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Close Contacts among Students Contributing to an Influenza Outbreak in a Semi-boarding Sports School, Chiang Mai Province, Thailand, 2022

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Abstract

On 11 Sep 2022, the Department of Disease Control was notified of a cluster of influenza-like illnesses (ILI) in a semi-boarding sports school in Sanpatong District, Chiang Mai Province, Thailand. The investigation objectives were to confirm the outbreak, describe its epidemiological characteristics, determine risk factors, and recommend control measures. A descriptive study followed by a retrospective cohort study was conducted. A case was defined as a person presenting at the school from 22 Aug to 20 Sep 2022 and having at least two symptoms compatible with ILI. We observed dormitory conditions and students' activities and collected throat and nasopharyngeal swab specimens. We identified 113 cases, resulting in an attack rate of 26.5% among the screened population and 18.9% among the total population. Almost all cases were students and none developed serious illness. Of 11 specimens tested, nine were positive for influenza A (H3N2). Key risk factors included attending a sports program with adjusted odds ratio (AOR) 2.9, 95% confidence interval (CI) 1.2–6.8, and being in close contact with other cases (AOR 2.3, 95% CI 1.4–3.7). Dormitory overcrowding and close contact during football practice were observed. We recommended regular ILI screening, especially for sports students, and adjusting the dormitory environment to maintain physical distancing.

Keywords: influenza A, influenza-like illnesses, ILI, school, outbreak investigation, Thailand

Background

Influenza A and B viruses are transmitted by direct contact through droplet spreading or via indirect contact with contaminated surfaces. The average incubation period is 2 days (range 1–4 days), with transmission more likely during the first 3–4 days of illness.[1] Common symptoms include fever or feeling feverish, dry cough, runny nose, and fatigue.[2]

The annual global influenza attack rate is 5–10% in adults and 20–30% in children.[3] In Thailand, the Ministry of Public Health (MOPH) through the Division of Epidemiology (DOE), Department of Disease Control (DDC), established an influenza-like illness (ILI) surveillance system in 2009. Currently, patients presenting at about 600 MOPH affiliated hospitals with symptoms compatible with ILI such as common cold, or related diagnoses such as acute pharyngitis, are reported to the DOE. The submitted reports are analyzed and presented in the form of weekly aggregated data on the DOE website.[4] From 1 Jan to 31 Dec 2022, the national incidence of influenza was 122.2 per 100,000 population.[5] In Chiang Mai Province, the corresponding incidence was 263.8 per 100,000 population.[6]

On 11 Sep 2022, the DDC was notified by the Office of Disease Prevention and Control Region 1 Chiang Mai (ODPC-1) that 57 students in a semi-boarding sports school in Sanpatong District, Chiang Mai Province had presented with influenza-like symptoms. The joint investigation team of the DDC, Sanpatong Hospital, and Sanpatong District Health Office initiated an on-site investigation during 12 to 14 Sep 2022. The

objectives of the investigation were to confirm the outbreak, describe its epidemiological characteristics, determine risk factors, and provide recommendations and control measures.

Methods

Descriptive Study

To confirm an outbreak, we extracted in-service patient data of influenza cases in Sanpatong District from 1 Jan 2017 to 17 Sep 2022 from Sanpatong Hospital's database and extracted data of the cases in Chiang Mai Province during the same period from the national surveillance system.

In this event, a suspected case was defined as a student or teacher in the school who had at least two of the following symptoms: fever, cough, sore throat, rhinorrhoea, myalgia, dyspnea, headache, and fatigue during 22 Aug to 20 Sep 2022. A confirmed case was defined as any suspected case with a positive result for influenza virus based on the reverse transcription polymerase chain reaction (RT-PCR) technique.

We conducted an active case finding among school students and teachers during 12 to 14 Sep 2022 via self-administered semi-structured questionnaires which traced back to the symptoms of the respondents approximately two weeks prior to the investigation. We monitored any other coming cases approximately two weeks thereafter. Phone interviews were conducted with participants who were not available during the initial investigation. We collected demographic data on gender, age, grade/class, enrolment in the education or recreation program, dormitory resident status and influenza vaccination history. Clinical variables included history of symptoms and treatment (if any).

We estimated the proportion of the cases on the day of the investigation to assess if the outbreak would continue, assuming that the reproductive number (R_0) ranged between 2.3–3.3.[7–9] Descriptive statistics included median with interquartile range (IQR), ratio, frequency, and proportion.

