

# PATTERNS OF SCHOOL ABSENTEEISM AMONG PRIMARY SCHOOL STUDENTS IN BANGKOK, THAILAND

Komchaluch Taweeseeneepitch<sup>1,2</sup>, Jaranit Kaewkungwal<sup>1,2,3</sup>, Pratap Singhasivanon<sup>1</sup>, Wongwat Liulark<sup>4</sup>, Podjane Jittamala<sup>1</sup>, Amnat Khamsiriwatchara<sup>2</sup>, Aumnuyphan Sangvichian<sup>2</sup>, Sirinya Krongrunroj<sup>2</sup> and Saranath Lawpoolsri<sup>1,2,3</sup>

<sup>1</sup>Department of Tropical Hygiene, Faculty of Tropical Medicine, Mahidol University, Bangkok; <sup>2</sup>Center of Excellence for Biomedical and Public Health Informatics (BIOPHICS), Faculty of Tropical Medicine, Mahidol University, Bangkok; <sup>3</sup>Center for Emerging and Neglected Infectious Diseases, Mahidol University, Bangkok; <sup>4</sup>Communicable Disease Control Division, Department of Health, Bangkok Metropolitan Administration, Bangkok, Thailand

**Abstract.** School absenteeism data can be used as surrogate data to identify potential disease outbreaks in schools and the community. We aimed to explore the patterns of school absenteeism, especially absence due to sickness with and without fever. Absenteeism data of anonymous students during academic year 2013 were extracted from an electronic school absenteeism monitoring system implemented in 6 primary schools in Bangkok. Absence status was classified into 4 groups: unexplained absences, absence for personal reasons, absence due to sickness with fever, and absence due to sickness without fever. The absence rate was calculated to describe the patterns of absenteeism by type of absence, sex, grade, school size and season. The overall absence rate was 47.40 per 1,000 school days. Unexplained absence rate was 29.34 per 1,000 school days. The absence for personal reasons rate was 12.84/1,000 school days. The absence due to sickness with fever rate was 3.87/1,000 school days. The absence due to sickness without fever rate was 1.35/1,000 school days. Patterns of school absences differed by school sizes and over time. Seventy-three percent of students with absence due to sickness reported they had fever. Absence due to sickness with fever occurred more commonly among younger students (Grades 1 and 2) and during the rainy season. Similar patterns of absence due to sickness and absence due to sickness with fever among the schools suggest data recording absence due to sickness may be used to estimate the incidence of acute febrile illness among students. This data regarding absence due to sickness may be useful for syndromic surveillance. Further studies of the correlation between absence due to sickness among students and disease occurrence in the community are needed.

**Keywords:** absenteeism, primary school, fever, absence due to sickness, syndromic surveillance

---

Correspondence: Saranath Lawpoolsri, Department of Tropical Hygiene, Faculty of Tropical Medicine, Mahidol University, 8<sup>th</sup> floor and 9<sup>th</sup> floor Tranakchit Harinasuta Building, 420/6 Ratchawithi Road, Ratchathewi, Bangkok 10400, Thailand.

Tel: +66 (0) 2306 9188-9, +66 (0) 81 9188688; Fax: +66 (0) 2644 4436

E-mail: saranath.law@mahidol.ac.th

## INTRODUCTION

School absenteeism data are useful for early detection of disease outbreaks (Omoe, 2010; Kass-Hout *et al*, 2012). School-based syndromic surveillance systems are an effective practical way of monitoring disease trends in communities (Lea *et al*, 2007; Sasaki *et al*, 2009; Crawford *et al*, 2011; Mann *et al*, 2011; Weng *et al*, 2015).

An increase in school absenteeism could indicate a disease outbreak but has low specificity for detecting communicable disease outbreaks (Short *et al*, 2011). Using absenteeism data that includes the reason for the absence may improve specificity in detecting disease outbreaks in schools and the community (Besculides *et al*, 2005) and improve outbreak predictions (Shen *et al*, 2008; Cheng *et al*, 2013). Absenteeism with symptom data needs to be validated, especially in resource-limited settings where information about illnesses in the community is limited (Lawpoolsri *et al*, 2014).

In Thailand, there is an attempt to establish a syndromic surveillance system using school absenteeism data (Sabcha-reon *et al*, 2012). In Thailand it is mandatory to record student attendance on a daily basis as part of student evaluations. The reason for the absence, including absence due to sickness and absence for personal reasons, are obtained from the parents and recorded. When the parents do not provide a reason for the absence, it is classified as unexplained. These data are usually recorded on paper and used within schools, which makes data sharing between schools and public health authorities difficult.

Recently, an electronic school absenteeism monitoring system was implemented at 7 pilot primary schools in Bangkok. The teachers record the presence

or absence of students each morning via tablet. The data are then electronically transferred to a central database, which can be shared with health centers at local and central levels (Lawpoolsri *et al*, 2014). The aim is to use absenteeism data to identify potential disease outbreaks, such as dengue infections and influenza. Teachers are required to contact parents and record if the student was sick with or without fever. However, contacting the parents of each absent student is difficult. This creates the question as to whether the data would be useful to identify outbreaks. Therefore, we aimed to evaluate absenteeism data, paying particular attention to students who were absent due to being sick and whether fever was present or not. This data can inform planning for a syndromic surveillance system that can be practically implemented on a large scale.

