Effectiveness of School Closure in Novel Influenza A(H1N1) Outbreak in Japan

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Background:

On 9 May 2009, Japan has found the first case for the novel influenza A(H1N1) virus, A(H1N1)pdm, at the quarantine station in Narita Airport. Around one week later, Kansai area has reported some outbreaks for the A(H1N1)pdm in the schools. Many countries planed school closure as one of the mitigation program. However, effectiveness of mitigation for A(H1N1)pdm in the school haven't been reported so often. Therefore, we reported a case of school closure and its effectiveness.

Materials and Methods:

We have collected the data for the medical information and epidemiological data concerning the cases and close contacts of N-junior high school (NJHS), through the Funabashi City Public Health Center (FPHC) and Education board of Funabashi City. FPHC collected the data for symptoms, trip history, medical records, antiviral prophylaxis, follow-up data and conducted contact tracing. Teachers have investigated fever and other health conditions of the students, during the period of school closures in N-junior high school area, which belongs to one junior high school and two elementary schools, and T-junior high school area, one junior high school and two elementary schools. Risk estimation was calculated by relative risk (RR) and its 95% confidential Interval (95%CI). Number of the feverish students was collected from case and control schools. Effectiveness of school closure was evaluated by comparing the number of the feverish case between N junior high school and control school.

Case Definition for Infection with A(H1N1)pdm as follows:

A)A confirmed case of novel influenza A(H1N1)pdm infection is defined as

- a person with fever (temperature of 37.0ºC or over) **and**;
- laboratory confirmed A(H1N1)pdm infection by real-time RT-PCR **and**;
- lived in Funabashi City from 1st to 19th June, 2009

B)A suspected case of Novel Influenza

One who has had fever **and** at least one following symptoms :

- Cough, sour throat, or rhinorea

Results:

Confirmed cases were 42 persons during the outbreak. Characteristics of confirmed cases were shown in Table 1. Male was 61.9% (26/42) and 10-19 years old was 90.5% (38/42) which was the highest rate of the cases. Epidemiological link for NJHS was 95.2% (40/42), and unknown epidemiological link was two cases (4.8%), those who were one adult and one kindergarten student. Of 42 cases, NJHS was 34 confirmed cases which were the highest cases in existing epidemiological link. Clinical episode showed in Table 2. Fever (37ºC and over; median: 38.1ºC), was the highest rate for the clinical episode and the next highest one was cough (82.5%). Confirmed case had two peaks in the epidemiologic curve (Fig 1). The first peak showed in 7th June and next peak was showed 9th and 10th June. The first case who has belonged in 3rd grade of NJHS was onset on 5th June. The first and second waves of this outbreak have mainly consisted with 3rd grade of NJHS Students. During 3rd and 5th of June, third grade of students have admitted to the school excursion. After school excursion, several clubs have played some games with many schools in neighboring cities on Saturday and Sunday (6th and 7th June). On 8th June, was the first day after school excursion, fifteen of the third grade students and two of the first grade students were absent from the NJHS. Number of the confirmed cases were 34 (attack rate, AR: 5.0%) among the NJHS students (Table 3). Of the each grades, the highest AR of the grade was third grade (10.7%). Of the third grade, Class 4 was the highest AR (34.2%) and the next one was the Class 5 (25.0%). Among the club, Softball club was the highest AR (50.0%) for A(H1N1)pdm, and the next highest one was tennis club (20.0%) in Table 5. Each clubs calculated for the Relative Risk (RR) and 95% Confidential Interval. The highest RR for club was softball (RR=6.53, 95%CI: 2.21-19.25) and next one was table tennis (RR=2.43, 95%CI: 0.94-6.23). Concerning the effectiveness for the school closure, we assessed the number of the feverish student showed in Fig 2. On 8th June, number of the feverish student was fourteen, *which led a 8-day school closure*. On 9th June, number of the feverish student was five at the first day of the temporally closed school. On 11th June, NJHS reported 13 feverish students which was the highest number of the feverish students which were the highest numbers after the temporary closed school. The day after number of the feverish students in NJHS has decreased during the temporally closed school. Among other schools, feverish students were between 0 and 4.

Table 1. Characteristics of the Confirmed Case (n=42)

Affiliation	Number of the Case	Rate (%)
Sex		
Male/Boy	26/42	61.9
Female/Girl	16/42	38.1
Age group		
0-9 years old	1/42	2.4
10-19 years old	38/42	90.5
20-29 years old	0/42	0.0
30-39 years old	0/42	0.0
40-49 years old	3/42	7.1
Affiliation		
Epidemiological Link for N Junior High School: Forty Cases (95.2%)		
N-Junior High School	34/40	85.0
T-Junior High School	1/40	2.5
T-Elementary School	1/40	2.5
S-Elementary School	1/40	2.5
C-College	1/40	2.5
Adult	2/40	4.8
Unknown Epidemiological Link for N Junior High School: Two Cases (4.8%)		
Adult	1/2	50.0
F-Kindergarten	1/2	50.0

