



Risk Factors Associated with an Influenza B Outbreak due to Inefficient Screening in a Prison in Thailand

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Abstract

On 3 Oct 2019, the Office of Disease Prevention and Control Region 12 Songkhla received notification of a suspected influenza cluster in a prison in Songkhla Province, Thailand. In cooperation with the local public health teams, we investigated the event to confirm the diagnosis, identify the source of infection, and implement control measures. A suspected influenza case was defined as an individual with fever and at least one of the following symptoms: cough, sore throat, runny nose, or dyspnea. A confirmed case was a suspected case who tested positive to influenza by the reverse transcription polymerase chain reaction technique. An environmental survey was conducted to assess risk behaviors and determine the occupancy rate. A case-control study was performed to identify associated factors of developing influenza. We identified 128 suspected cases, of which seven were confirmed to have type B influenza. All were male and their median (interquartile range) age was 29 years (24–35). The overall attack rate was 5.2%. The first case developed symptoms in the new prisoner zone and moved to another zone without undergoing respiratory screening. The analytical study revealed that sleeping within one meter of a confirmed case (adjusted odds ratio (AOR) 1.77, 1.07–2.92), and sharing drinking glasses with others (AOR 1.83, 1.18–2.82) were significant risk factors. The overcrowded prison (165% occupancy) led to limited availability of vaccines, causing 83.5% of prisoners to be unvaccinated. Strict screening of new prisoners before moving to another area and early isolation of symptomatic prisoners are recommended.

Keywords: influenza B outbreak, prison, Southern Thailand, screening, isolation

Introduction

Influenza is an infectious disease caused by viral infection. It has caused multiple global pandemics.¹ Three types of influenza viruses—A, B, and C—infect humans with types A and B causing widespread epidemics.² The incubation period is about two days, ranging from 1–4 days.² Transmission occurs through respiratory droplets when an infected person coughs or sneezes. High-risk areas include crowded places such as schools, factories, and prisons.

In Thailand, overcrowded prisons, or those with high occupancy rates, have an increased risk of influenza outbreaks.³ According to the Disease Outbreak

Surveillance Program, Division of Epidemiology, Ministry of Public Health, prisons were identified as the most prevalent environment (37%) for influenza outbreaks between 2017 and 2019.⁴ In 2019, The National Health Security Office of Thailand initiated a flu vaccination program in all prisons, distributing around 125,254 doses. However, only about one in three prisoners received the vaccine.⁵ The program targeted seven vulnerable groups: individuals over 65, those with certain chronic diseases, obesity, neurological impairments, thalassemia or compromised immune systems, children aged six months to two years, and pregnant women beyond 34 weeks gestation.⁶

On 3 Dec 2019, the Office of Disease Prevention and Control 12 Songkhla (OPDC 12) received a report of 14 suspected influenza cases among prisoners in a prison in Songkhla Province. From 6 to 11 Dec 2019, an ODPC 12 investigation team, in collaboration with the Provincial and District Public Health Office, conducted an outbreak investigation to confirm the diagnosis, identify the source of the infection, investigate risk factors for the outbreak, provide recommendations, and implement control measures.

Methods

We interviewed prison staff to gather information about the prison's characteristics, annual influenza vaccinations and the process of admitting and transferring new prisoners, particularly the process of screening for respiratory diseases.

An active case finding was conducted among prison staff and prisoners. Prisoners were screened for fever, focusing on those with a body temperature exceeding 38 °C or a recent fever since 2 Nov 2019. Those meeting the criteria were interviewed using a semi-structured questionnaire. Cases were classified based on the World Health Organization (WHO) criteria. Suspected cases included prisoners and prison staff in the prison with fever or body temperature exceeding 38 °C, along with one or more of the following symptoms: cough, sore throat, runny nose, and dyspnea, between 2 Nov and 12 Dec 2019. Confirmed cases were those meeting the suspected case definition and testing positive for the influenza virus via reverse transcriptase polymerase chain reaction technique.

