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Factors Associated with Influenza-like Illness among Inmates in an All-male Prison, Songkhla Province, Thailand, 2023

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Abstract

On 9 Feb 2023, the Office of Disease Prevention and Control Region 12 Songkhla was informed of an influenza-like illness (ILI) cluster in an all-male prison in Songkhla Province. We investigated to identify the causative agent, possible sources and risk factors, and provide control measures. We conducted an active case finding by interviewing inmates and officers. Prison facilities and hygiene behaviors of inmates and officers were inspected. A retrospective cohort study was performed. Basic and effective reproductive numbers were estimated. The overall attack rate was 12.6% (474/3,648). Most cases were inmates from Wing C (80.4%). There were no severe cases or deaths. Of ten specimens tested, all were positive for influenza B/Victoria lineage, V1a.3a.2. Fifty-four percent of inmates had received influenza vaccine within the last 12 months. A mismatch between the viral strain in the vaccine and the one causing this outbreak likely contributed to the outbreak as the vaccine provided to the inmates was manufactured during the previous year's influenza season. Vaccine effectiveness was 36.2% against ILI. Having high-risk conditions (adjusted odds ratios (AOR) 2.83, 95% confidence interval (CI) 1.27–6.32) and sharing drinking glasses (AOR 2.02, 95% CI 1.21–3.36) were significant risk factors. The basic reproductive number for ILI in this outbreak was 1.36. The effective reproductive number ranged from 0.18–3.69. For effective management of ILI outbreaks in prisons, a continuous program of influenza vaccination following updated World Health Organization recommendations and a comprehensive surveillance system with rigorous respiratory illness management practices are suggested.

Keywords: influenza, prisons, viral strain, vaccine effectiveness, reproductive numbers

Introduction

Seasonal influenza is a leading cause of morbidity and mortality. The World Health Organization (WHO) estimates an annual average of 3 to 5 million severe illnesses and 290,000 to 650,000 deaths due to influenza worldwide.[1] The highest burden of influenza is in Sub-Saharan Africa and Southeast Asia.[2] In Thailand, the incidence of influenza lower respiratory tract infections was 1231.1 and the mortality rate 3.0 per 100,000 population in 2017.[3] The Department of Disease Control reported that around 80,000 influenza cases and 41 clusters of influenza-like illness (ILI) occurred in 2022. Of these clusters, 19 (47%) occurred in correctional facilities.[4]

Annual influenza vaccination is recommended for all individuals aged six months or older, prioritizing those facing high risk of severe illness, including the elderly (age over 65 years), pregnant women, immunocompromised individuals, and individuals with obesity or chronic medical condition.[5,6] A national

influenza vaccination policy has been in effect in Thailand since 2004; seasonal influenza vaccines being provided to healthcare personnel, individuals under the age of two years or over the age of 65 years, and other vulnerable populations.[7] In addition, these vaccines are offered to inmates belonging to high-risk groups as part of a prison wellness initiative.[8]

On 9 Feb 2023, the Office of Disease Prevention and Control Region 12 Songkhla (ODPC-12) was alerted of an outbreak of ILI affecting approximately 100 inmates in an all-male prison in Songkhla Province, Thailand. An investigation was conducted by healthcare staff from ODPC-12, Songkhla Provincial Public Health Office, and Songkhla Hospital on 10 Feb 2023. The objectives of the investigation were to verify the outbreak, describe its epidemiological characteristics, identify associated factors, and provide recommendations.

Methods

Epidemiological Investigation and Descriptive Study

We interviewed prison staff and inmates and reviewed the infirmary records. Suspected ILI cases were inmates or prison officers who, during 18 Jan to 9 Mar 2023, developed at least one of the following symptoms: fever (either body temperature ≥38 °C or self-reported), rhinorrhea, cough, sore throat, and dyspnea. Confirmed cases were suspected cases whose nasopharyngeal swabs were positive for influenza or SARS-CoV-2 viruses. A semi-structured questionnaire was used for data collection. Information on demographic characteristics, clinical history, and associated factors such as smoking status, influenza vaccination status, hygiene behaviors, and infection control measures were obtained.