Laboratory Study

We reviewed laboratory findings of specimens collected by local health staff on 8 Sep 2022, consisting of throat swab specimens for influenza by RT-PCR, dengue NS1 antigen, and severe acute respiratory syndrome coronavirus 2 by antigen test kit. We collected nasopharyngeal specimens for RT-PCR for influenza on 13 Sep 2022 from students randomly selected from the pool of suspected cases who still had symptoms during the investigation.

Environmental Study

We conducted a walkthrough survey by performing a thorough observation of the school environment (dormitories, restrooms, classrooms and cafeteria), accompanied by school staff. We assessed the dormitory capacity and density using a cut-off value of 1.6 m^2/person.[10]

Analytic Study

We conducted a retrospective cohort study starting since the onset of the first case on 22 Aug 2022 until 20 Sep 2022. The source population was school students. The sample size was calculated using a hypothesised risk ratio of 2.67 for being in close contact with influenza cases.[10–13] By assuming 25% incomplete information, we aimed to obtain at least 190 respondents. We distributed the questionaries to all 560 students via a secure online website. Due to difficulties in internet access, 10 students completed paper-based questionnaires instead.

The main outcome was being either a suspected or a confirmed case. We calculated the risk ratio (RR) and 95% confidence interval (CI). For multivariable analysis, we used a multiple logistic regression model, including variables with a *p*-value <0.2 from the univariable analysis. In this step, we excluded certain variables that captured the same constructs to avoid multicollinearity, for example, dropping "senior class" while keeping "age group" or discarding "being male" while keeping "being in a sports program". We grouped variables that measured the same related behaviour together, for example, creating a new variable "being a close contact with other cases" was defined as a person who had a history of sitting, sleeping near, or having meals with a case. Results were shown in the form of an adjusted odds ratio (AOR) and 95% CI. We analysed the data using Stata v16.

Results

Descriptive Study

A surveillance report in Sanpatong District from January 2017 to September 2022 showed an increase in the number of influenza cases by the end of August 2022. The study school is located in Sanpatong District, Chiang Mai Province. It is a semi-boarding school accommodating (290 boarding students, 270 non-boarding students, and 37 teachers). Among the 597 persons in the school, males outnumber females by a factor of 2:1 (397 males: 200 females). There are two academics tracks: a general program and a sports program. Classes range from grade 7 to grade 12, and there are 23 classes.

We identified 113 cases (from 427 screened students and teachers), for an attack rate of 26.5% and 18.9% among the total school population. The median age of the cases was 15 years (IQR: 12–19). The attack rate among males and females was 27.1% and 25.3%, respectively. The highest attack rate was found among students aged 16–17 years (35.2%). The majority of cases (112/113, 99%) were students. The attack rates were highest among students in senior classes (33.2%) and in those enrolled in the sports program (35.0%) (Table 1).

Table 1. Attack rates of influenza cases in a semi-boarding sports school in Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022 (n=597, including both students and teachers)

Student/teacher	No. of population	No. of screened population (%)	No. of cases	Attack rate by screened population (%)
Gender (n=597)				
Male	397	273 (68.8)	74	27.1
Female	200	154 (77.0)	39	25.3
Age, years (n=597)				
12–13	102	97 (95.1)	14	14.4
14–15	173	134 (77.5)	36	26.9
16–17	189	142 (75.1)	50	35.2
≥18	133	54 (40.6)	13	24.1
Type of person (n=597)				
Teacher	37	10 (27.0)	1	10.0
Student	560	417 (74.5)	112	26.9
Student grade* (n=560)				
Junior	276	206 (74.6)	42	20.4
Senior	284	211 (74.3)	70	33.2
Residence (n=560)				
Dormitory student	290	211 (72.8)	66	31.3
Non-dormitory student	270	206 (76.3)	46	22.3
Student education program (n=560)				
Sports	207	157 (75.9)	55	35.0
General	353	260 (73.7)	57	21.9

**Junior = grades 7–9; Senior = grades 10–12; Missing data were excluded.*

Among the cases, there was no hospitalizations or deaths. The most common clinical symptoms were runny nose (83.6%), cough (82.8%), fever (75.9%), headache (66.4%), sore throat (56.0%), fatigue (55.2%) and myalgia (42.2%). Most cases visited the school infirmary (39.1%) and local drugstores (34.7%). History of influenza vaccination among students was 11.8% (49/417).