A semi-structured questionnaire was used to gather data, including demographic characteristics (age, gender, dormitory), signs and symptoms, annual influenza vaccination and high-risk behaviors. The high-risk behaviors were divided into four parts: 1) contact history with case, such as sleeping near (less than one meter) a case, eating at the same table with a case, and having close contact (less than one meter) with a case; and 2) sharing personal belonging with other prisoners (e.g., clothes and towels, spoons, drinking glasses and phone at the visiting room); 3) personal hygiene (washing hand with soap after using toilets; and 4) history of receiving the annual influenza vaccine.

We purposively sampled 10% of the suspected cases with illness onset less than five days prior to the day of investigation. Throat swab samples were collected and sent to the OPDC 12 laboratory center, where they were tested for influenza.

An environmental study was conducted to inspect various prison zones, including handwashing stations, screening points, isolation rooms, dining areas, dormitories, vocational training areas, and guest

visitation rooms. We assessed dormitory density by calculating the area per prisoner and the occupancy rate by dividing the current number of all prisoners by the prison's capacity.⁷

We conducted an unmatched case-control study to investigate factors associated with being a case. The case group included all suspected and confirmed influenza cases, while the control group consisted of asymptomatic prisoners during the same period. We excluded those with suspected influenza symptoms or influenza diagnoses two weeks before the outbreak period. Convenience sampling was used to select the control group at a 4:1 ratio. All selected participants were interviewed. The sample size was determined using an unmatched case-control formula with a significance level of 0.05 and a power of 0.85.⁸ The estimated influenza proportion among those with long-time exposure to the ward in the prison and among those without was 71% and 44%, respectively.⁹ This resulted in 37 case group participants and 148 control group participants.

Statistical Analysis

Descriptive statistics for continuous data included median and interquartile range (IQR), while categorical data were presented as frequency and proportion. Analytic statistics involved univariable and multivariable logistic regression to determine factors associated with being a case. We calculated odds ratio (OR) and 95% confidence intervals (CI). Variables with a *p*-value <0.1 in univariable analyses and the influenza vaccine variable (due to strong evidence in preventing infection) were included in the multivariable model.¹⁰ Adjusted OR with 95% CI were reported. Microsoft Excel 2016 and R version 4.2.1 were used for data processing.^{11,12} Significant factors from the model were used to calculate the population attributable fraction (AF_p) to determine the proportional reduction in disease if exposure to a risk factor was eliminated using the following modified formula:¹³

$$AF_p = \frac{P_c(OR - 1)}{OR}$$

where P_c is the exposure prevalence among case.

Ethics

Ethical clearance was omitted as this investigation was conducted in response to a disease outbreak. Interviewees were informed about the benefits and objectives before interviews. Responses were documented without recording names or addresses. Completed questionnaires were securely stored, with access limited to the principal investigator who will responsibly dispose of the data after publication.

Results

Descriptive Study

At the time of the investigation, the prison contained 2,844 prisoners (2,497 males and 347 females) and 78 prison staff. Around 83.5% (2,041/2,443) of prisoners were unvaccinated against influenza in 2019 due to limited vaccine supply caused by overpopulation. The prisoners were divided into five zones. Zones 1 and 2 contained general male prisoners. Zone 1 had one dormitory and Zone 2 had four dormitories with an area for vocational training. Zone 3 was designated for new male prisoners and had three dormitories. New prisoners usually received a two-week orientation course, which included an introduction to prison rules to help them adjust to their new environment. Prison health officials typically screened for underlying diseases, conducted urine drug tests, assessed mental health, and checked for recent respiratory symptoms to prevent outside infections to enter the prison. Usually, new prisoners without symptoms participated in routine activities, such as waking up at a certain time, exercising, eating meals in the canteen, participating in recreational activities, attending orientation sessions, and sleeping in dormitories. Prisoners with fever or respiratory symptoms were isolated until recovery before rejoining others or moving to another zone. Occasionally, when a large number of prisoners entered simultaneously and overwhelmed Zone 3, prison staff placed both symptomatic and asymptomatic prisoners in the same dormitory necessitating swift relocation to other zones, which could compromise the effectiveness of disease screening and isolation efforts. Zone 4 consisted of a medical clinic and had no dormitory. Zone 5, reserved for female prisoners, had one dormitory and was physically separated from the other zones in terms of location, activities, and prison staff.

