First Pandemic A (H1N1) pdm09 Outbreak in a Private School, Bangkok, Thailand, June 2009

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Objective: *On June 9, 2009, the Thailand Ministry of Public Health received their first report of an outbreak of the pandemic A (H1N1) pdm09 that occurred in a school. The authors conducted a study to describe the epidemiological characteristics of the outbreak and its resurgence, estimate the basic reproduction number (R_0) and review recommendations for prevention and control.*

Material and Method: *Active case finding in the school and reviewing reports to the national surveillance system identified 184 students infected by the new virus. A survey described the illness in the students and the prevention and control measures taken by the school. The basic reproduction number was estimated from data in the early epidemic phase. The other survey was done to assess factors contributing to the resurgence of the outbreak.*

Results: *Students with the pandemic A (H1N1) pdm09 had a mild illness resembling seasonal influenza. Overcrowding in the classroom and activities that mixed students from different classes contributed to transmission in the school. The basic reproduction number for this school-based setting is 3.58. The second outbreak occurred because of poor monitoring of absenteeism and management of ill students.*

Conclusion: *This was the first outbreak of the pandemic A (H1N1) pdm09 in Thailand. The source could not be identified. Effective control measures monitoring, screening, strict personal hygiene and proper management of ill students.*

Keywords: *Basic reproduction number, The pandemic A (H1N1) pdm09, School, Thailand*

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In February 2009, residents in a small community in Veracruz, Mexico developed an illness characterized by fever, cough and headache[1]. In March, this disease soon spread to other cities in Mexico and the United States. By the end of April, the virus that caused these illnesses, the pandemic A (H1N1) pdm09, had spread to ten other countries and in another month, the rest of the world[2,3]. The virus was being imported by travelers who visited Mexico or other countries with this disease. Many countries, including Thailand, began screening inbound passengers for flu-like symptoms at their international airports to prevent introduction of the virus. Despite these efforts, on May 13, 2009, government officials in Thailand reported that two people returning from Mexico contracted influenza of the pandemic A (H1N1) pdm09 virus. This was the first importation of the virus into Thailand.

To assist with the early detection of an outbreak, the Ministry of Public Health (MOPH) asked school officials monitor the absentee rate and inform health authorities when there were three or more absent students per class per day. On June 9, 2009, the MOPH was notified that a male student at a private school in Bangkok (School "S") was confirmed to be infected with the pandemic A (H1N1) pdm09 virus. The student and his family had no history of travel outside Thailand.

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During that week, many of the students in School S developed an upper respiratory tract infection (URI). Subsequently, staff from the MOPH and the Bangkok Health Department conducted an investigation to identify the source and mechanism that caused the outbreak, to describe the epidemiological characteristics of the outbreak, to estimate the basic reproduction number (R_0), to give recommendations for prevention and control and to identify the risk factors for the resurgence of the outbreak.

Material and Method

To determine the source of the outbreak, we interviewed the index case and his family and all grade six students who visited the nursing room after the opening day of school on May 18, 2009, to the day before onset of the index case, June 6, 2009. The authors conducted active case findings for influenza-like-illness (ILI) among all grade 6 students, foreign teachers and grade 4-6 teachers in the school.

A person with an ILI was defined as a student or staff of School S or a household member of a student who developed fever and cough or sore throat between May 18 and August 11, 2009. A confirmed case is defined as a person with the pandemic A (H1N1) pdm09 by a throat swab test that identified RT-PCR.

To describe the epidemiological characteristics of the outbreak, we collected data on all confirmed cases of the pandemic A (H1N1) pdm09 reported to the national influenza surveillance or by schools. We assessed the magnitude of the outbreak by conducting a survey in grade 6 students with the highest attack rates and grade 9 students with a low attack rate. The authors conducted an environmental survey to observe classroom conditions and student activities that could contribute to the spread of influenza.