## MATERIALS AND METHODS

### Participants

We conducted a prospective cohort study at 6 of the 7 primary schools that implemented the electronic school absenteeism monitoring system under the Bangkok Metropolitan Administration (BMA) in Lat Krabang District, Bangkok, Thailand. The one school excluded from this study had a small population and the data from that school deviated from the data from other schools. The 6 participating schools were classified into three groups by size. One school was classified as large because it enrolled 2,000 students. Three schools were classified as medium because they enrolled 500-1,000 students. Two schools were classified as small because they enrolled <500 students.

### Procedure

School absenteeism data for the 6 target primary schools from 16 May 2013

to 10 March 2014 were extracted from the electronic school absenteeism monitoring system. This database is hosted by the Center of Excellence in Biomedical and Public Health Informatics, Faculty of Tropical Medicine, Mahidol University. The student data was collected only by a code, not by name, so the data could not be linked to the student. For each student, the following information was recorded: school name, sex, grade, day of absence, and type of absence: unexplained, absence for personal reasons, absence due to sickness with fever, and absence due to sickness without fever. These variables were used to explore absentee patterns by sex, grade, school size and season and calculate the absence rate and chance the absences were due to a public health condition.

#### **Data analysis**

The accessed data were screened for potential errors. Absences listing more than 10 days were excluded from the study. These long absences were assumed to be due to errors in data entry, such as when a student transferred to another school and the records were not updated.

Baseline characteristics of all absent students from the 6 study schools were recorded. The absence rate was calculated using the student number to determine the number of absences and the total school days misses per each academic year. The monthly absence rates were calculated by the type of absence. The duration of each absence in school days was recorded. The absence rates by type of absence were calculated by sex, grade, school size and season. Significant differences in absences by sex, grade, school size and season were calculated using Poisson regression. A  $p$ -value  $<0.05$  was considered statistically significant. Statistical calculations were

performed using STATA, version 11, 2010 (StataCorp LP, College Station, TX).

#### **Ethical considerations**

This study was approved by the Ethics Committee of the Faculty of Tropical Medicine, Mahidol University. Written informed consent was obtained from all study subjects and their parents prior to participation. The data were evaluated anonymously.

## **RESULTS**

In total, 25,636 absences were recorded for the 6 study schools during the 2013 academic year study period. Of these, 254 absences (1%) lasted  $>10$  days and were excluded. The remaining 25,382 absences were included in the study.

#### **Baseline characteristics of study subjects.**

A total of 5,732 students attended the 6 study schools during study period. Fifty-two percent were male. The numbers of students by grade were similar. Ninety percent of study subjects were enrolled in large (51%) or medium schools (41%) (Table 1).

#### **Temporal patterns of absenteeism by type of absence**

The absence rate varied during the study period from 45 to 167/1,000 school days. Similar temporal patterns were seen by type of absence. Unexplained absences peaked two times: at the end of the first (93/1,000 school days) and second (129/1,000 school days) semesters. Both unexplained absences rate and rate of absence due to sickness peaked in March 2014 (129 and 19/1,000 school days, respectively) (Fig 1).

#### **Patterns of school absenteeism**

Of the 25,382 absences recorded during the study period, 80% lasted only 1

day (Fig 2). An absence  $\geq 4$  days occurred in 3.3% of all absences. Among absence episodes due to sickness with fever and sickness without fever, 6.1% and 5% were absent  $\geq 3$  days, respectively (Fig 3).

The overall absence rate was 47.40/1,000 school days. Sixty-two percent of absences were unexplained absences, 27% were for absence for personal reasons and 11% were due to sickness. Of those absences due to sickness, 74% were absence due to sickness with fever (Table 2).

The unexplained absences rates were significantly ( $p = 0.01$ ) higher among grade 6 students (39.64/1,000 school days) and among those from large schools ( $p = 0.01$ ) (48.62/1,000 school days). The unexplained absences rate was significantly ( $p = 0.01$ ) higher in winter (32.56/1,000 school days) than other seasons. Male students were significantly ( $p = 0.01$ ) more likely to have an unexplained absence than female students.

Rates of absence for personal reasons were significantly ( $p = 0.01$ ) higher among grade 3 students (19.49/1,000 school days). Students from small (18.86/1,000 school days) and medium (17.39/1,000 school days) were significantly ( $p = 0.01$ ) more likely to have more absence for personal reasons than the large school (6.17/1,000 school days). Absence for personal reasons was significantly ( $p = 0.01$ ) more often in the winter (14.28/1,000 school days) than the other seasons (rainy = 13.22/1,000 school days and summer = 9.11/1,000 school days). There was no significant difference ( $p = 0.74$ ) in absence rates between males and females.