On 19 Aug 2022, a student attended an inter-school sports tournament. The first three cases developed symptoms on 22 Aug 2022. Those students went to school and then came into contact with other students. The number of cases reached its peak on 9 Sep 2022. The epidemic curve showed a propagated pattern (Figure 1).

Laboratory Study

Specimens from 11 student cases, including six nasopharyngeal and five throat swab specimens, were sent for RT-PCR. Nine tested positive for influenza A subtype H3N2. Mixed organisms were identified in two specimens (one showing influenza A and rhinovirus; the other showing influenza A with respiratory syncytial virus). Tests for other viruses, namely dengue (n=16) and severe acute respiratory syndrome coronavirus 2 (n=57) performed by local healthcare staff were negative.

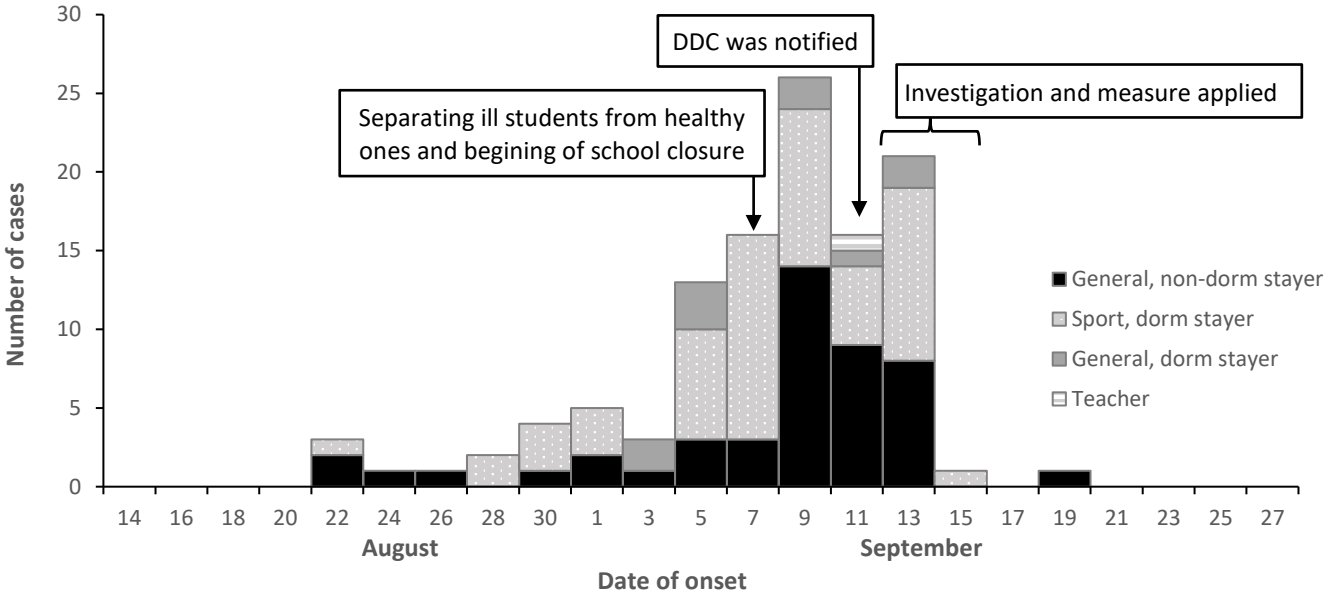

Figure 1. Number of influenza cases among students and teachers according to academic track and dormitory resident status in a semi-boarding sports school in Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022 (n=113)

Environmental Study

The school contained eight dormitories (five male and three female). Each dormitory was divided into four rooms on average. Each room contained a few small windows, and some were air-conditioned. Between 15–20 students stayed together in one room. There were five dormitories with an area density of less than 1.6 m^2/person.[10] The attack rate was high in these dormitories. The room specific attack rate varied between 0–67%. One male dormitory had the highest overall attack rate (AR) (Figure 2).