The authors reviewed prevention and control measures implemented by public health sectors and School S. The authors also investigated a second outbreak in School S to determine the cause of the resurgence. The authors interviewed students in grade 7, classes 4-8 with ILI symptoms and reviewed practices used for preventing disease transmission.

The basic reproduction number, R_0, is defined as the average number of secondary infections produced by an index case in a completely susceptible population[4-7]. The basic reproduction number was estimated from data in the early epidemic phase when there were few interventions and the effects of susceptible depletion were small. We estimated the initial exponential growth rate, r, for the cumulative number of cases by using nonlinear regression method. The basic reproduction number was then computed by substituting r into the following expression[8]

$$R_0 = 1 + Vr + f(1-f)(Vr)^2,$$

where V is the mean serial interval (time between the onset of symptoms for first and second generation cases) and f is the ratio of the mean infectious period to the mean serial interval.

Results

This school is a private school for boys in Bangkok. There are 5,271 students divided into 12 grades and 7 classes per grade. The teaching faculty consists of 311 Thai teachers and 43 foreign teachers. The school semester began on May 18, 2009. A typical classroom is around 60 m^2 with 60-70 students. All classrooms are air-conditioned except rooms in primary school grade 1-4. Everyday, all students came together two times to sing the national anthem before the start of classes in the morning and in the afternoon. Students play on the ground floor of the school buildings during lunch and at the end of the school day before returning home. Common objects in the school include public phones, door knobs and an automatic teller machine. Each school minivan transports 12-15 students between home and school, during a period of between 30 and 60 minutes.

The index case was an 11-year old boy who attended class 2 in grade 6 with an underlying asthma. At school on June 6, 2009, he developed a high grade fever, productive cough and running nose. He visited a private hospital on June 7 and his throat swab was positive for Flu Arapid antigen test. Another throat swab was collected for testing for the pandemic A (H1N1) pdm09 and he was hospitalized on that day. His complete blood count and chest x-ray were normal. He was diagnosed as influenza and bronchitis. On June 9, the RT-PCR revealed he was positive for the pandemic A (H1N1) pdm09. He was given oseltamivir and was isolated in a single room. This student and his family did not have a history of travelling abroad or close contact with international travelers. Throat swabs were taken from all 3 family members and only the mother's sample was positive for the pandemic A (H1N1) pdm09 but she did not have any ILI symptoms.

Of the 19 grade-six students who had fever and respiratory symptoms and visited the nursing room during May 15-June 5, 2009, 14 (73.3%) were interviewed. Five (35.7%) had a history of travelling aboard in March or April or had contact with an

influenza-symptomatic family member or visitors during summer holidays. Of 57 (62.6%) teachers interviewed, 13 had ILI and all had their onset dates after the onset date of the index case (June 6). The Thai teachers presented onset of ILI symptoms in the first wave of epidemic and the foreign teachers became symptomatic in the following wave. The pandemic A (H1N1) pdm09 viruses were discovered in the throat swab from one Thai and one foreign teacher.

When we retrospectively reviewed, the number of absentee students per class in grade 6 class 3 increased over the threshold for notification (over 3 students per day) during June 4-9. In the following week, many students had URI symptoms and absenteeism in grade 6, class 1 to 3 was above the threshold. School officials decided to close classes in grade 6, class 2 to 4, which had students with the pandemic A (H1N1) pdm09 and the highest number of absentees on June 11. However, after the pandemic A (H1N1) pdm09 in School S was announced to the public on June 11, there were increasing numbers of absentees in all grades. The parent association of School S and the public health sector decided to close the school from 12-18 June for intensive cleaning and to break hopefully the transmission cycle.

The majority of the pandemic A (H1N1) pdm09 cases were from the national influenza surveillance system collected by Bureau of Epidemiology (BOE). As of August 6, the system received reports of 243 people with pH1N1 that were associated with school S, 231 were students and 12 were personnel or a family member of a student. Among the students, 184 (77.1%) were interviewed by telephone or by a self-administered questionnaire. The others were monitored by influenza surveillance and school survey (Fig. 1).