On 11 Nov 2019, 29 prisoners were relocated from dormitories 2 and 3 of Zone 3 to different dormitories in Zone 2, including the first case, who entered the

prison on 6 November and developed symptoms on 10 November, along with two others presenting with respiratory symptoms on 11 November. These prisoners were not screened or isolated and stayed in Zone 3 for less than one week due to overcrowding. Consequently, symptomatic prisoners from Zone 3 were placed with asymptomatic prisoners in Zone 2. Approximately two weeks later, on 29 November, medical staff identified a suspected cluster of influenza cases in Zone 2 due to a surge in cases visiting the clinic.

From the active case finding, we identified 128 cases, of which 7 (5.5%) were confirmed. All cases were male, with an attack rate of 5.2% among male prisoners (128/2,443), and no deaths. No cases were reported among prison staff. The median (IQR) age of the cases was 29 years (24–35). All had fever with other common symptoms including cough (81.9%), runny nose (65.7%), sore throat (58.1%), and dyspnea (17.1%). Oseltamivir, an antiviral drug, was administered to 35 cases (27.3%) with severe symptoms, such as high-grade fever, severe cough, and dyspnea. Most (96.9%) did not belong to any vulnerable group. Four cases belonged to vulnerable group: two were obese, one had chronic obstructive pulmonary disease, and one had compromised immunity. There were no reported complications or referrals.

The first case developed symptoms on 10 November, and the last case on 12 December, with the peak on 2 Dec 2019 (Figure 1). The attack rates in zones 1, 2, 3, and 4 were 0.1%, 7.3%, 11.7% and 5.5%, respectively (Table 1). Zone 3, used for new arrivals, had the highest attack rates, especially in dormitories 2 and 3, at 22.9% and 27.8%, respectively. In Zone 2, dormitories 1, 2, 3, and 4 had attack rates of 9.8%, 8.2%, 3.7%, and 4.0% respectively.

The survey of cases identified high-risk behaviors as sharing drinking glasses (62.4%), using phones in the visiting room (51.5%), sleeping within one meter of a case (41.6%), close contact (within one meter) with a case (38.6%), eating at the table with a case (20.8%), sharing spoons (13.9%), sharing clothes or towels (12.9%).

Table 1. Number of influenza cases and area density by dormitory, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand

Prison zone	Total population screened	Number of cases	Attack rate (%)	Area density (m ² /prisoner)
Zone 1 (General prisoner zone)				
Dormitory 1	890	1	0.1	0.6
Zone 2 (General prisoner zone)				
Dormitory 1	435	43	9.8	0.6
Dormitory 2	365	30	8.2	0.6
Dormitory 3	217	8	3.7	0.9
Dormitory 4	221	9	4.0	0.9
Zone 3 (New prisoner zone)				
Dormitory 1	208	21	10.1	0.7
Dormitory 2	35	8	22.9	0.6
Dormitory 3	18	5	27.8	1.2
Zone 4 (Healthcare zone)				
	54	3	5.5	-