Prison staff and inmates who met the criteria for a suspected case were classified according to their risk of developing severe ILI. The following conditions were considered to be high-risk: age ≥65 years, chronic lung, heart, liver, and/or kidney diseases, diabetes mellitus, hypertension, body mass index over 30 kg/m^2, and immunocompromised status. Prison staff and inmates who did not meet these criteria were classified as low risk. We also screened for cases with severe symptoms (dyspnea, stupor, dehydration, respiratory rate more than 24 times per minute, or oxygen saturation equal to or less than 94%) and prolonged illness (having body temperature over 38 °C for more than 48 hours).

Laboratory Study

We collected ten nasopharyngeal swabs from suspected cases who were symptomatic on the day of investigation.[9] All specimens were tested for respiratory pathogens using real-time polymerase chain reaction (RT-PCR) for influenza and antigen test kit for SARS-CoV-2 at the Regional Medical Sciences Center Region 12 Songkhla.[10,11] Positive specimens were sent for pathogen identification by whole genome sequencing.

Environmental Study

For the environmental characteristics, we inspected the physical structures of prison facilities, including dormitories, dining areas, workshops, handwashing areas, and visiting rooms. The living conditions, routine activities, and sanitation behaviors of inmates in the prison were directly observed during a walk-through survey. Prison staff, including wardens and nurses, were interviewed about the prison entry procedures, respiratory illness screening protocol and management algorithm.

Analytic Study

We conducted a retrospective cohort study among all inmates in Wing C where the outbreak initially occurred. Inmates who were not available for the interview on the investigation day were excluded. Sample size was calculated using parameters from a previous study of an ILI outbreak in a prison.[12–14] The minimum sample size required to achieve 80% power with 95% confidence interval was 55 participants each in the exposed and unexposed cohorts. The key exposure factor of interest was sleeping near cases. The primary outcome was the incidence of ILI symptoms among inmates from 18 Jan to 9 Mar 2023. ILI symptoms comprised having a body temperature over 38 °C and either cough or sore throat. The dependent variables were age, risk category, smoking status, influenza vaccination status, and hygiene practices. Participants were considered to be vaccinated if they had received the latest dose of influenza vaccine at least 14 days but no more than 12 months prior to the onset of symptoms, or before the date of investigation for asymptomatic cases.[5]

Statistical Analysis

We used R version 4.2.1 for the statistical analysis.[15] For the descriptive study, categorical data were presented as frequencies and percentages while continuous data were presented as median and percentile. The basic reproductive number (R_0) was estimated using the attack rate of ILI among inmates from Wing C prior to interventions using R_0 package.[16] The effective reproductive number (R_t) was estimated using the Walling and Teunis method with a lognormal serial interval distribution and a mean of

3.7 days and standard deviation of 2.0 days.[17,18] For the analytic study, we employed univariable analysis by calculating crude relative risks (RR) using a two-by-two table and multivariable logistic regression for multivariable analysis to determine factors associated with ILI. Known variables from a literature review and variables with p-values less than 0.05 from the univariable analysis were included into the multivariable analysis. Adjusted odds ratios (AOR) with corresponding 95% confidence interval (CI) were presented. Vaccine effectiveness (VE) against ILI was estimated as 100% × (1 – AOR).

Ethics

This study was part of the routine outbreak surveillance and response activities of the Thai Department of Disease Control, Ministry of Public Health. Verbal informed consent was acquired before the interview and specimen collection.

Results

Clinical Setting

The outbreak occurred in a male-only prison facility in Songkhla Province, Thailand. It is a central prison which exclusively receives inmates transferred from other correctional facilities. The Department of Corrections, Ministry of Justice set the prison capacity at 2,755 inmates; however, the population at the time of the investigation was 3,648. Additionally, there were 108 correctional and nine healthcare officers present.

In 2022, the prison received a total of 3,556 doses of influenza vaccines. Of these, 1,443 doses were trivalent vaccines for the 2021–2022 northern hemisphere influenza season, and 537 doses were quadrivalent vaccines for the 2022 southern hemisphere influenza season. The trivalent vaccines provided did not contain the strains of influenza virus (influenza B/Victoria, V1A.3a.2) later identified in this outbreak.

Outbreak Description

We identified 471 inmates and three nurses that met our case definitions of suspected (464) and confirmed (10) cases for an overall attack rate of 12.59% (474/3,765). The median (interquartile range) age of the cases was 36 years (30–42 years). As shown in Table 1, the wing-specific attack rate was highest in Wing C. A total of 68 inmates with prolonged illness were treated with oseltamivir. There were 44 cases with high-risk conditions. No hospitalized cases or deaths were reported. Of ten nasopharyngeal swab specimens tested, all were positive for influenza B/Victoria lineage, V1a.3a.2.