The median age of the 195 cases was 11 years old (range 4-70 years). All students were male and the male to female ratio among the others was 1:1.3. There were 53 (30.8%) individuals hospitalized with no deaths or complications. The median duration of illness was 3 days (range 1-17 days). Students in grade 6 had the highest attack rate (12.9%) but this should be an underestimation. Because the MoPH changed its recommendation for testing the pandemic A (H1N1) pdm09 after the announcement of outbreak in this school and evidenced by local transmission in Thailand. The recommendation was changed from testing in every suspected case to testing only in severe cases or new clusters. Consequently, the number of throat swabs tested from School S student and personnel was reduced. Students in primary grade were the main group in the early of this outbreak while numbers of these in secondary grade markedly increased since June 11. Most of the pandemic A (H1N1) pdm09 cases had onset dates after school closing. The numbers of cases sharply decreased after the peak (June 12) because of the changing policy of the Ministry in testing only severe cases (Fig. 2). Most common symptoms of the 178 students with the pandemic A (H1N1) pdm09 were fever (86.5%), followed by cough (75.8%), headache (58.4%) and diarrhea (15.7%) (Table 1). Fever was more commonly found in younger students, 28 (100%) of the students in grade 1-3 and 29 (82.4%) of the students in grade 10-12. Myalgia, headache and diarrhea were more prominent in teenagers while cough, sore throat and secretion in throat were slightly higher among younger students.

Using the number of cases in the early epidemic phase for the primary School Students where the outbreak first occurred, the exponential growth rate, r, was calculated to be 0.2668 and the basic reproduction

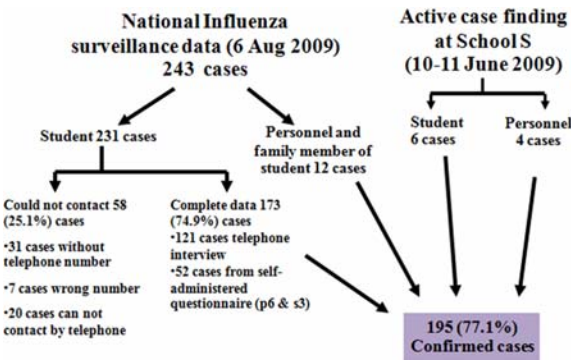

Fig. 1 Sources for names of people who attend or work at school S and have a confirmed diagnosis of the pandemic A (H1N1) pdm09.

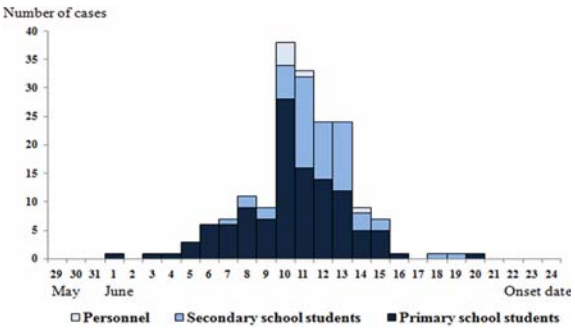

Fig. 2 Date of onset of students and staff of school S with a confirmed diagnosis of the pandemic A (H1N1) pdm09 (n = 178).

number, R_0, was estimated to be 3.58 [95% confidence interval: 2.88 to 4.28], which is close to other estimates in school-based settings[9] for a mean infectious period of 5 days and mean incubation period of 2 days.

The response rates for the ILI survey in grade 6 and grade 9 students were 94.8%. Attack rates of ILI in grade 6 and grade 9 were 41.2% (186/452) and 23.7% (96/405), respectively (Table 2). Classroom-specific attack rate of ILI grade 6 students ranged between 30 and 70% but below 40% in grade nine students. The epidemic curve of influenza cases among grade 6 students showed the peak before school closure while these in grade 9 students were at low level, suggesting an active phase of the epidemic before the school closure (Fig. 3). Grade 9 students had a camping activity outside the school in the first week of June 2009 and remained susceptible. However, the number of cases declined in both grades, after 7-day school closing.