Table 2. Clinical Episode while investigation (n=42)

	Number of the Case	Number of Eligible Response	Rate (%)
Fever (37.0ºC and over)	41	41	100.0
Cough	33	40	82.5
Sore Throat	14	32	43.8
Runny nose	15	37	40.5
Headache	6	13	46.2
Joint Pain/Muscle Pain	2	13	15.4
Diarrhea	2	29	6.9
Feeling sick/Vomit	3	28	10.7

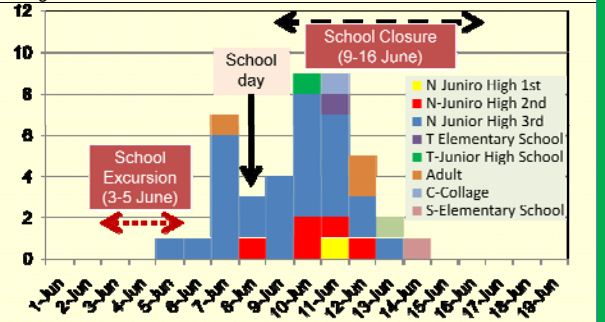

Fig 1. Novel influenza A(H1N1) cases of onset day by affiliation (n=42)[a, b]

a) Case Definition: Suspected Novel Influenza Infection by the Physician and RT-PCR Positive
b) Definition of Onset: The first appearance day of the signs of body temperature 37ºC

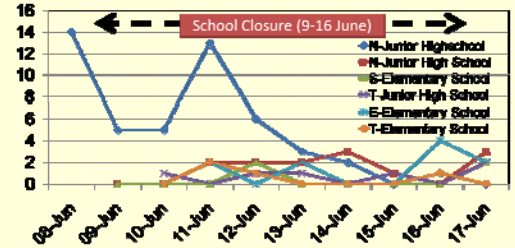

Fig 2. Number of the feverish cases in the school

Table 3. Attack rate of NJHS

Class	Number of the enrollment	Number of the case	Attack Rate (%)
First grade	223	1	0.4
Second grade	198	5	2.5
Third grade	262	28	10.7
Class 1	38	1	2.6
Class 2	38	2	5.3
Class 3	37	1	2.7
Class 4	38	13	34.2
Class 5	36	9	25.0
Class 6	37	2	5.4
Class 7	38	0	0.0
Total	683	34	5.0

Table 4. Relative risk for the Club in NJHS (n=226)[a, b]

Club name	Number of the enrollment	Number of the Case	Attack Rate (%)	Relative Risk (RR)	95% CI [c]
Tennis	5	1	20.0	2.34	0.38-14.30
Track	32	4	12.5	1.62	0.57-4.56
Softball	4	2	50.0	6.53	2.21-19.25
Kendo	13	1	7.7	0.91	0.13-6.30
Soccer	25	2	8.0	0.95	0.23-3.85
Table Tennis	29	5	17.2	2.43	0.94-6.23
Orchestral	36	2	5.6	0.62	0.15-2.57

a) Except for the class 5 among 3rd grade
b) Except for the no cases repot club
c) CI: Confidence Interval

Discussion:

Our study investigated the risk factors for the novel influenza A(H1N1)pdm virus outbreak in the junior high school and evaluate the effectiveness of the school closure.

Softball club and table tennis club were significant or marginally significant risk factors for the transmission. We have estimated the risk factors for the transmission in the school life. Activities at softball and table tennis club suggested the risk factor for the A(H1N1)pdm. Although, we couldn't identified the type of infection. On the other hand, we couldn't estimate the risk factor for the virus transmission. School excursion might have been an opportunity of the transmission of the novel influenza virus. However, our data have not analyze the risk factors (actual risk behaviors) for the source of the infection, because of both overwrapped many kinds of the risk behavior (e.g. seat location in the train or bus, hotel room, and group of school excursion during the day time) and the small sample size. Therefore, we will need further investigation for what to cause the infection in the school life.

The number of the feverish student were quickly reduced after temporally school closure in the NJHS as same as the number of the feverish students in other schools. Several study suggested that school closure might be one of the effective mitigation for influenza, but they haven't mentioned its *effectiveness for the quantitative effectiveness*. Our data showed the clearly reduced the number of the feverish students during the temporally school closure in NJHS as same as the number of the feverish students in other schools. Therefore, we demonstrated the school closure was one of the effective mitigation strategy regarding the A(H1N1)pdm especially during containment phase.

Conclusion:

Close contact at school is a source to easily transmit the A(H1N1)pdm among the school students. Continuous data collection at school for the number of the feverish students and of the absentees is useful for school officials to determine the timing of school closure. School closure ,launched appropriate timing, for short period of time is the one of the effective mitigation strategies against the pandemic influenza.