Absence due to sickness comprised 11% of all absences (5.22/1,000 school days). The rates of absence due to sickness were higher among grade 1 (9.00/1,000 school days) and grade 3 students (7.92/1,000

Table 1  
Baseline characteristics of study subjects during the study period ( $N = 5,732$ ).

| Characteristics | Students<br><i>n</i> (%) |
|-----------------|--------------------------|
| Sex             |                          |
| Male            | 2,989 (52)               |
| Female          | 2,743 (47)               |
| Grades          |                          |
| 1               | 924 (16)                 |
| 2               | 950 (16)                 |
| 3               | 930 (16)                 |
| 4               | 961 (16)                 |
| 5               | 966 (16)                 |
| 6               | 1,001 (17)               |
| School size     |                          |
| Large           | 2,942 (51)               |
| Medium          | 2,359 (41)               |
| Small           | 431 (7)                  |
| All             | 5,732 (100)              |

school days) ( $p = 0.01$ ) than the other grades (grade 2 = 3.92/1,000 school days, grade 4 = 4.31/1,000 school days, grade 5 = 5.23/1,000 school days and grade 6 = 2.21/1,000 school days). The rates of absence due to sickness among students in medium sized schools (6.37/1,000 school days) was significantly higher ( $p = 0.01$ ) than among students from other sized schools (large sized school = 4.32/1,000 school days and small sized school = 3.59/1,000 school days). Absence due to sickness was significantly ( $p = 0.01$ ) less likely to be reported during winter (3.66/1,000 school days) than the other seasons (rainy = 6.19/1,000 school days and summer = 5.74/1,000 school days).

#### Patterns of sickness with fever among sick subjects

The proportions of study subjects with sickness with fever varied by grade,

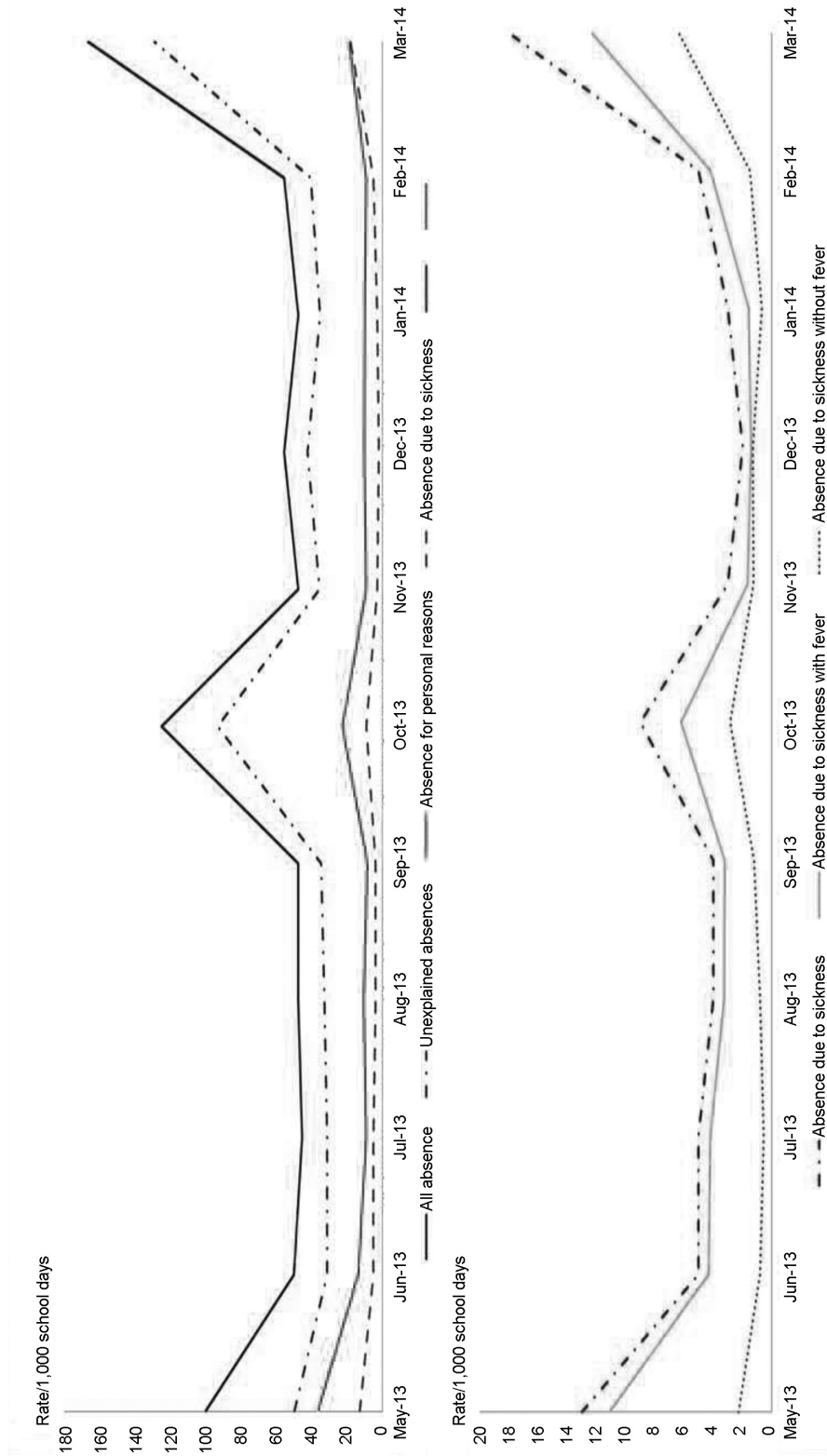


Fig 1—Temporal patterns of absence rates by type of absence during the study period.