School S was closed the school on June 12. Public health personnel provided health education to all teachers on the natural history of novel influenza and prevention measures. They also taught the students how to wash their hands properly and wear facemasks. When the school was closed, janitors cleaned the surfaces of furniture, equipment and public objects with detergent. The school opened again on June 19, personal hygiene practices were strengthened, alcohol hand gel and masks were provided. Surveillance of absentee students was established by teachers (Fig. 4). Every student who had a body temperature $\geq$38.5°c, cough, sneeze or running nose was isolated. Students with fever were sent home. Students who had only respiratory symptoms without fever were allowed to study in the class if they wore masks.

After June 19, there were many absentee students in all grades especially in grade 7 in the 2nd week of school reopening. Grade 7 students were transferred to a grade 5 classroom without air conditioning while the grade 5 students were out on a camping activity from June 30 to July 3 but numbers of absentees were still high. The investigation team was requested to assess this situation on July 1, 2009. The authors surveyed classrooms 4 to 8 of grade 7 and found more than 50 % of attack rates in all classrooms. Forty-one (46.1%) grade 7 student ILI had close contact with an ill person from the school, followed by home (12.4%) and tutorial school (2.2%). Only 10 (11.6%) students who had ILI symptoms wore masks every day during illness. For those who wore masks, 10

Table 1. Characteristic of the pandemic A(H1N1)pdm09 confirmed cases from School S outbreak

	Total (n = 178)
Median age in years (range)	11 (6.0-18.0)
Male, number (%)	178 (100.0)
Clinical presentation, number (%)	
Fever	154 (86.5)
Cough	135 (75.8)
Headache	104 (58.4)
Running nose	98 (55.1)
Sore throat	84 (47.2)
Productive cough	71 (39.9)
Diarrhea	28 (15.7)
Myalgia	27 (15.2)
Fatigue	7 (3.9)
Median of duration of illness, days (range)	3 (1.0-17.0)

Table 2. Attack rate of confirmed pandemic A (H1N1) pdm09, ILI and absenteeism among grade 6, 7, 9 students and teachers

	Number surveyed	ILI cases(%)	Confirmed cases (%)	Absenteeism cases (%)	Total
Student					
Grade 6	452	186 (41.2)	60 (12.9)	14 (3.0)	466
Grade 7*	187	89 (47.6)	1 (0.4)	61 (24.6)	248
Grade 9	405	96 (23.7)	12 (2.7)	33 (7.5)	438
Total	1,044	371 (35.5)	73 (6.3)	108 (9.4)	1,152
Teacher					
Foreign	39	9 (23.1)	1 (2.6)	N/A	43
Grade 4-6 Thai	18	4 (22.2)	2 (4.2)	N/A	48

*4 from 8 classes
N/A: not available data

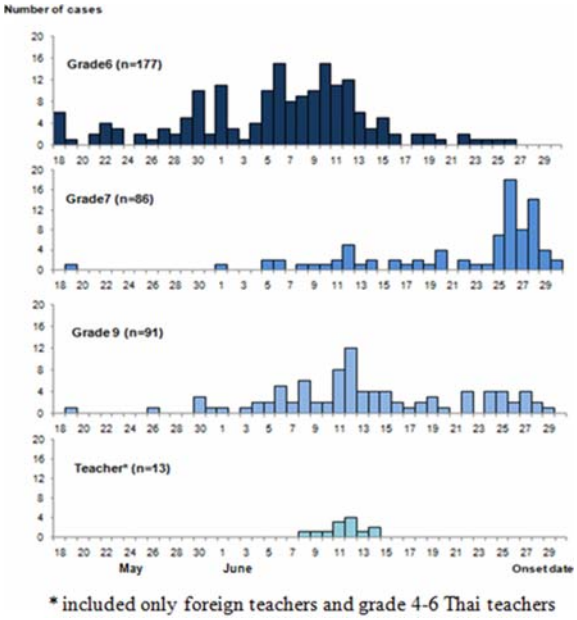

Fig. 3 Date of onset of students and teachers of grades 6, 7, 9 in school S with influenza-like-illness and teacher * since open the first semester of 2009 (18 May 2009).