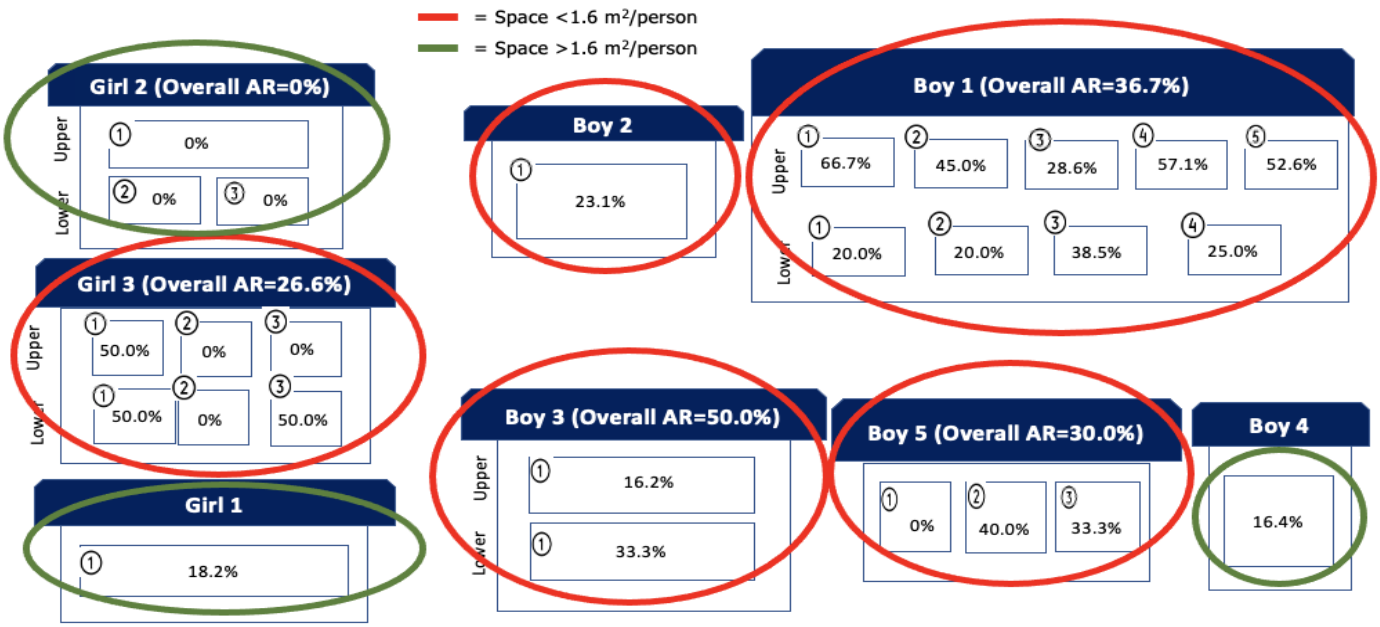

Figure 2. Attack rates in male and female dormitories by density in a semi-boarding sports school in Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022

Prior to the investigation, the school director terminated all onsite learning and separate ill students from the others. Some students did not wear masks consistently while staying in their dormitories. Most of the students had meals together in a canteen, studied in the same classes, and stayed in a crowded dormitory (Table 2). Sports students spent extended periods in close proximity with one another throughout the day. They were required to practice football in the morning (6:00–7:00 AM) and in the afternoon (4:00–6:00 PM). During football practice, mask wearing was not enforced.

Table 2. Daily schedule of students at a semi-boarding sports school, Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022

Time	Academic track/type of resident		
	Sports track, dormitory resident	General track, dormitory resident	General track, non-dormitory resident
6:00–7:00 AM	Football practice	-	-
7:00–8:00 AM	Breakfast at the canteen		-
8:00–8:30 AM	Enrol in the national anthem assembly at the football field		
8:30 AM–12:00 PM	Study		
12:00–1:00 PM	Lunch		
1:00–4:00 PM	Study		
4:00–6:00 PM	Football practice	-	-
6:00 PM	Dinner at canteen		-

Analytic Study

A total of 417 students participated in the analytic study resulting in a response rate of 74.5%. On univariable analysis, being at least 16 years old, being in a senior class, enrolled in the sports program, staying in a crowded dormitory, and being in close contact with other cases contributed to an increased infection risk with a *p*-value <0.2 (Table 3). History of vaccine administration had a non-significant protective effect. On multivariable analysis, being enrolled in the sports program (AOR 2.9, 95% CI 1.2–6.8), being in close contact with cases (AOR 2.3, 95% CI 1.4–3.7) and age ≥16 years (AOR 1.75, 95% CI 1.10–2.75) were significant risk factors for influenza infection (Table 4).