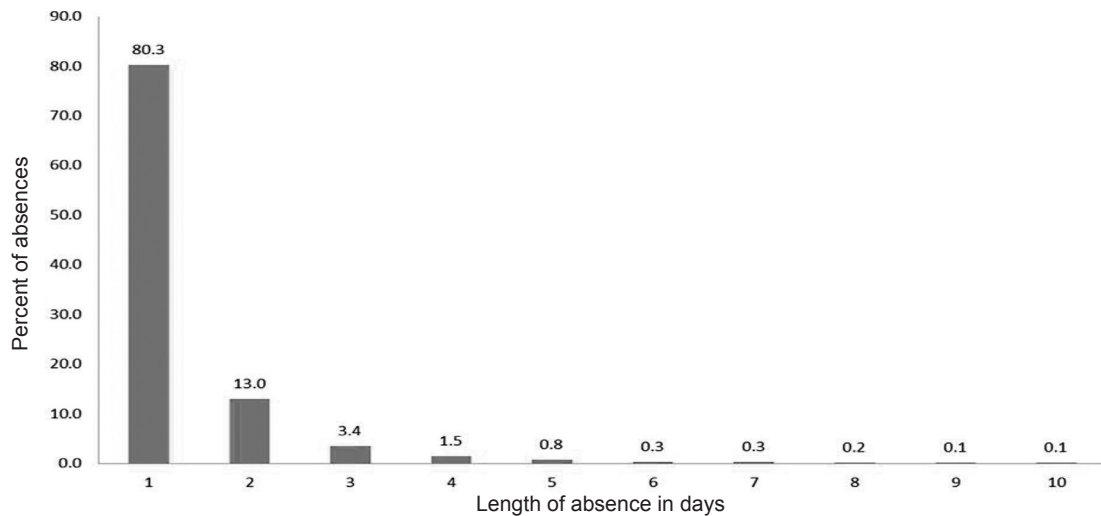


Fig 2—Percentages of absences by length of absence.

school size and season. Among absence due to sickness of study subject, 74% of them had fever. The proportion of study subjects who were absence due to sickness with fever varies by grades, school sizes and seasons. Among study subject with absence due to sickness, subjects in grade 3 were significantly ( $p = 0.01$ ) less likely to have fever (46.84%) than subjects in the other grades (grade 1 = 82.33%, grade 2 = 83.42%, grade 4 = 89.32%, grade 5 = 86.81% and grade 6 = 77.83%). About 89% of subjects with absence due to sickness in the medium sized schools were significantly ( $p = 0.01$ ) more like to have fever than among subjects from other sized schools (large sized school = 48.84% and small sized school = 76.60%). More study subjects with absence due to sickness were significantly ( $p = 0.01$ ) to have fever during rainy season (81.00%) than during the other seasons (winter = 62.84% and summer = 70.56%) (Table 3).

## DISCUSSION

School absences may assist in surveil-

lance of disease outbreaks as well as school attendance may correlate with academic success (Allensworth and Easton, 2005; Omoe, 2010). In most countries, disease surveillance relies on passive detection of disease, which has a low sensitivity for timely detection of outbreaks. Integrating absenteeism data may enhance the sensitivity of surveillance systems (Wagner *et al*, 2001; Zhao *et al*, 2007) in order to initiate timely control measures (Peterson *et al*, 1979; Ohkusa, 2010; Kom Mogto *et al*, 2012).

Absenteeism data for students has been proposed to monitor academics and public health (Schmidt *et al*, 2010). Social problems may be reflected by unexplained absences or absence for personal reason while public health problems may be reflected by absence due to sickness. Absentee data is more useful if the reason for the absence is clarified, such as absence due to sickness (Crawford *et al*, 2011; Sabchareon *et al*, 2012; Ohkusa, 2010; Mook *et al*, 2007). This information is not routinely collected at schools in Thailand. In this study, we collected absence data and classified it into absence due to sickness with