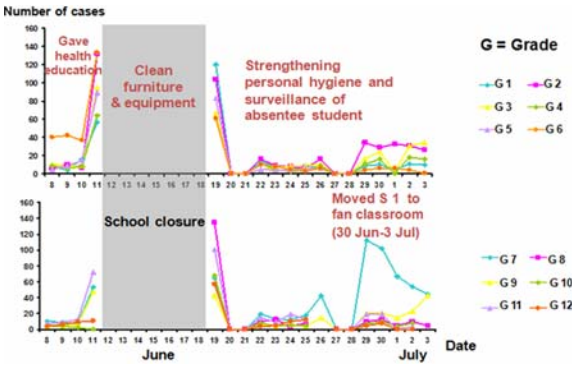

Fig. 4 Number of absent students by grade during 8 June to 3 July 2009 matched with public officer and school action.

(24.4%) did not wear it correctly, not covering their mouths and noses all the time. In 54 students who had symptoms of ILI 22 (40.7%) were identified and sent home, 14 (25.9%) were still in the class and wearing masks and 18 (33.3%) were not identified by the teachers. This allowed symptomatic students staying in the class and spreading the disease to other students. The second influenza outbreak occurred in grade 7 where there were many susceptible students because of a low number of immunized persons in the first influenza outbreak, unidentified cases by the school teachers, improper use of masks, and crowded condition of the classroom. In the second wave of outbreak, we did not collect the specimens for confirming the cases, but they had epidemiological linkage to the pandemic A (H1N1) pdm09 outbreak.

After the authors reported their findings to the school officers, the school issued guidelines following the criteria from BOE; a student or school personnel who had at least 2 of 4 symptoms (fever, cough, sore throat, running nose) had to be isolated at home. Moreover, a student or school personnel who had a temperature of more than 37.5°C was asked to leave school for home. Additional measures included postponing of camping activities, stopping air-conditioning in classroom and continuing absentee surveillance. After the investigation and a long weekend, numbers of absentees declined but were still relatively high in some primary grade class then slowly declined after strictly operated with the new guideline.

Among the 155 pandemic A (H1N1) pdm09 cases, the authors found 28.4% of them had at least one secondary case develop in their household. The overall secondary attack rate among the 655 susceptible household contacts was 9.2%. Median age of them was 18.5 years old (range 5 months to 72 years old). Age-specific attack rates among groups less than 5 years old, 5-15 years old and more than 15 years old were 14.8%, 16.0% and 7.4%, respectively. The median serial interval for pH1N1 transmission was 3 days.

Regarding risk behavior during illness of these secondary cases, 64.5% (98/152) of the confirmed cases slept in the same room with their parents or their brother or sisters. Of 156 the pandemic A (H1N1) pdm09 cases, 39.4% used masks everyday during their illness, 42.3% used sometime and 18.3% never used them. The only statistically significant risk factor associated with secondary household transmission was sleeping with parents/brother/sister (adjusted OR 3.47, 95%CI 1.17-10.30) (Table 3). The authors found that secondary transmission was 2.21 times (adjusted OR 2.21, 95% CI 0.90-5.46) more likely to occur among cases with an onset date before 11 June, the date of public announcement, but not significant after adjustment.