Table 3. Univariable analysis of risk factors associated with influenza infection among students at a semi-boarding sports school, Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022

Exposures	Exposed (person)		Non-exposed (person)		Risk ratio	95% CI	
	Case	Non-case	Case	Non-case		Lower	Upper
Individual factors (n=417)							
Male (vs female)	74	184	38	121	1.20	0.85	1.68
Age ≥16-years (vs <16 years)	64	128	48	177	1.57‡	1.13	2.16
Senior class (vs junior class)	70	141	42	164	1.62‡	1.16	2.26
Sports program (vs general program)	55	102	57	203	1.59‡	1.16	2.18
Staying in a crowded dormitory* (vs staying in uncrowded dormitory or not staying in a dormitory)	57	117	55	188	1.44†	1.05	1.98
Risk behavior and hygiene							
Sharing utensils with others (vs not sharing) (n=407)	41	108	66	192	1.07	0.77	1.50
Sharing utensils with cases (vs not sharing) (n=402)	9	15	97	281	1.46	0.84	2.51
Taking off masks (vs always wearing mask) (n=407)	95	254	12	46	1.31	0.77	2.24
Not washing hands after touching surfaces (vs always washing hands) (n=407)	7	13	100	287	1.35	0.72	2.51
Not covering nose while coughing (vs always covering nose) (n=407)	5	10	102	290	1.28	0.61	2.67
Being close contact to cases							
Sitting near cases (vs not sitting near cases) (n=404)	27	37	80	260	1.79‡	1.26	2.53
Sleeping near cases (vs not sleeping near cases) (n=404)	29	45	78	252	1.65‡	1.17	2.33
Having meal with cases (not having meal with cases) (n=399)	15	28	89	267	1.39§	0.89	2.18
Receiving Influenza vaccine (vs not receiving) (n=417)	11	38	101	267	0.81	0.47	1.41

**Staying in a crowded dormitory with an area <1.6 m²/person was compared against staying in an uncrowded dormitory (with an area ≥1.6 m²/person) or not staying in a dormitory. Missing data were excluded. †p-value <0.05. ‡p-value <0.01. §p-value <0.2. vs: versus.*

Table 4. Multivariable analysis of risk factors associated with influenza infection among students at a semi-boarding sport school, Sanpatong District, Chiang Mai Province, 22 Aug–20 Sep 2022 (n=417)

Exposures	Adjusted odds ratio	95% CI	
		Lower	Upper
Age ≥16 years (vs < 16 years)	1.75†	1.10	2.75
Staying in crowded dormitory (vs staying in uncrowded dormitory or not staying in a dormitory)*	0.58	0.24	1.41
Sport program (vs general program)	2.86†	1.20	6.81
Being a close contact with cases (vs not being a close contact)	2.27‡	1.38	3.73

*We excluded the following variables despite demonstrating p-value <0.2 from univariable analysis to avoid multicollinearity problems: being male (due to high collinearity with sport program) and being in senior class (due to high collinearity with age at least 16 years). We also grouped variables, "sitting near a case", "sleeping near a case" and "having meal with a case" together and renamed them as "being a close contact with a case". *Staying in crowded dormitory with an area <1.6 m²/person was compared against staying in uncrowded dormitory (with an area ≥1.6 m²/person) or not staying in a dormitory. †p-value <0.05. ‡p-value <0.01. CI: confidence interval. vs: versus.*

Control Measures

Control measures were still useful and recommended to be promptly implemented. At the time of the investigation, the proportion of cases was approximately one-fifth of the school population. We foresaw the outbreak had not reached its peak as the proportion of cases remained below the immunity threshold, estimated to be between 56–70% ($1–1/R_0$).[14]

Approximately 7–10 days after the outbreak's onset (Figure 1), the school director endorsed school closure and switched all onsite activities to an online platform. We also established an ILI surveillance system among students and school teachers. This entailed assigning one student per class or dormitory room to observe their peers for ILI symptoms. Additionally, we requested the school director to designate infirmary teachers to report findings to the investigation team. We also conducted health education sessions to promote personal hygiene and correct use of personal protective equipment to students and teachers at the school.

Discussion

This investigation confirmed the presence of an influenza A (H3N2) outbreak within the school. Both epidemiological investigation findings and laboratory results were compatible with influenza A, although the possibility of co-infection in a few cases could not be entirely ruled out.