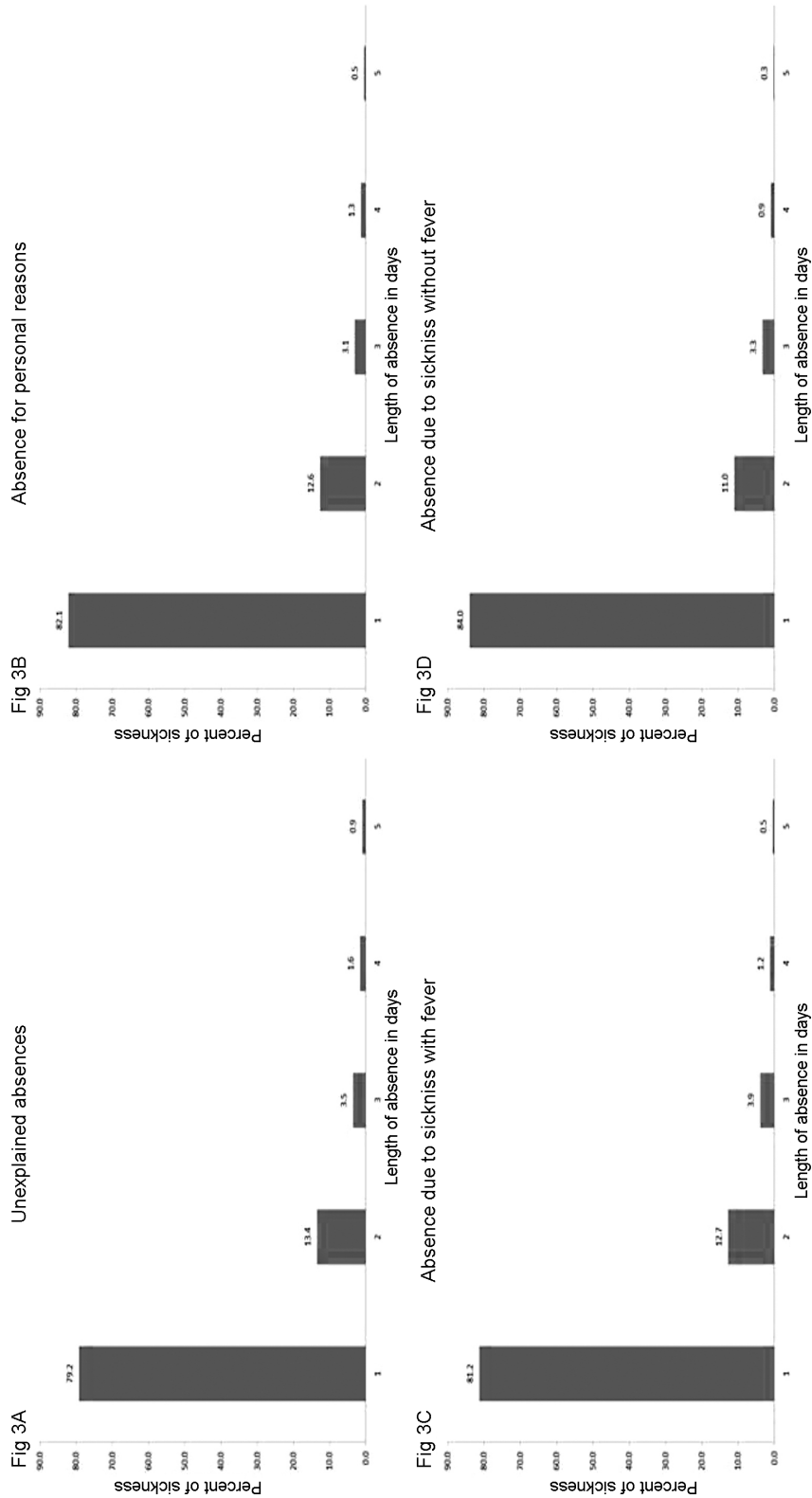


Fig 3-Percentages of absences by length and type of absence.

Table 2  
Absences by sex, grade, school size and season among study subjects during the study period.

