numerator was the number of influenza admissions in 2020 divided by the number of all-cause admissions in 2020, and the denominator was the median value of the previous 4 years (2016-2019) of influenza admissions divided by the median of previous 4 years of all-cause admissions(15). A logistic regression model was used to explore the factors associated with 30-day mortality. The factors with *p*-values less than 0.1 from the univariable analysis were included in multiple logistic regression analyses to control for potential confounding factors. Prior to including the chosen independent variables in the multivariable analysis, the variance inflation factor analysis (VIF) was employed to analyze multicollinearity between factors. The VIF for each factor in this study was less than 5, indicating low multicollinearity. The results of logistic regressions were reported as odds ratios (OR) and adjusted odds ratios (aOR) with corresponding 95% confidence intervals (CI), and the significance level was 0.05.

Results

There was a total of 219,365 influenza inpatients. The weekly number of inpatients between 1 January 2016 and 31 December 2020 exhibited 2 peaks, with a smaller peak during weeks 3-13 and a larger peak during weeks 25-49. This seasonal pattern was consistent across the years 2016-2018. In 2019, there were a higher number of inpatients, which rapidly decreased in week 6 of 2020, and no second peak was observed in 2020 (Figure 1). The prevalence ratio of admissions in 2020 was 66% lower than the admissions prevalence ratio for the control period of 2016-2019.

During the pre-COVID-19 period, the highest morbidity rate was observed among those aged 0-4 years, with a rate of 457.13 per 100,000 population, followed by 129.22 and 43.37 per 100,000 population among those aged 5-14 years and aged 65 years and over, respectively. The highest morbidity rate was found in the northeastern region. Additionally, 93% of the inpatients did not have any comorbidities. The median LOS was 3 days (Q1-Q3 2-4 days) and the adjusted RW was 0.25. The overall mortality rate during pre-COVID-19 period was 0.38 per 100,000 population.

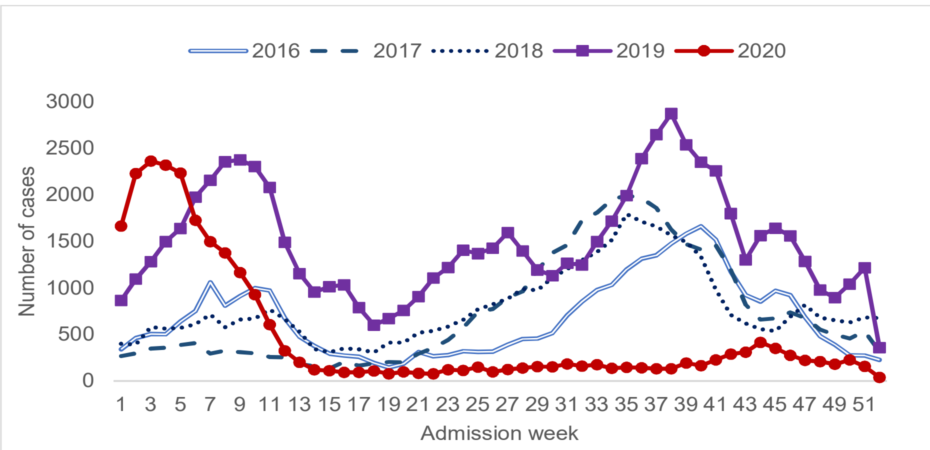

Figure 1 A comparison of weekly influenza admissions from 2016-2020.

During the COVID-19 period, the order of morbidity rates by age group remained the same. The highest morbidity rate was observed among those aged 0-4 years, followed by aged 5-14 years and aged 65 years and over, the same as the pre-COVID-19 period. The sex distribution was consistent between both periods, but the highest morbidity rate shifted to the northern region (Table 1). The influenza vaccination revealed a minimal increase in influenza vaccine coverage among all age inpatients over the period of 2016 to 2020. However, a notable finding was observed in the elderly population aged 65 years and over, where the vaccine coverage increased significantly by approximately 2 times during the same time frame (Table 2). Furthermore, 87% of individuals did not have any comorbidities. The median LOS decreased to 2 days (IQR 2-3 days), and the adjusted RW was 0.25. The mortality rate during the COVID-19 period increased to 0.74 per 100,000 population (Table 3).