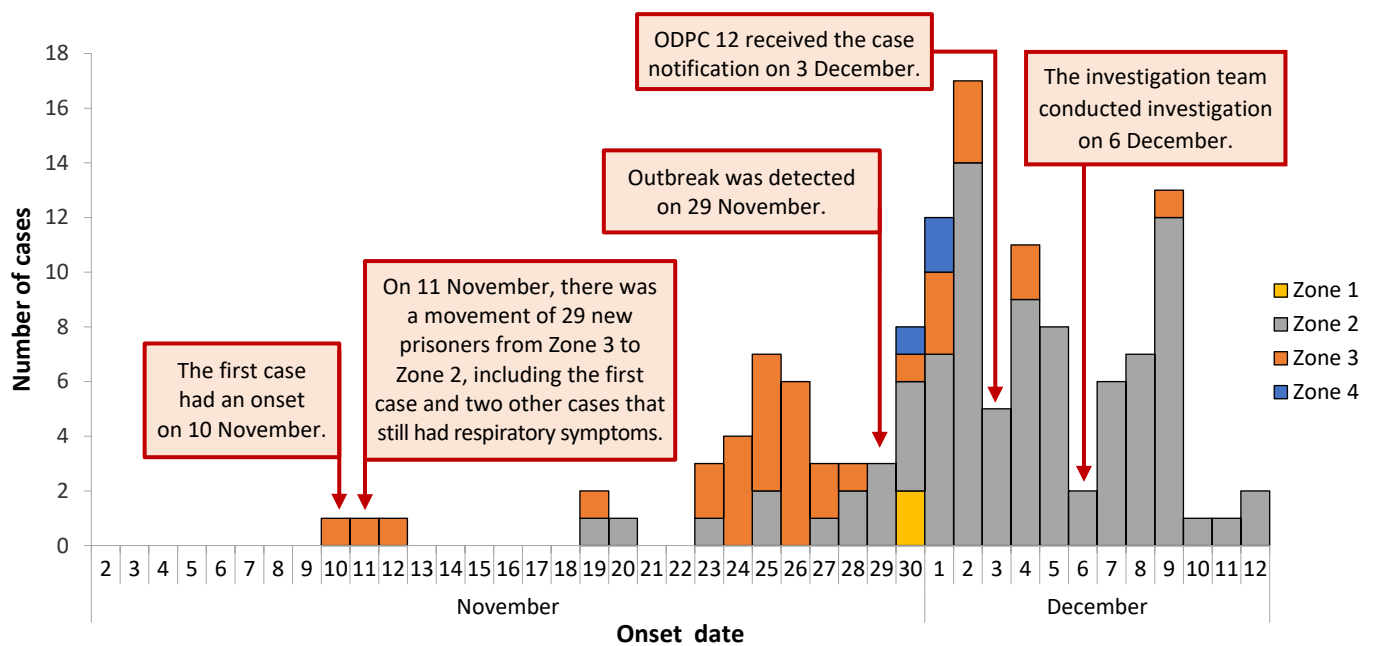


Figure 1. Number of influenza cases by onset date, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand (n=128)

Laboratory Study

Nine of the 128 suspected cases (7.0%) had throat swabs performed, of which seven tested positives for influenza type B virus (lineage or clades were not reported). Influenza types A and C virus were not detected.

Environmental Study

The average area density of all dormitories was 0.8 m²/prisoner and the prison occupancy rate was 165% (2,844/1,720). In all dormitories, there were fans for ventilation, but the air circulation was insufficient, resulting in musty odors and damp surroundings. Handwashing stations and soap were available, but

infrequently used. The phones in visiting room were not disinfected after each use. The dining area provided utensil and individual trays.

Analytic Study

The analyzed group consisted of 587 individuals, including 128 cases and 459 controls. The multiple logistic regression analysis revealed that sleeping near case (OR 1.77, 95% CI 1.07–2.92) and sharing drinking glasses (OR 1.83, 95% CI 1.18–2.82) were statistically significant associated with influenza infection. The population attributable fraction (AF_p) for these factors were 16.3% and 29.8%, respectively.