Table 1. Attack rates of an influenza B outbreak in a prison among inmates and staff during 18 Jan–10 Mar 2023, Songkhla Province, Thailand (n=3,765)

	Onset date of the first case	Cases/total	Attack rate (%)
Inmates			
Wing A	-	0/257	0.00
Wing B	6 Feb 2023	44/788	5.58
Wing C	25 Jan 2023	381/795	47.92
Wing D	8 Feb 2023	25/780	3.21
Wing E	11 Feb 2023	20/801	2.50
Wing F	16 Feb 2023	1/227	0.36
Prison officers	**31 Jan 2023**	**3/117**	**2.56**
Total		**474/3,765**	**12.59**

The epidemic curve of the ILI outbreak is shown in Figure 1. On 25 Jan 2023, a 35-year-old hypertensive man from Wing C developed fever, cough, sore throat, and rhinorrhea. He visited the prison infirmary on the same day and was sent back to his living quarters after receiving supportive care. He had been in prison for one year and had never left the facility. He had been participating in workshops at the educational center every day since 1 Feb 2023, and had received the seasonal influenza vaccine provided by the prison during the past year. A number of inmates from Wing C reported having respiratory symptoms on the following days. On 6 Feb 2023, a prison nurse noticed that over 40 inmates visited the infirmary due to respiratory symptoms, exceeding the median number of 15 per day. On 9 Feb 2023, the hospital and ODPC-12 were notified. The outbreak subsequently spread to Wings B, D and E. The onset of the last known case was on 5 Mar 2023 and no further case was identified after 10 Mar 2023. Based on the epidemic curve and the high attack rate, we found that the R_0 for this event was 1.36 (95% CI 1.32–1.40) and as shown in Figure 2, the R_t on the investigation day was 1.71 (ranging from 0.18–3.69 throughout the course of the outbreak).

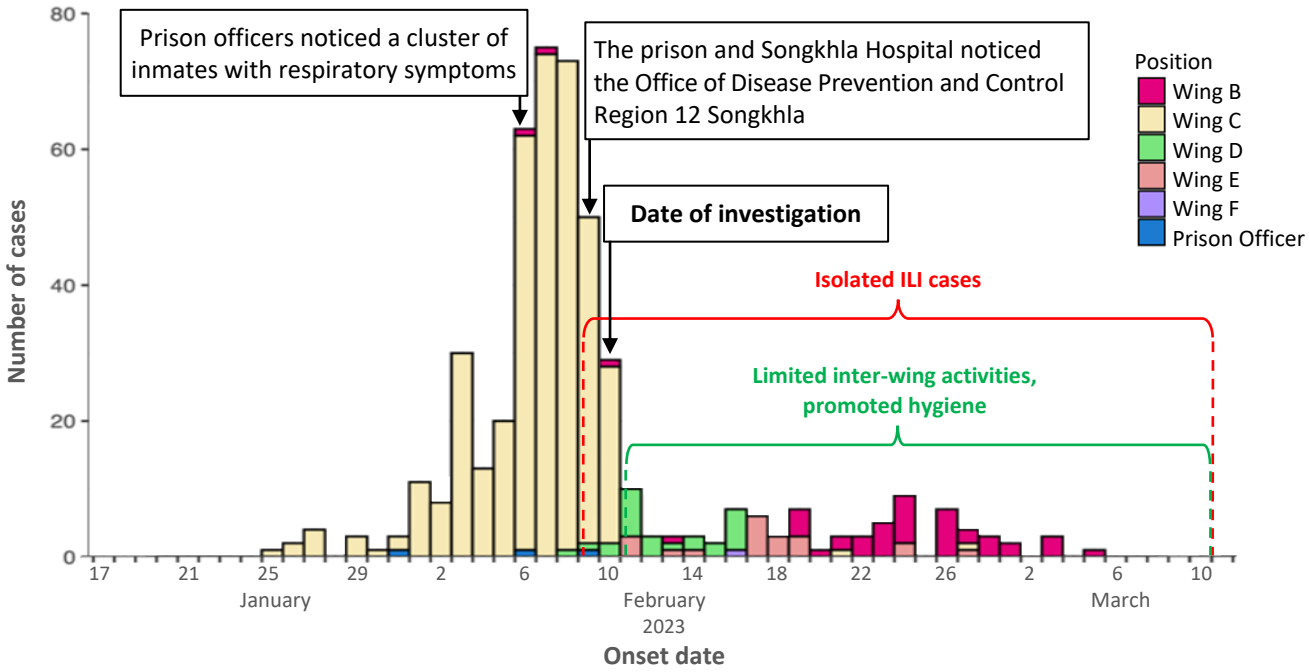

Figure 1. Number of influenza B cases in a prison by date of onset during 18 Jan–10 Mar 2023, Songkhla Province, Thailand