Discussion and Conclusion

The outbreak in School S was among one of the first known indigenous transmission of the pandemic A (H1N1) pdm09 in Thailand. Another simultaneous known outbreak was among staffs of one entertainment place in one province two hours away

Table 3. Factors that associated with household secondary attack cases among confirmed pandemic A (H1N1) pdm09 cases

Risk factor	ARI with exposure		ARI without exposure		Crude OR	95%CI	Adjusted OR#	95%CI
	n	%	n	%				
Sleeping with parents or brother/ sister	35/98	35.7	9/54	16.7	2.78	1.23-6.25	3.47	1.17-10.30
Onset before 11 June*	23/61	37.7	19/87	21.8	2.17	1.05-4.48	2.21	0.90-5.46
During illness stay l home at all time	39/131	29.8	5/23	21.7	1.53	0.55-4.24	2.06	0.53-7.96
Had household member $\leq$15 years old	29/87	33.3	15/68	22.1	1.77	0.86-3.62	1.97	0.79-4.89
Not always wear mask	32/95	33.7	12/60	20	2.03	0.96-4.31	1.41	0.55-3.64
Cough and running nose	27/76	35.5	8/27	29.6	1.31	0.51-3.32	1.16	0.41-3.33

Multiple logistic regression
* Time that this school outbreak was widely known by the media

from Bangkok[10]. All teachers with ILI developed their symptoms after the index case. Many teachers and students had a history of travelling in countries with wide-spread, local transmission. They might have been infected on an airplane. Thus, the pandemic A (H1N1) pdm09 probably was introduced to this school from a student from another grade who was unconcerned about the pandemic A (H1N1) pdm09 during the 2 weeks after the semester opening (18 May).

The clinical presentation of the pandemic A (H1N1) pdm09 in school children could not differentiate from other respiratory illnesses. Consequently, parents and teachers could not tell the difference between seasonal influenza and the new influenza virus. Using absenteeism to detect the pandemic A (H1N1) pdm09 in the school was hindered by the fact that the responsible person did not analyze the data and did not know what to do when the number was above the threshold. However, absenteeism data were useful to indentify the second outbreak because teachers were then more aware of the number of ill students. They, thus, knew about the threshold and what to do when the threshold was exceeded. School officers also closely monitored the absenteeism data for abnormal trends.

The limited classroom space and a large number of students led to overcrowding in the classroom and playing areas. In addition, there were many activities that allowed mixing of students from different grades and classes such as the daily assemblies and traveling to and from school in a minivan. All of this contributed to the spread the pandemic A (H1N1) pdm09 in this school.

The R_0 of the pandemic A (H1N1) pdm09 cases in this school outbreak setting was estimated to be 3.58 for the mean infectious period of 5 days. It was significantly higher than those reported from other countries such as USA (R_0 = 1.3-1.7)[11], Mexico (R_0 = 2.2-3.1)[12] and Japan (R_0 = 2.3)[13], Ontario Canada (R_0 = 1.31)[14] were. The differences could be understood by considering the fact that their R_0 was based on community-wide settings, e.g. city or the whole country, but our estimate was in a school. The density of population in a school-based setting is higher than for those in the community settings are. The infected individuals had more opportunities for multiple and lengthy contacts and the young students were non-immuned to the novel influenza virus at the early pandemic phase. Consequently, the virus transmission rate is higher in a school-base setting. Paterson et al used survey data from students in a school outbreak

to calculate the effective reproduction number R, which is comparable to R_0, in a school-based setting. They reported that the basic reproduction number for this school-based setting was about 3.45 for an infectious period of 5 days which was close to our estimate on this Thai school-base setting, $R_0 = 3.58$. The R_0 in this school setting was also higher than the estimated R_0 in the general population in Thailand ($R_0 = 1.8\text{-}2.1$)[12]. The children were higher affected in terms of attack rate[13,14].

From this outbreak, most confirmed cases were primary students who had poor personal protection behavior and had close contact with their friends in school. A second round of influenza outbreak occurred in grade 7 because the presence of many susceptible students, loose screening criteria and poor prevention practices against influenza measures.