Table 2. Factors associated with an influenza B outbreak, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand

Associated factors	Cases (n=128)	Controls (n=459)	Univariable	Multivariable	
			Crude OR (95% CI)	Adjusted OR	95% CI
Contact history					
Sleeping near a case*	48	95	2.42 (1.54–3.78) [†]	1.77	1.07–2.92
Eating at the same table with a case	26	44	2.47 (1.40–4.34) [†]	1.74	0.96–3.15
Close contact with a case*	57	144	2.00 (1.29–3.06) [†]	1.41	0.87–2.29
Share personal belongings					
Sharing clothes or towels	14	41	1.27 (0.62–2.48)		
Sharing spoons	12	45	0.97 (0.45–1.93)		
Sharing drinking glasses	84	235	1.90 (1.23–2.95) [†]	1.83	1.18–2.82
Sharing a phone in the visiting room	59	254	0.67 (0.44–1.01) [†]	0.66	0.44–1.01
Personal hygiene					
Washing hands with soap after using the toilet	44	190	0.75 (0.48–1.1)		
Immunization					
Receiving the annual influenza vaccine	3	13	0.83 (0.15–3.10)	1.15	0.31–4.22

*Within 1 meter. [†]P-value <0.1. Variance inflation factor <10 for all factors, no multicollinearity. OR: odds ratio. CI: confidence interval.

Action Taken

We emphasized to the prison's chief executive officer the importance of implementing customized health screening, focusing on respiratory symptoms, particularly in Zone 3, even under crowded condition. Symptomatic individuals should be isolated until their symptoms abate, while asymptomatic prisoners should complete an incubation period of around one week before being transferred to another zone. Oseltamivir was administered to suspected and confirmed cases to reduce the spread of the disease. We distributed additional face masks to prisoners, in addition to what the prison already had, to cover all prisoners, specifically those who were symptomatic, and hand sanitizers to prisoners in all zones, particularly in zones 2 and 3. We urged prisoners to avoid group activities and to refrain from arranging visits from friends or relatives until the outbreak subsides.

Discussion

This investigation identified an influenza B outbreak in a Thai prison with an attack rate of 5.2%. No cases of influenza types A or C were identified. Some prisoners tested negative for all types. Overcrowding was evident in all dormitories. We found statistically significant associations for sleeping near another case and sharing drinking glasses with others. The likely cause of this outbreak was the movement of newly admitted prisoners without effective screening and, for asymptomatic prisoners, an insufficient incubation period. Vaccine supply was insufficient.

The attack rate among prisoners was 5.2%, which was higher than outbreak rates for influenza type B (approximately 0.6%) and type A (approximately 2.3%) in communities reported by a previous meta-regression analysis.¹⁴ Despite the fact that the influenza type B virus strain mutates more slowly compared to type A, it leads to more severe outbreaks in crowded and densely populated places such as schools, military camps, nursing homes, and prisons.^{15,16} However, the severity of outbreaks also depends on the presence of high-risk individuals among the cases, as well as their access to treatment with antiviral drugs and prevention through vaccination.^{17,18}

Laboratory testing to confirm influenza virus infection for two suspected cases yielded negative results for both influenza types A and B. However, we believe that there was a high likelihood of these two cases having influenza B due to clinically compatible symptoms and epidemiological links with confirmed cases. An inability of the test to confirm the pathogen may have occurred for various reasons, such as inadequate sample collection, improper handling before testing, or testing outside the viral shedding period.¹⁹

According to the WHO's definition of influenza-like illness, cases should have a fever of 38 °C or higher and present with coughing. However, in the current prison outbreak, where there was overcrowding (165% occupancy) and limited space (dormitory density 0.8 m²/prisoner—the standard is >3.4 m²/prisoner), the risk of respiratory diseases spreading quickly was high. To improve the sensitivity of case detection, we modified the WHO's definition. Currently, prisoners are screened if they have a history of fever or a temperature above 38 °C, along with any respiratory symptom, and regardless of cough. This change aimed to increase the screening sensitivity from 20.0% noted in the previous study, which assessed the validity of influenza case definitions.²⁰