The attack rate of this outbreak among the screened population was 26.5%, which was similar to the attack rate observed in other school settings.[15] The attack rates among sports students and senior-class students were higher than their counterparts. This may be attributed to the daily activities of these students that facilitated influenza transmission. Although there was a substantial overlap between students enrolled in the sports program and senior students, both variables were independent risk factors for infection.

We found that fever was not the most prevalent clinical presentation. Hence, relying solely on temperature screening may be insufficient for ILI surveillance. Prior evidence indicated a broad range of seasonal influenza presentations.[16] In this study, fever was present in 76% of cases, while other studies reported percentages ranging from 42 to 86%.[17–19]

This outbreak was likely to have originated from an imported case within the community with the initial case being a student enrolled in the sports program who had played football with students from other schools. At that time, there was a gradual rise in the number of influenza cases in Sanpatong District. Subsequently, the joint activities within the school environment likely facilitated the spreading of the disease, as evidenced by the propagated pattern of the epidemic curve.

The risk of influenza infection was notably higher among those having close contact with cases and those enrolled in the sports program. Sports students in particular had an increased likelihood of physical contact with their peers. Additionally, the nature of football games made it challenging to maintain mask-wearing and proper personal hygiene practices. These findings were similar to other epidemiological studies that also supported an elevated risk of infection among those in close contact with a case.[20–22]

In the univariable analysis, influenza vaccination was shown to have a protective effect against influenza infection but without statistical significance. Previous evidence confirmed its efficacy in preventing hospitalization and severe illness.[27–29] The lack of statistical significance may be attributed to several factors. For example, some participants were uncertain about their recent influenza vaccination status, and for those who reported to have received the vaccine, we could not trace back to the lots of vaccines administered to each individual to assess whether the antigenic strain in the vaccine matched the viral strand present in this outbreak.

Although crowded dormitories did not show statistical significance in the multivariable analysis, they had the potential to enhance disease transmission, as suggested by previous studies. For example, Wongsanuphat et al. showed that being in an area with a density of less than 1.1 m^2/person could result in an attack rate as high as 33.2%, although that study was conducted in a prison setting and the 1.1 cut-off value may not precisely match the school setting.[23] Another study reported that the risk of developing influenza infection during a New Year's party was higher among attendees who shared the same dining table with a case.[24]

The school closure probably had a significant role in controlling the outbreak. The school director had endorsed this once the outbreak was realized. Prior studies suggested that timely school closure, ideally within a week after the outbreak's onset, could be an important measure for halting an outbreak.[25–26] Moreover, the implementation of ILI surveillance among students and teachers could help limit the transmission and enhance awareness.[27]

Limitations

Firstly, not all students and teachers participated in the questionnaire survey due to the school closure prior to our investigation. However, we tried to enrol additional participants as much as possible by conducting phone interviews to complement the self-administered survey. If we had been able to include all students and teachers in the survey, the attack rate might have been lower (assuming that the absent participants posed a lower risk of infection). Secondly, there was a possibility of response bias among students due to the online distribution of questionnaires. However, guidance by the investigation team was provided alongside the questionnaire and we also interviewed the teachers to triangulate their answers. Lastly, there may have been recall bias as ill individuals were prone to recall the history of contact than those who were not. This potential bias could lead to an overestimation of the measure of association.

Recommendations

We recommended that the school maintain the ILI surveillance system after the end of the outbreak. Daily monitoring of the symptoms of students, especially among sports students, by teachers or volunteer students would be helpful.[30] We also recommended implementation of intensive health education on personal hygiene and the proper use of personal protective equipment. We also suggested that the dormitories' environment should be adjusted to make them less crowded under guidance of local health authorities. Furthermore, it is advisable to have yearly influenza vaccination administered to all students and teachers in the boarding school as prior evidence suggests its benefit in preventing severe illness.

Conclusion

We report an influenza A (H3N2) outbreak at a semi-boarding sports school in Sanpatong District, Chiang Mai Province. The overall attack rate was 26.5% among the screened population and 18.9% among the total population with the majority of cases being students. There were no hospitalizations or fatalities. The source of the infection likely originated from the community, potentially introduced by students participating in an inter-school sports competition. Being involved in a sports program and being in close contact with a case posed a significant risk of infection. We recommended implementing ILI surveillance system within the school. Adjustments to the dormitories' environment, particularly their density, should be considered to mitigate the risk of future outbreaks.

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