Table 1 Descriptive characteristics of influenza cases in the pre-COVID-19 period (2016-2019) and the COVID-19 period (2020)

	Pre-COVID-19 Period n (morbidity rate per 100,000 population)	**COVID-19 Period n (morbidity rate per 100,000 population)**
Sex		
Male	20,928 (65.38)	1,683 (5.26)
Female	19,117 (57.40)	1,569 (4.69)
Age group		
0-4 years	15,943 (457.13)	11,616 (366.40)
5-14 years	10,187 (129.22)	6,902 (89.39)
15-49 years	7,879 (23.10)	3,958 (11.90)
50-64 years	3,141 (24.82)	1,650 (12.33)
65 years and over	3,115 (43.37)	1,821 (23.09)
Region		
North	6,725 (57.62)	5,702 (49.12)
Central	13,540 (60.58)	7,423 (32.97)
North-East	14,713 (67.05)	10,140 (46.34)
South	5,336 (57.13)	2,682 (28.48)

Table 2 Influenza vaccine coverage in Thai population, 2016-2020

	2016	**2017**	**2018**	**2019**	**2020**
Vaccine coverage per 100,000 population (total population)	3.77	3.77	4.16	4.36	5.17
Vaccine coverage per 100,000 population (only persons aged 65 and over)	9.89	16.18	16.98	18.03	20.58

Table 3 Admission characteristics of influenza inpatients in the pre-COVID-19 period (2016-2019) and the COVID-19 period (2020)

Variables	**Pre-COVID-19 Period**	**Pre-COVID-19 Period**
Length of stay, median (Q1-Q3)	**3 (2-4) days**	**3 (2-4) days**
Adjusted RW, median (Q1-Q3)	**0.25 (0.25-0.40)**	**0.25 (0.25-0.40)**
Charlson comorbidity index		
0 score, %	93.12	93.12
1-2 scores, %	6.03	6.03
3-4 scores, %	0.44	0.44
>4 scores, %	0.40	0.40
30-day mortality, per 100,000 population	0.38	0.38

During the pre-COVID-19 period, the mortality rate was highest among males, particularly in the age groups of 0-4 years and aged 65 years and over. The northern and northeastern regions also experienced higher mortality rates. The adjusted RW was 0.55 and vaccination patients were higher mortality rate than non vaccination patients. Median CCI was 1 point. However, during the COVID-19 period, similar trends were observed in terms of sex and geographical area, LOS, and CCI but the age group with the highest mortality shifted to 0-4 years, followed by 5-14 years. Additionally, the adjusted RW was lower than pre-COVID-19 period (Table 4).

Table 4 Factors associated with 30-day mortality in influenza admission in the pre-COVID-19 period (2016-2019) and the COVID-19 period (2020)

variables	Pre-COVID-19 Period (n=193,418)		COVID-19 Period (n=25,947)	
	statistic	**OR (95%CI)**	**statistic**	**OR (95%CI)**
Sex	**Mortality rate per 100,000 persons**	**n=192,955**	**Mortality rate per 100,000 persons**	**n=3,252**
Female	0.37	Ref	0.06	ref
Male	0.39	0.94 (0.83, 1.05)	0.07	1.16 (0.64, 2.11)
Age group	Mortality rate per 100,000 persons	n=193,418	Mortality rate per 100,000 persons	n=25,947
0-4yr	1.34	ref	5.64	ref
5-14yr	0.42	1.06 (0.88, 1.29)	1.47	1.07 (0.85, 1.36)
15-49yr	0.11	1.53 (1.26, 1.86) **	0.23	1.28 (0.98, 1.68)
50-64yr	0.34	3.77 (3.08, 4.61) **	0.32	1.71 (1.22, 2.39)**
≥65yr	1.41	10.14 (8.65, 11.89) **	0.92	2.67 (2.02, 3.52)**
Area	Mortality rate per 100,000 persons	n=193,418	Mortality rate per 100,000 persons	n=25,947
Central	0.24	ref	0.65	ref
North	0.44	0.64 (0.54, 0.77)**	0.97	1.00 (0.78, 1.28)
North-east	0.44	0.85 (0.74, 0.97)**	0.83	0.90 (0.73, 1.13)
South	0.32	0.79 (0.65, 0.95)**	0.47	0.84 (0.6, 1.18)
Length of stay	Median (days)	n=193,418	Median (days)	n=25,947
(days)	3	1.04 (1.03, 1.05)**	3	1.05 (1.03, 1.07)**
Adjusted RW	Median	n=193,418	Median	n=25,947
	0.55	1.32 (1.29, 1.35)**	0.25	1.29 (1.21, 1.39)**
Vaccine	Mortality rate (%)	n=193,418	Mortality rate (%)	n=25,947
No	0.61	ref	1.88 %	ref
Yes	0.92	1.49 (1.06, 2.09)**	1.35 %	0.72 (0.32, 1.61)
Charlson	Median (score)	n=193,418	Median (score)	n=25,947
comorbidity index	1	1.95 (1.89, 2.00)**	1	1.82 (1.73, 1.91)**