| Variable         | Number of study subjects | Number of school days | Total absences        |                        | p-value | Unexplained absences  |                        | p-value | Absence for personal reasons |                        | p-value |
|------------------|--------------------------|-----------------------|-----------------------|------------------------|---------|-----------------------|------------------------|---------|------------------------------|------------------------|---------|
|                  |                          |                       | Number of school days | Rate/1,000 school days |         | Number of school days | Rate/1,000 school days |         | Number of school days        | Rate/1,000 school days |         |
| Sex              |                          |                       |                       |                        |         |                       |                        |         |                              |                        |         |
| Male             | 2,989                    | 364,996               | 18,129                | 49.67                  | 0.01    | 11,488                | 31.47                  | 0.01    | 4,734                        | 12.97                  | 0.74    |
| Female           | 2,743                    | 337,338               | 15,165                | 44.95                  |         | 9,120                 | 27.03                  |         | 4,288                        | 12.71                  |         |
| Grade            |                          |                       |                       |                        |         |                       |                        |         |                              |                        |         |
| 1                | 924                      | 80,806                | 4,608                 | 57.25                  | 0.01    | 2,743                 | 33.94                  | 0.01    | 1,138                        | 14.08                  | 0.01    |
| 2                | 950                      | 113,663               | 4,439                 | 39.05                  |         | 2,782                 | 24.48                  |         | 1,211                        | 10.65                  |         |
| 3                | 930                      | 126,981               | 6,630                 | 52.51                  |         | 3,149                 | 24.80                  |         | 2,475                        | 19.49                  |         |
| 4                | 961                      | 119,360               | 5,395                 | 45.20                  |         | 3,558                 | 29.81                  |         | 1,322                        | 11.08                  |         |
| 5                | 966                      | 129,621               | 5,346                 | 41.24                  |         | 3,147                 | 24.28                  |         | 1,521                        | 11.73                  |         |
| 6                | 1,001                    | 131,903               | 6,876                 | 52.13                  |         | 5,229                 | 39.64                  |         | 1,355                        | 10.27                  |         |
| School size      |                          |                       |                       |                        |         |                       |                        |         |                              |                        |         |
| Large            | 2,942                    | 294,348               | 17,399                | 59.11                  | 0.01    | 14,310                | 48.62                  | 0.01    | 1,817                        | 6.17                   | 0.01    |
| Medium           | 2,359                    | 334,168               | 13,127                | 39.28                  |         | 5,187                 | 15.52                  |         | 5,813                        | 17.39                  |         |
| Small            | 431                      | 73,818                | 2,768                 | 37.50                  |         | 1,111                 | 15.05                  |         | 1,392                        | 18.86                  |         |
| Season           |                          |                       |                       |                        |         |                       |                        |         |                              |                        |         |
| Rainy (May-Oct)  | 5,884                    | 327,183               | 15,260                | 46.64                  | 0.01    | 8,910                 | 27.23                  | 0.01    | 4,324                        | 13.22                  | 0.01    |
| Winter (Nov-Jan) | 4,596                    | 247,906               | 12,520                | 50.50                  |         | 8,073                 | 32.56                  |         | 3,539                        | 14.28                  |         |
| Summer (Feb-Mar) | 4,526                    | 127,245               | 5,514                 | 43.33                  |         | 3,625                 | 28.49                  |         | 1,159                        | 9.11                   |         |
| All              | 5,732                    | 702,334               | 33,294                | 47.40                  |         | 20,608                | 29.34                  |         | 9,022                        | 12.84                  |         |



Table 3  
Absences due to sickness and sickness without fever among study subjects by variables during the study period.

| Variable           | Number of study subjects | Number of school days | Absence due to sickness |                        | p-value | Absence due to sickness with fever |                        | Proportion of absences among study subjects with sickness who had fever |
|--------------------|--------------------------|-----------------------|-------------------------|------------------------|---------|------------------------------------|------------------------|---|
|                    |                          |                       | Number of school days   | Rate/1,000 school days |         | Number of school days              | Rate/1,000 school days |   |
| Sex                |                          |                       |                         |                        |         |                                    |                        |   |
| Male               | 2,989                    | 364,996               | 1,907                   | 5.22                   | 0.97    | 1,418                              | 3.89                   | 74.52   |
| Female             | 2,743                    | 337,338               | 1,757                   | 5.21                   |         | 1,301                              | 3.86                   | 74.09   |
| Grade              |                          |                       |                         |                        |         |                                    |                        |   |
| 1                  | 924                      | 80,806                | 727                     | 9.00                   | 0.01    | 600                                | 7.41                   | 82.33   |
| 2                  | 950                      | 113,663               | 446                     | 3.92                   |         | 372                                | 3.27                   | 83.42   |
| 3                  | 930                      | 126,981               | 1,006                   | 7.92                   |         | 471                                | 3.71                   | 46.84   |
| 4                  | 961                      | 119,360               | 515                     | 4.31                   |         | 460                                | 3.85                   | 89.32   |
| 5                  | 966                      | 129,621               | 678                     | 5.23                   |         | 589                                | 4.54                   | 86.81   |
| 6                  | 1,001                    | 131,903               | 292                     | 2.21                   |         | 227                                | 1.72                   | 77.83   |
| School size        |                          |                       |                         |                        |         |                                    |                        |   |
| Large              | 2,942                    | 294,348               | 1,272                   | 4.32                   | 0.01    | 621                                | 2.11                   | 48.84   |
| Medium             | 2,359                    | 334,168               | 2,127                   | 6.37                   |         | 1,895                              | 5.67                   | 89.01   |
| Small              | 431                      | 73,818                | 265                     | 3.59                   |         | 203                                | 2.75                   | 76.60   |
| Season             |                          |                       |                         |                        |         |                                    |                        |   |
| Rainy (May-Oct)    | 5,884                    | 327,183               | 2,026                   | 6.19                   | 0.01    | 1,634                              | 4.99                   | 81.00   |
| Winter (Nov-Jan)   | 4,596                    | 247,906               | 908                     | 3.66                   |         | 570                                | 2.30                   | 62.84   |
| Summer (Feb-March) | 4,526                    | 127,245               | 730                     | 5.74                   |         | 515                                | 4.05                   | 70.56   |
| All                | 5,732                    | 702,334               | 3,664                   | 5.22                   |         | 2,719                              | 3.87                   | 73.71   |

and without fever, absence for personal reasons and unexplained absences among students attending six primary schools in Bangkok. We also classified these absences by sex of student, grade, size of school and season.