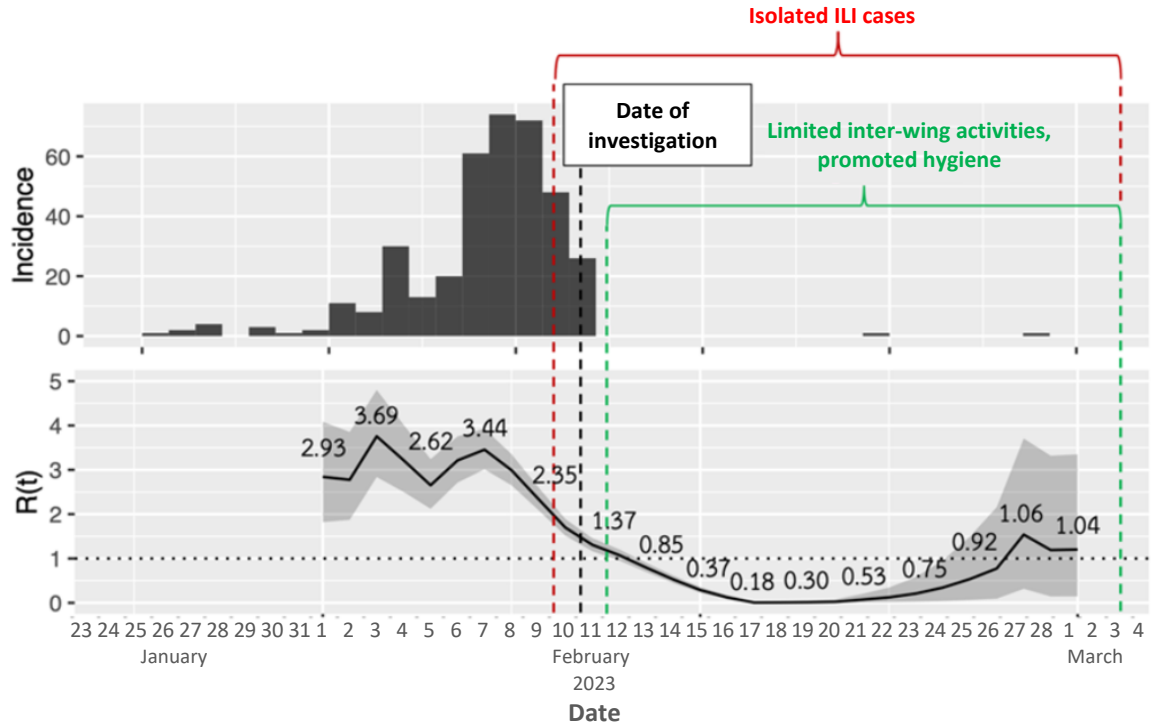

Figure 2. Effective reproductive numbers of an influenza B outbreak in a prison during 18 Jan–10 Mar 2023, Songkhla Province, Thailand

Environmental Study

The prison facility has six zones: a kitchen zone (Wing A), a high-security zone (Wing B), an education zone (Wing C), a zone for new inmates (Wing D), a zone for vulnerable inmates (Wing E), and an infirmary zone (Wing F). Each zone has one to two dormitories with eight to nine cells per dormitory. Each cell houses approximately 10 to 120 inmates who sleep on the floor with a personal pillow and blanket. The sleeping space per person ranges from 1.16 to 1.60 m^2. There are isolation rooms for inmates with respiratory symptoms in all dormitories. All inmates stayed in their wings and followed a fixed routine. The only exception was during daily workshops in an educational center in Wing C, where selected inmates from all wings participated in the activities with external instructors. These instructors received body temperature screening prior to entering the prison.

It was found that approximately 20% of inmates washed their hands after doing activities and using toilets; soap was frequently unavailable. Food was often shared directly, without the use of a serving spoon. Drinking fountains with shared cups were available, but some inmates used them without washing the cups first.