**the significance level 0.05

The univariate analysis for the pre-COVID-19 period revealed that age group, area, length of stay, adjusted RW, vaccine and the CCI were associated with mortality. During the COVID-19 period, the associated factors remained largely consistent, except for the vaccine and area (Table 4). The VIF analysis found that all the factors did not exhibit strong multicollinearity (VIF<4). However, the LOS already included in the adjusted RW calculation, we thus dropped the LOS from multivariable analysis. We excluded "area" from the model due to its contrasting results between the 2 periods. However, we retained "vaccine" in the model because there is clear evidence that it provides protection against influenza infection and reduces hospital admissions. The findings of the multivariable analysis indicated that all factors were associated with a significant increase in mortality rate during the pre-COVID-19, and the results in COVID-19 were consist with pre-COVID-19 periods except vaccine. Specifically, the factors that were significantly associated with increased mortality rate during the pre-COVID-19 period included being aged 50 years and over (aOR 2.23, 95% CI 1.80, 2.76), adjusted RW (aOR 1.22, 95% CI 1.20, 1.24), and CCI (aOR 1.82, 95% CI 1.75, 1.88). During the COVID-19 pandemic, significant predictors included aged 65 years and over (aOR 1.48, 95% CI 1.09, 1.99), adjusted RW (aOR 1.20, 95%CI 1.14, 1.27), and CCI (aOR 1.79, 95%CI 1.69, 1.89). The influenza vaccine showed a low association with mortality during the pre-COVID-19 period but was not statistically significant during the COVID-19 period (Table 5).

Table 5 Factors associated 30-day mortality in influenza admission in pre-COVID-19 period (2016-2019) and COVID-19 period (2020), multivariable analysis

variable	Pre-COVID-19 Period (n=193,418) adjusted OR (95% CI)	COVID-19 Period (n=25,947) adjusted OR (95% CI)
Age group		
0-4yr	ref	ref
5-14yr	1.09 (0.90, 1.32)	1.08 (0.85, 1.38)
15-49yr	1.09 (0.89, 1.33)	0.9913 (0.74, 1.31)
50-64yr	2.23 (1.80, 2.76)**	0.98 (0.68, 1.41)
≥65yr	5.34 (4.51, 6.33)**	1.48 (1.09, 1.99)**
Adjusted RW	1.22 (1.20, 1.24)**	1.20 (1.14, 1.27)**
Vaccine	0.64 (0.45, 0.92)**	0.62 (0.27, 1.42)
Charlson comorbidity index	1.82 (1.75, 1.88)**	1.79 (1.69, 1.89)**

**the significance level 0.05

Discussion

Our study found that the pattern of influenza inpatients in hospitals had 2 peaks: the rainy (July-September) and winter (January-March) seasons. We observed an increase in the number of influenza-associated admissions in 2019 compared to the preceding years, followed by a decline in February 2020 and a plateau until the end of 2020. Our findings are consistent with reported seasonal influenza and influenza-like illness surveillance in Thailand[16-17]. There was a high number of influenza outbreaks in 2019, followed by a decline in February 2020 and a plateau until the end of 2020[17-18]. However, laboratory-confirmed influenza cases began to decrease in March 2020, likely due to the Thai population becoming aware of the first domestic COVID-19 infection in week 5. There has been an increase in public awareness. Subsequently, in week 9, the Ministry of Public Health announced the Communicable Disease Act, followed by mandatory quarantine measures for travelers from specific countries[7, 10-11].