The overall absence rate among study subjects in our study (48/1,000 school days) was approximately one-third that of a study conducted in the United Kingdom (130/1,000 school days) (Schmidt *et al*, 2010). In our study, 62% of total absences were due to unexplained absences. Possible reasons for this could include not being able to contact the parents to learn the cause of the absence or the student was absent without parent's knowledge. One study from the United Kingdom found 27% of studied students were truant without their parents' knowledge (Malcolm *et al*, 2003). Further studies are needed to determine underlying causes for high percentage of absences at the large study school.

Absence for personal reasons in our study was defined as an absence for a known reason other than sickness. Students may be absent from school for family reasons, which comprised 82% of the absences for personal reasons in our study with a duration of leave of 1 day. Absence for personal reasons was more common at small and medium sized than at the large school in our study. At smaller schools, the parent teacher relationship may be closer and an identifiable cause for the absence was more likely to be communicated from the parent to the teacher.

Absences due to sickness have been used as an indicator of disease outbreaks (Cheng *et al*, 2013; Lawpoolsri *et al*, 2014; Weng *et al*, 2015). Adding specific symptoms, such as rash, respiratory symptoms or gastrointestinal symptoms to the school absentee data can increase the sensitivity

of detecting a disease outbreak (Meynard *et al*, 2007; Shen *et al*, 2008). Generally, such information is not routinely collected. Regarding the presence or absence of fever should improve the sensitivity of disease outbreak monitoring using absenteeism data.

Previous studies found absence rates can be used to predict disease outbreaks (Besculides *et al*, 2005; Egger *et al*, 2012). In our study, only 11% of absences were due to illness. Therefore, in this study setting, the absence rate may not be a useful indicator for disease outbreaks. In our study, absence due to sickness and sick with fever (Fig 1) had similar patterns over time. Approximately 74% of our sick study subjects reported having fever. The proportions of sickness with fever did not vary by sex or grade. Only half of sick study subjects in our study at the large school reported a fever. This suggests the usefulness of using only absence due to sickness to predict outbreaks of infectious diseases may vary by school. However, using absence due to sickness as an indicator for disease outbreak detection may be more useful during the rainy season; approximately 81% of study subjects who were absence due to sickness during the rainy season had a fever. In Thailand, infectious diseases, such as dengue, influenza and pneumonia, are more common during the rainy season (BMA, 2013). Febrile illnesses usually require several days to improve. In our study, a larger proportion of 3-day absence was observed among those who were absent due to sickness with fever than those who were absent due to the other reasons. There were no disease outbreaks during the study period.

Information about fever among sick study subjects was obtained from the parent and may be prone to bias. The parents may have simply touched the child and

determined they had fever on this basis. This could cause over-reporting of fever, particularly those with a 1-day absence due to sickness.

This study was conducted in a sub-urban, industrialized part of Thailand. Absenteeism may vary by location. One study from rural Cambodia reported 90% of absences were due to illness (Cheng *et al*, 2013). Another study conducting in five Asian countries, including rural areas of Thailand (Ratchaburi and Kamphaeng-Phet Province), Indonesia, Malaysia, Philippines and Vietnam, reported 19.3% of absences were due to an acute febrile illness (Capeding *et al*, 2013).

Our study provides absenteeism data for primary school students in sub-urban industrialized Thailand; including a parental report of fever, which is not routinely collected. Absence due to sickness accounted for only 11% of total absences in our study. Therefore, absence due to sickness data rather than total absence data should be further studied for its benefits in disease surveillance in our study area. The majority of sick study subjects reported having a fever. Our findings suggest routine data collection regarding absence due to sickness may be potentially useful for disease surveillance, but it involves extra workload for data collection. No disease outbreaks occurred during the study period so the benefit of this data for disease outbreak surveillance is unclear and required further study.

#### ACKNOWLEDGEMENTS

We are grateful to the principals, teachers and students of the six study schools for their participation. We would like to thank staff of Lat Krabang District Office, Bangkok Metropolitan Administration for their support in implementing

the study. This study was supported by the Office of Higher Education Commission and Mahidol University under the National Research Universities Initiative.

#### REFERENCES

- Allensworth E, Easton JQ. The on-track indicator as a predictor of high school graduation. Chicago: Consortium on Chicago School Research June 2005: 1-26.
- Besculides M, Heffernan R, Mostashari F, Weiss D. Evaluation of school absenteeism data for early outbreak detection, New York City. *BMC Public Health* 2005; 5: 1-7.
- Bangkok Metropolitan Administration (BMA). Annual epidemiological surveillance report. Bangkok: Epidemiology Section, Communicable Disease Control Division, Department of Health, Bangkok Metropolitan Administration, Thailand, 2013. [Cited 2015 Jun 22]. Available from: <http://www.bmadcd.go.th/Website%20bmadcd/home/book56.html>
- Capeding MR, Chua MN, Hadinegoro SR, *et al*. Dengue and other common causes of acute febrile illness in Asia: an active surveillance study in children. *PLOS Negl Trop Dis* 2013; 7: e2331.
- Cheng CKY, Channarith H, Cowling BJ. Potential use of school absenteeism record for disease surveillance in developing countries, case study in rural Cambodia. *PLOS One* 2013; 8: e76859.
- Crawford GB, McKelvey S, Crooks J, Siska K, Russo K, Chan J. Influenza and school-based influenza-like illness surveillance: a pilot initiative in Maryland. *Public Health Rep* 2011; 126: 591-6.
- Egger JR, Hoen AG, Brownstein JS, *et al*. Usefulness of school absenteeism data for predicting influenza outbreaks, United States. *Emerg Infect Dis* 2012; 18: 1375-7.
- Kass-Hout TA, Buckeridge D, Brownstein J, *et al*. Self-reported fever and measured temperature in emergency department records