School closure could slow influenza transmission and prevent resurgence[15]. Strict isolation of new cases should be maintained[16,17]. Screening criteria using fever as the main symptom might miss some cases because half of children with the pandemic A (H1N1) pdm09 had a fever for only 1 day[18]. Although most confirmed cases had fever, older children had a lower proportion of fever. In China, only 36.0% of the confirmed pandemic A (H1N1) pdm09 cases were median of age 23.4 (range 0.6-74.8) years old, had a fever greater than 38°C and some cases had an URI symptom before fever[19]. In the next pandemic, the MOPH should pay close attention to international schools since they are high risk areas for imported cases. Aggressive surveillance may help in detecting imported cases and abnormal ILI clusters. Surveillance of absentee students is a useful tool for case detection and monitoring the pandemic A (H1N1) pdm09 outbreak[20]. Therefore, it should be strengthened and supervised on how to conduct, develop and use data from schools with indigenous pandemics to avoid or limit the number of schools with outbreak.

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Potential conflicts of interest

None.

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การระบาดของไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ที่ถูกรายงานครั้งแรกในโรงเรียนของประเทศไทยในเดือนมิถุนายน พ.ศ. 2552

กัลยา จงเชิดชูตระกูล, Alden K. Henderson, โสภณ เอี่ยมศิริถาวร, ชรินทร์ โหมดชัง, พจมาน ศิริอารยาภรณ์

ภูมิหลัง: *ในวันที่ 9 มิถุนายน พ.ศ. 2552 กระทรวงสาธารณสุขได้รับรายงานเป็นครั้งแรกว่ามีการระบาดของไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ในชุมชน ซึ่งเกิดขึ้นในโรงเรียนเอกชนแห่งหนึ่งในกรุงเทพฯ จึงได้มีการดำเนินการศึกษาเพื่ออธิบายลักษณะทางระบาดวิทยาของการระบาดและการระบาดซ้ำ ประเมินค่าความเร็วในการแพร่กระจายของเชื้อไวรัส (R_0) ทบทวนมาตราการควบคุมและป้องกันการระบาดของโรค*

วัสดุและวิธีการ: *จากการดำเนินการค้นหาผู้ป่วยรายใหม่ในโรงเรียนและทบทวนข้อมูลจากระบบเฝ้าระวัง โรคไข้หวัดใหญ่ของประเทศพบนักเรียนที่ป่วยด้วยโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 จำนวน 184 ราย ทางผู้ศึกษาได้เก็บข้อมูลในส่วนของการเจ็บป่วยของนักเรียน มาตราการการควบคุมและป้องกันโรคของทางโรงเรียน ค่าได้ถูกคำนวณจากข้อมูลการเจ็บป่วยในช่วงแรกของการระบาด ในส่วนของการระบาดซ้ำของโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ในโรงเรียนแห่งนี้ทางผู้ศึกษาได้มีการเก็บข้อมูลปัจจัยที่สนับสนุนให้เกิดการระบาดซ้ำ*

ผลการศึกษา: *นักเรียนที่ป่วยเป็นโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 มีอาการไม่รุนแรงเช่นเดียวกับไข้หวัดใหญ่ตามฤดูกาล การที่นักเรียนอยู่อย่างหนาแน่น และการทำกิจกรรมร่วมกันของนักเรียนต่างห้อง ทำให้มีการแพร่กระจายของโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ในโรงเรียน ค่าความเร็วในการแพร่กระจายของเชื้อไวรัส (R_0) ของโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ในโรงเรียนนี้เท่ากับ 3.58 การระบาดซ้ำเกิดจากการเฝ้าระวังนักเรียนที่ขาดเรียน และมาตรการการดูแลนักเรียนที่ป่วยที่ไม่มีประสิทธิภาพ*

สรุป: *การระบาดแรกๆ ของโรคไข้หวัดใหญ่สายพันธุ์ใหม่ เอ 2009 ในโรงเรียนแห่งนี้เป็นการระบาดแรกของการระบาดภายในประเทศไทย สาเหตุของการระบาดยังไม่สามารถระบุได้ชัดเจนมาตราการการควบคุม และป้องกันโรคที่มีประสิทธิภาพ คือ การติดตามคัดกรองสุขอนามัยส่วนบุคคลที่เข้มงวดและการจัดการที่เหมาะสมในนักเรียนที่ป่วย*