The source of this outbreak was likely due to the movement of newly admitted prisoners without effective screening. Additionally, there was a risk posed by prisoners who did not exhibit symptoms but could be contagious during the incubation period when they had recently acquired the infection. This continuous transmission could occur if they were not segregated into separate dormitory areas from the beginning of the illness or isolated appropriately before being moved to other zones. Lack of precautionary measures was a major contributing factor to a previous outbreak in Canada.²¹

The significant risk factors contributing to the person-to-person transmission of the disease in this current investigation were delays in segregating infected patients, sleeping within one meter of a case, which showed a with 16.3% reduction in the risk of becoming a case, the high occupancy rate in the prison and the high density of prisoners in the dormitories. These factors align with previous reports on influenza outbreaks in prisons and highlight the importance of promptly isolating infected individuals, following the guidelines recommended by the Infectious Diseases Society of America.^{22,23}

Under a limited supply of vaccines from the Thai government, a concerning issue arises in Thailand as nearly half of the country's prisons experienced at least one outbreak during 2017–2019.⁴ This issue is compounded by the inherent nature of prisons, which have a higher prevalence of respiratory illnesses and immunosuppression (HIV infection) among prisoners compared to the broader community.^{24,25} This poses a high risk as vulnerable people infected with influenza can easily transmit the virus to others due to the close living quarters and constant turnover of people.²⁶ Thailand should implement a policy to distribute flu vaccines to all prisoners, with a particular focus on covering all vulnerable groups. While this measure

might increase the budget burden, it has the potential to help reduce both the number of infected cases and all related costs, including treatment and disease control expenses.²⁷

Due to an insufficient quantity of vaccines and the continuous influx of new prisoners who may be infectious, vaccination alone is not a suitable short-term control measure during an outbreak in prisons. However, previous studies have shown promising results with Oseltamivir, which may be a potential option for reducing the number of influenza cases.¹⁶ However, non-pharmaceutical interventions such as early case detection and isolation, limited movement, and the provision of sanitation and practical advice on disease prevention, remain crucial and must be implemented alongside other interventions.¹⁸

Limitations

Restricted by limited vaccination data for individuals and frequent prisoner movement, especially those without symptoms, we were unable to calculate the vaccine effectiveness. Furthermore, due to safety concerns, prison guards could not directly escort us to all dormitories, limiting our exploration of environmental sanitation behaviors through direct observation. Therefore, we conducted interviews with prison staff and prisoner health volunteers. Due to time constraints, we employed convenience sampling for controls, potentially introducing selection bias. To mitigate this, prison staff called upon control groups primarily from zones 2 and 3 across various dormitories where numerous cases occurred, assuming similar exposure to minimize bias. It should be acknowledged that while controls were selected based on the absence of influenza symptoms and recent diagnoses within two weeks prior to the outbreak period, some may have had prior infections beyond this timeframe, potentially affecting their immunity, which could potentially influence our findings.

Conclusion

We confirm an influenza outbreak in a prison in Songkhla Province, Thailand. A total of 128 cases were found, all of which were male prisoners, with no severe cases. The source of the outbreak was suspected to be from outside the prison, due to new prisoners moving from an induction zone to other incarceration zones without screening. All dormitories were overcrowded. Risk factors included close contact with infected cases and sharing drinking glasses. To mitigate the risk of future influenza outbreaks, prisons and local public health authorities should implement rigorous screening procedures for new prisoners. Symptomatic individuals should be promptly isolated until

symptom-free, and asymptomatic prisoners should undergo a sufficient incubation period before being transferred to another zone. Prioritizing education on personal hygiene, with an emphasis on discouraging the sharing of personal items, is essential. These measures can effectively prevent the spread of influenza and enhance overall public health within prisons.

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Suggested Citation

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