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# Investigation of a large school-based outbreak of tuberculosis infection in Eastern China

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## ABSTRACT

**Background:** School-based tuberculosis (TB) happens frequently in Eastern China. This study aims to identify the risk factors of a school-based TB outbreak in Eastern China and actions that could be taken to prevent future similar school TB outbreaks. **Methods:** A retrospective cohort study was conducted to quantify the risk of developing TB, while a retrospective review was conducted to identify the contributing factors of the outbreak. **Results:** A total of 411 students were in the same school year as the index case; 25 students with TB were detected. The index case was a 19 year-old male student diagnosed with cavitary smear-positive TB 40 days after complaining of TB symptoms. Being in the same class as the index case resulted in a significantly higher risk of having active TB (OR = 35.2, 95% CI = 11.7–105.9). Contacts with the same sex as index case were at a 3.5-times higher risk of having TB than were female contacts. Participants with a Mantoux testing result  $\geq 10$  mm induration were at a 7.2-times higher risk of having TB than those with testing result  $< 10$  mm. **Conclusions:** TB contacts with the same sex as index case had a higher risk of having TB. Delayed diagnosis, lack of preventive treatment, and no follow-ups were the typical contributing factors of the outbreak. The capacity of the health authorities should be enhanced to guarantee a proper response to school-based TB outbreaks in Eastern China.

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## Introduction

Tuberculosis (TB) is a major cause of morbidity and mortality worldwide. China has the third largest number of TB cases in the world and is among the 22 countries with a high TB burden [1].

School-based transmission of *Mycobacterium tuberculosis* has been well documented, both in countries where the TB incidence is low [2–8] as well as in China [9, 10]. A TB outbreak in school is a major concern for children and parents and generates large volumes of work for health-care workers. In these situations, actions must be based on robust scientific evidence to ensure that the appropriate

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response is being followed. Several studies in western countries have evaluated the risk of developing TB in children from exposure to an open TB case [2, 11-13]. However, in China, which has a background of high TB incidence, the evidence base for the management of school-based TB outbreaks is small. The only evidence base for management of TB in schools is the National Guideline for School Tuberculosis Control and Prevention of China, which mostly refers to government documents; however, estimates regarding the risk of developing TB from a school contact in China are not provided [14].

Zhejiang is one of the smallest provincial-level political units of Eastern China, but it is also one of the most densely populated and affluent provinces. From 2008 to 2012, there were 12 school-based TB outbreaks reported to the Zhejiang Provincial Center for Disease Control and Prevention, almost all of which occurred in high schools or colleges. The incidence rate of TB in Zhejiang has declined from 93 per 100 000 persons in 2005 to 53 per 100 000 persons in 2014. However, the incidence of TB among students has remained around 20 per 100 000 students in recent years, with around 1500 TB cases reported in schools each year in Zhejiang [15]. This discrepancy suggests challenges to TB control in schools in China. In other countries, overcrowding, inadequate ventilation, sustained contact, and delay in diagnoses have been reported as contributing factors in school TB outbreaks [2, 3, 8]. However, there have been few reports from China describing factors contributing to school-based TB outbreaks.

This report describes a large scale TB outbreak in a private high school. There were two grades in this high school; each had 8 classes with an average of 50 students in each class; all students lived on campus. Through the investigation, we aimed to (1) identify the risk of developing TB from contacting with an active TB case in a poorly controlled school-based TB outbreak (2) identify the causes of the outbreak and actions that could be taken to prevent future similar school TB outbreaks in Zhejiang, China.

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## Materials and methods

### Case ascertainment

Cases diagnosed among students of the affected high school were investigated as part of this outbreak. Cases were diagnosed by a respiratory specialist according to the Chinese Guidelines for Tuberculosis Prevention and Treatment. Laboratory-confirmed cases of TB were defined as those with *M. tuberculosis* complex detected with sputum smear microscopy. Clinical cases were defined as those for which the *M. tuberculosis* complex could not be identified, but that were characterized by a radiologic, pathologic, or therapeutic response that was consistent with active TB.

When the index case was detected in first school year, 56 students in the same class as the index case were screened in 7 days. Sixteen months later, as the second and third TB cases were found to be in the same class as the index case, and as the classmates of the index case were scattered in different classes during the second school year, the

screening of the whole second school year batch was carried out immediately. Students were screened by using Mantoux testing. Hospital nurses skilled in administering and reading tuberculin skin tests participated in the screening. Students with a testing result  $\geq 10$  mm of induration were referred for further clinical assessment. All the subjects referred were assessed for TB infection based on clinical history, clinical examination, chest radiograph, and microscopic examination of sputum if coughing.

### Epidemiologic investigation

A group of four experts (two epidemiologists, one laboratory worker, and one clinician) was invited to assist local health authorities in investigation of the outbreak. This investigation group reviewed all the cases and the health service response to the outbreak. The group also interviewed contact screening and assessed the school's environment and infection control protocols. Contact information on birth data, history of BCG vaccination, and where did the students live was also collected. Students in the same class and same dormitory as the diagnosed TB case were considered TB contacts.

### Statistical analysis

Standard descriptive statistics were used to summarize the data. Univariate and multivariate analyses were performed to determine the characteristics of contacts that were associated with developing TB. A *P* value  $< 0.05$  was considered statistically significant. All analysis was carried out with SPSS version 18.

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## Results

### Identification of outbreak cases

The index case was a 19-year-old male student diagnosed with cavitary smear-positive TB 40 days after complaining of TB symptoms when he was in the first school year. After the second and third TB cases were diagnosed, and as the classmates of the index case were scattered in different classes during the second school year, screening of the whole second school year batch was carried out. Twenty-two students in the same school year were diagnosed with TB. Of the 24 cases, 5 were female, 19 were male and 13 (52.0%) were classmates of the index case during the first school year. Seven cases were found to attend the same class with these classmates of the index case (Fig. 1).

All patients were treated with anti-TB medicines for 6 months under directly observed therapy (DOT) according to the WHO guidelines and were instructed to remain isolated at home until 3 consecutive AFB-smear-negative sputa were obtained.

### Contact investigation

When the index case was detected in first school year, students in the same class as the index case were screened

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