Since the beginning of the COVID-19 pandemic, the prison adopted a respiratory screening protocol. Upon admission, new inmates underwent a five-day solitary confinement period in Wing F followed by an additional five days in quarantine rooms in Wing B with other new inmates. If an inmate exhibited respiratory symptoms during quarantine, they were immediately isolated, and the remaining inmates' quarantine period was extended by an additional five days. Inmates who left and re-entered the prison were isolated for five days in Wing F and another five days in their assigned wing. Inmates requiring frequent visits to the hospital or court hearings were permanently relocated to an isolation zone in Wing F. Due to space constraints, inmates with mild respiratory symptoms that did not meet the criteria for ILI were not isolated.

Other preventive measures included restrictions on direct contact between visitors and inmates, requiring telephone conversations through a glass wall. Inmates were also mandated to wear face masks at all times and promptly report any respiratory symptoms to prison officers. Prison nurses were responsible for monitoring the number of inmates with respiratory illnesses and notifying local health officers if the number of inmates with ILI exceeded 20–30 per day. Notably, all records were maintained in paper format and were not summarized daily, resulting in a delayed outbreak notification. Furthermore, these preventive measures were not consistently enforced, and with varying degrees of compliance.

Analytic Study

Of 795 inmates in Wing C, 792 were available to be interviewed and were recruited into the analytic study. Having high-risk conditions and sharing drinking cups with other inmates were significant risk factors for ILI with AOR of 2.83 (95% CI 1.27–6.32) and 2.02 (95% CI 1.21–3.36), respectively (Table 2). At the time of the outbreak, 54.28% (1,980/3,648) of inmates were vaccinated. From the multivariable analysis, the VE of the influenza vaccine was 36.19% (AOR 0.64, 95% CI 0.33–1.22) against ILI.

Table 2. Univariable and multivariable analyses of factors associated with ILI among inmates of Wing C during 18 Jan–10 Mar 2023, Songkhla Province, Thailand

Variable	Case no./total no. among exposed individuals	Case no./total no. among unexposed individuals	Univariable analysis (n=792) RR (95% CI)	Multivariable analysis (n=402) AOR (95% CI)
Age	-	-	-	0.99 (0.96–1.02)
High risk (vs. low risk)	20/82	119/710	1.46 (0.96–2.20)	2.83 (1.27–6.32)
Current or former smoker (vs. never)	119/686	15/92	1.06 (0.65–1.74)	1.36 (0.61–3.01)
Vaccinated (vs. unvaccinated)	114/660	25/132	0.91 (0.62–1.35)	0.64 (0.33–1.22)
Sharing drinking cups	74/324	65/468	1.64 (1.22–2.22)	2.02 (1.21–3.36)
Being coughed or sneezed on	33/103	65/461	2.27 (1.58–3.26)	1.38 (0.74–2.59)
Sleeping near cases	62/234	40/266	1.76 (1.23–2.52)	2.00 (0.77–5.16)
Eating near cases	61/244	47/345	1.84 (1.30–2.59)	2.25 (0.74–6.85)
Working near cases	52/210	49/287	1.45 (1.02–2.05)	0.42 (0.14–1.25)

RR: relative risk. AOR: adjusted odds ratio. CI: confidence interval. vs: versus

Public Health Response

On 9 Feb 2023, a daily screening program for respiratory symptoms was initiated for all inmates by prison officers. Inmates with ILI were isolated and monitored for signs of severe symptoms for five days after symptoms onset. Activities involving inmates from more than one wing and activities with external instructors were postponed until eight days after the onset of the last known case. Correctional facilities to which inmates were transferred during the time of the outbreak were informed of the outbreak situation.

Discussion

Outbreak management in correctional facilities is challenging due to multiple factors. Insufficient health data management and lack of awareness of respiratory illnesses among inmates contributed to the delay in outbreak detection and control. The R_t was observed to be declining at the time of the investigation, suggesting that the outbreak had already entered the receding stage. Additionally, overcrowding at the prison meant there was limited space for inmate isolation. This led to the rapid spread of ILI among

inmates. Similar issues have been reported in previous outbreaks.[19–21]

The most likely source of the ILI outbreak was the entrance of visiting instructors. The outbreak began in Wing C, where educational sessions were held. Although there is a screening guideline for visitors, it was not effective in detecting asymptomatic carriers which account for up to 36% of ILI cases.[22] Another possible source of the outbreak was inmates and prison staff who exited and re-entered the prison prior to the beginning of the outbreak. However, the only cases among these groups were prison nurses who cared for inmates with ILI.