- used for syndromic surveillance. *J Am Med Inform Assoc* 2012; 19: 775-6.
- Kom Mogto CA, De Serres G, Douville Fradet M, *et al.* School absenteeism as an adjunct surveillance indicator: experience during the second wave of the 2009 H1N1 pandemic in Quebec, Canada. *PLOS One* 2012; 7: e34084.
- Lawpoolsri S, Khamsiriwatchara A, Liulark W, *et al.* Real-time monitoring of school absenteeism to enhance disease surveillance: a pilot study of a mobile electronic reporting system. *JMIR Mhealth Uhealth* 2014; 2: e22.
- Lea T, Yue Q, Kenneth K, Laura E. Arizona's near real time school-based syndromic surveillance program. *Adv Dis Surveill* 2007; 4: 19.
- Malcolm H, Wilson V, Davidson J, Kirk S. Absence from school: a study of its causes and effects in seven LEAs. London: Department of Education and Skills, 2003. [Cited 2015 Oct 10]. Available from: <http://dera.ioe.ac.uk/8655/1/RR424.pdf>
- Mann P, O'Connell E, Zhang G, Llau A, Rico E, Lequen FC. Alert system to detect possible school-based outbreaks of influenza-like illness. *Emerg Infect Dis* 2011; 262-4.
- Meynard JB, Ardillon V, Dussart P, *et al.* Implementation of a new syndromic surveillance system in April 2006 in French Guiana. *Adv Dis Surveill* 2007; 2: 159.
- Mook P, Joseph C, Gates P, Phin N. Pilot scheme for monitoring sickness absence in schools during the 2006/07 winter in England: can these data be used as a proxy for influenza activity? *Euro Surveill* 2007; 12: E11-2.
- Ohkusa Y. Empirical study on early detection of local health crisis management information and information sharing systems including government institutions. FY2009 Health Science and Labour research grant from the Ministry of Health, Labour and Welfare. Multidisciplinary research project report on health and safety crisis management measures. Tokyo: Ministry of Health, Labour and Welfare, 2010 (in Japanese).
- Omoe H. Syndromic surveillance\_toward the early detection of infectious disease epidemics. *Quart Rev* 2010; 37: 1-25. [Cited 2012 Jul 18]. Available from: <http://data.nistep.go.jp/dspace/bitstream/11035/2846/1/NISTEP-STT037E-9.pdf>
- Peterson D, Andrews JS Jr, Levy BS, Mitchel B. An effective school-based influenza surveillance system. *Public Health Rep* 1979; 94: 88-92.
- Sabchareon A, Sirivichayakul C, Limkittikul K, *et al.* Dengue infection in children in Ratchaburi, Thailand: a cohort study. I. Epidemiology of symptomatic acute dengue infection in children, 2006-2009. *PLOS Negl Trop Dis* 2012; 6: 1-8.
- Sasaki A, Hoen AG, Ozonoff A, *et al.* Evidence-based tool for triggering school closures during influenza outbreaks, Japan. *Emerg Infect Dis* 2009; 15: 1841-3.
- Schmidt WP, Pebody R, Mangtani P. School absence data for influenza surveillance: a pilot study in the United Kingdom. *Euro Surveill* 2010; 15. pii:19467.
- Shen S, Stone N, Hatch B, *et al.* Pilot evaluation of syndrome-specific school absenteeism data health surveillance. *Adv Dis Surveill* 2008; 5: 61.
- Short VL, Marriott CK, Ostroff S, Waller K. Description and evaluation of the 2009-2010 Pennsylvania Influenza Sentinel School Monitoring System. *Am J Public Health* 2011; 101: 2178-83.
- Wagner MM, Tsui F, Espino JU, *et al.* The emerging science of very early detection of disease outbreaks. *J Public Health Manag Pract* 2001; 7: 51-9.
- Weng TC, Chan TC, Lin HT, *et al.* Early detection for cases of enterovirus- and influenza-like illness through a newly established school-based syndromic surveillance system in Taipei, January 2010 - August 2011. *PLOS One* 2015; 10: e0122865.
- Zhao H, Joseph C, Phin N. Outbreaks of influenza and influenza-like illness in schools in England and Wales, 2005/06. *Euro Surveill* 2007; 12: E3-4.