Our analysis found that during the COVID-19 period, there were no changes in the length of hospital stay, adjusted relative weight, or comorbidity of inpatients when compared to the pre-COVID-19 period. These factors are often used as indicators of severity in admission, with higher values indicating more severe cases. However, given that, in many epidemic areas, only patients with severe conditions were allowed to be admitted during the COVID-19 period (as several health facilities considered COVID-19 cases a priority for admission), one might assume that the overall severity of admitted patients would be higher[19]. Interestingly, our findings suggest that the severity of patients admitted with influenza did not change during the COVID-19 period, indicating that patients admitted during the pandemic were not necessarily more severe than those admitted prior to the pandemic. Since February 2020, the Ministry of Public Health in Thailand has been actively preparing resources for the treatment of COVID-19. As the COVID-19 outbreak evolved, patients with respiratory symptoms were suspected to have COVID-19, prompting Thailand to make significant efforts to enhance its capacity for patient care. These efforts have not only enabled the country to effectively manage and treat COVID-19 patients but also ensure that adequate resources and medical facilities are available for the treatment of influenza patients[20]. The number of influenza deaths during the COVID-19 period was higher than the previous 4 years[21]. SARS-CoV-2 infection was more severe and presented with a higher case fatality rate than the influenza infection[2, 22-23]. We found the mortality rate increased from 0.38 to 0.74 per 100,000 persons during the COVID-19 period. One important factor as a protective measure was the influenza vaccine, which demonstrated a vaccine effectiveness of 20-26% in preventing influenza-related deaths during the 2010-2016 seasons[24]. However, the coverage of influenza vaccination showed an increasing trend from 2016 to 2020. The potential explanation could be the administration of vaccinations may have been delayed or disrupted due to the challenges posed by the COVID-19 pandemic. It is important to note that for the purposes of this study, we utilized a 30-day mortality variable, which encompassed any deaths occurring within 30 days of influenza admission, regardless of whether the patient had been discharged. One interesting observation is that the turnover rate of patients during the COVID-19 period was faster compared to the pre-pandemic period. This could potentially be attributed to the inclusion of deaths related to other causes, such as COVID-19 itself, in our study. Considering the impact of COVID-19 as a contributing factor to mortality outcomes is crucial, as it can provide a more comprehensive understanding of the overall mortality burden during this period. Furthermore, it is possible that some influenza patients chose to stay home due to hesitancy in seeking emergency room care during the pandemic, despite the potential for influenza to progress to a severity beyond treatable measures[25]. COVID-19 contributed to the higher mortality observed during the COVID-19 pandemic, which warrants further investigation.

In multivariable analysis, being aged 50 years or older during the pre-COVID-19 period and being aged 65 years or older during the COVID-19 period, adjusted RW, and comorbidities were significant factors linked with mortality. Patients with multiple comorbidities were at a greater risk of mortality, and those who died from influenza had longer hospital stays and used more medical resources than those who survived[14,19,23].

Our study has some limitations due to the use of administrative data of only patients covered by the Universal Health Coverage Scheme to investigate the pattern of influenza-related morbidity and mortality rates in the Thai population. There is a possibility of underestimation of results in this study due to accessibility to healthcare, especially during the COVID-19 pandemic. In addition, the potential inaccuracies in medical diagnosis and coding could introduce misclassification bias. Moreover, in the year 2020, a significant proportion of variables were found to be missing, exceeding 20%, and there were instances of incomplete data due to delayed reporting in November and December. These missing and incomplete data could potentially introduce uncertainties and affect the comprehensiveness of our analysis. The duration of studying the burden of influenza prior to and during the COVID-19 pandemic differs due to limitations in accessing data from the NSHO. Changes in data access systems have made it impossible to retrieve historical data. However, this study compares morbidity and mortality rates during the same time periods (weeks), revealing varying figures within the same time frames.

In addition to our findings, we recommend that public health agencies should launch a risk awareness campaign targeting vulnerable populations, particularly the elderly and individuals with multiple comorbidities. This campaign aims to mitigate influenza infection and related fatalities by expediting the administration of influenza vaccines among these groups. Furthermore, we recommend that healthcare providers use the CCI and adjusted RW as vigilant signs to take special care of patients at high risk of mortality.

Moreover, we recommend that further studies be conducted on several topics. Firstly, it would be helpful to explore the cause of the increased mortality rate during the COVID-19 period. Coinfection, particularly the occurrence of simultaneous infections, could be an intriguing factor to investigate in relation to mortality outcomes. Additionally, future studies should explore the impact of COVID-19 preventative measures on influenza transmission and related outcomes, including hospital admissions, severity, and mortality. Lastly, it is advisable to further investigate the efficacy and effectiveness of influenza vaccines in the population, especially among high-risk groups, such as the elderly and those with comorbidities. These efforts could improve our understanding of influenza epidemiology and inform public health policies to reduce the burden of influenza in the population.

Conclusion

In Thailand, the pattern of influenza inpatient admissions showed 2 peaks during the rainy and winter seasons. The number of admissions increased in 2019, declined in February 2020, and remained stable until the end of the year, likely influenced by COVID-19 preventive measures. The majority of inpatients were in the young age group (0-4 years) and located in the northern and northeastern regions of the country.

Notably, the severity of influenza cases admitted during the COVID-19 period did not significantly differ from the pre-COVID-19 period. The Ministry of Public Health in Thailand made preparations for COVID-19 treatment while ensuring adequate resources for influenza patient care. During the COVID-19 period, the mortality rate increased, potentially including deaths from other causes. Factors associated with death were being aged 65 years or older, the Charlson Comorbidity Index (CCI), and adjusted relative weight (RW), which were consistent across both periods.

However, it is important to consider data limitations and potential inaccuracies in diagnosis and coding. Public health campaigns targeting vulnerable populations and further research on mortality causes, the impact of COVID-19 measures, and the efficacy of influenza vaccines are recommended to improve the understanding and management of influenza in the population.

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