Hygiene behaviors played an important role in the transmission of ILI among inmates. The environmental survey revealed the sharing of drinking cups, working, eating, and sleeping near cases, and being coughed or sneezed on; this was also confirmed by the univariable analysis. These findings are consistent with previous studies which found that poor hygiene behaviors, such as sharing drinking cups and inadequate handwashing, are linked to ILI in prisons.[12,23,24] In this event, upon adjusting for covariates, only sharing drinking cups remained significant.

The R_0 of ILI in this outbreak was 1.36 (95% CI 1.32–1.40), which is higher than the median R_0 of seasonal influenza (1.28) reported by Biggerstaff et al.[25] On the other hand, a study of an influenza outbreak in a Thai prison by Karnjanapiboonwong et al. estimated an R_0 of 4.50.[19] The R_0 of outbreaks in confined settings tend to be larger than those in the general population due to the increased contact rates.[26] Prison overcrowding can accelerate the spread of infection by increasing the number of opportunities for transmission between individuals.

The outbreak of ILI in an all-male prison in Songkhla Province, Thailand was caused by the influenza B/Victoria, V1A.3a.2 virus. This virus is antigenically similar to the influenza B/Austria/1359417/2021-like virus, which is recommended to be included in the 2023 influenza vaccine composition for both northern and southern hemispheres.[27] As of 2023, circulating influenza B/Victoria has not shown resistance to antiviral medications.[28] The percentage of influenza incidence caused by Influenza B virus in Thailand has increased from 15% in 2022 to 30% in 2023. However, influenza A/H3 virus remained the predominant circulating strain in Thailand.[29] We found that influenza vaccination was not effective in reducing the likelihood of ILI. These findings could be explained by the following reasons. Firstly, the effectiveness of influenza vaccines is reduced when the strains of influenza in the vaccine do not match the circulation strain. A meta-analysis by Tricco et al. found a VE of 77% (95% CI 18–94%) for matched influenza B strains and 52% (95% CI 19–72%) for mismatched influenza B strains.[30] Secondly, the outcome of interest in this study was ILI, which is non-specific to any respiratory pathogens. The VE against ILI identified by a syndromic definition will always be lower than that against laboratory-confirmed influenza.[31]

This study has some limitations. First, the retrospective design could have introduced recall bias, as the cases may have been more likely to remember details of past exposure to symptomatic inmates than the non-cases, leading to an overestimation of the measure of association. Second, the prison did not keep well-organized records of vaccination status and medical conditions of inmates. This resulted in incompleteness of the data provided. Third, the source of the outbreak could not be confirmed due to the unverified illness status of external instructors. Finally, the VE in the study was estimated using a non-laboratory-based case definition. This could have led to an overestimated VE against influenza infection.

We recommend improving the sensitivity of the respiratory illness surveillance system in the prison by incorporating a daily summary of infirmary data and establishing a lower threshold for timely notification. Also, the respiratory illness screening and management algorithm should be strictly followed. This includes examining visitors and external instructors for respiratory tract symptoms before entering the prison and isolating all inmates with respiratory symptoms once detected. Personal drinking cups should be provided to inmates in dormitory rooms and dining areas, and handwashing facilities should include soap and alcohol gel. Routine health education sessions on general and respiratory hygiene should be conducted for inmates and prison officers. Seasonal influenza vaccines with updated viral strains based on WHO recommendations should be prioritized for distribution, particularly in high-risk settings such as correctional facilities.

Conclusion

This study confirms an outbreak of ILI caused by influenza B/Victoria, V1A.3a.2 among prison inmates. Overcrowded conditions in the prison facilitated transmission of the virus. Although more than half of the inmates were vaccinated, the vaccine strains did not match the circulating strain, resulting in lower vaccine effectiveness. From the analytic study, sharing drinking cups was a significant risk factor for ILI. Control measures such as isolating symptomatic inmates and limiting inter-wing activities were

implemented. To mitigate future ILI outbreaks, recommendations include enhanced surveillance systems, stricter respiratory illness management algorithms, lower notification thresholds, and prioritized routine vaccination with WHO-recommended and updated viral strains.

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