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Investigation of a Countywide Outbreak of Paratyphoid Fever Associated with Consuming Cold and Raw Food

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Abstract

Paratyphoid fever is endemic in Yunnan Province, China. We investigated a countywide outbreak of paratyphoid fever in Yuanjiang County of the province in 2010. From January through October of the year, 469 cases were identified. *Salmonella* Paratyphi A was isolated from 370 (79%) cases. Three hundred eighty (80%) patients were adults aged between 20 to 49 years, 277 (60%) were farmers, and more than half of the cases occurred in the capital township of the county. A case-control study of culture-confirmed cases and controls matched with healthy family members was conducted to detect behavior risk factors. Consuming cold and raw food (matched odds ratio 5.5, 95% confidence interval 2.4-12.3) was associated with the infection. Poor sanitary system in both hospital and the city were observed during the environmental study, and 10 (8%) recovering patients and 2 (8%) healthy relatives of patients were identified as carriers. Improvement on sanitation, cooked food and access to safe water, and appropriate treatment for patients and carriers were suggested in outbreak control and prevention.

Key words: Paratyphi A, outbreak, case-control study, continual exposure, China

Introduction

Enteric fever is a clinical syndrome caused predominantly by human-restricted *Salmonella enterica* serovar Typhi (typhoid fever) and Paratyphi A (paratyphoid fever), and rarely by *Salmonella* Paratyphi B and C.¹ Globally, in the year of 2000, it was estimated that typhoid fever caused 21.6 million illnesses and 216,510 deaths while 5.4 million were sickened by paratyphoid fever.² Especially across East and South Asia, Paratyphi A is becoming increasingly common.³

In developing countries with low and middle income, enteric fever infection was linked with unsafe drinking water and food, and poor sanitation.^{3,4} However, in developed countries, outbreaks of enteric fever have become relatively rare⁵ and usually associated with travel to endemic regions.⁶

In China during 2010, the leading 3 provinces with highest number of enteric fever cases were Yunnan, Guangdong and Guangxi. In addition, around 34%

(4,860/14,041) of all the cases in China were in Yunnan Province.⁷

This study was based on the investigation of a paratyphoid fever outbreak occurred in Yuanjiang County, Yunnan Province, China during 2010. The reasons that are likely to be the cause of infection spread were discussed.

Methods

Descriptive Epidemiology

All cases of typhoid and paratyphoid fever recorded in a routine surveillance system in Yunnan Province were reviewed from 2005 through 2009. The number of cases in 2010 was compared to the median of last five years by month for outbreak confirmation.

A national standard diagnostic criteria⁸ was used as case definition in this outbreak investigation. A suspected case of paratyphoid fever was a patient who had fever for three days or more, body temperature more than or equal to 38°C, headache,

malaise and bellyache. A probable case of paratyphoid fever was a patient who had fever for five days or more, body temperature more than or equal to 39°C, headache, malaise, relative bradycardia, bellyache and skin rash, with low white blood cell count. A confirmed case of paratyphoid fever was a patient who was confirmed of *Salmonella* paratyphoid fever infection by using blood, bone marrow, urine, or stool culture, or Widal test.

An active case finding was conducted by local public health bureau in May 2010. All township health centers and village administration divisions were asked to search suspected cases for paratyphoid fever according to the above guideline in their own administrative regions. The results were reported to Yuanjiang County Center for Disease Control and Prevention (CDC) for verification. All suspected cases were asked to undergo blood culture test at county CDC for confirmation of infection.

The demographic data of all cases were collected and described in terms of time, place and person distribution through an epidemic curve, attack rate by region and frequency table to formulate etiological hypotheses.

Laboratory Test

Blood samples of current cases, stool samples of recovering cases and patients' relatives, and water samples from environment were collected. *Salmonella* Paratyphi A was isolated by culture of these samples.

Case-control Study

A case-control study was designed for detection of behavior risk factors. A case was defined as a patient confirmed by the above standard diagnosis in Yuanjiang County from August through November 2010. A control was a healthy person living together with a patient during one month before the patient's onset of symptoms. The ratio of case to control was 1:1. Investigation was conducted by face to face interview with a set of structured questionnaire, which included demographic characteristics, signs and symptoms of patients, personal behaviors concerning with drinking water and food, and also food items in daily meals during one month prior to patient's onset. Conditional logistic regression analysis was used to calculate matched odds ratio and 95% confidence interval using R statistical software.

Environmental Investigation

Environmental investigation was carried out at areas around the county hospital, vegetable fields around the hospital, restaurants and city sewage system. The waste water treatment was not implemented in the

county hospital. Specimens of sewage in the hospital were collected for laboratory test to look for fecal contamination. Although other specimens from the environmental survey were asked for laboratory test by the investigation team, these were not collected at that time due to limited local public health service.

Results

Area of Outbreak

Yuanjiang County is located in the central part of Yunnan Province, spanning approximately 2,858 square kilometer and with a population of 200,000. Around 80% of the total population is engaged in farming. Yuanjiang County has hot climate all year; it could be higher than 40°C in summer. The county is made up of the 14 township level administrative divisions as in figure 1. The capital of the county is located in Township A.

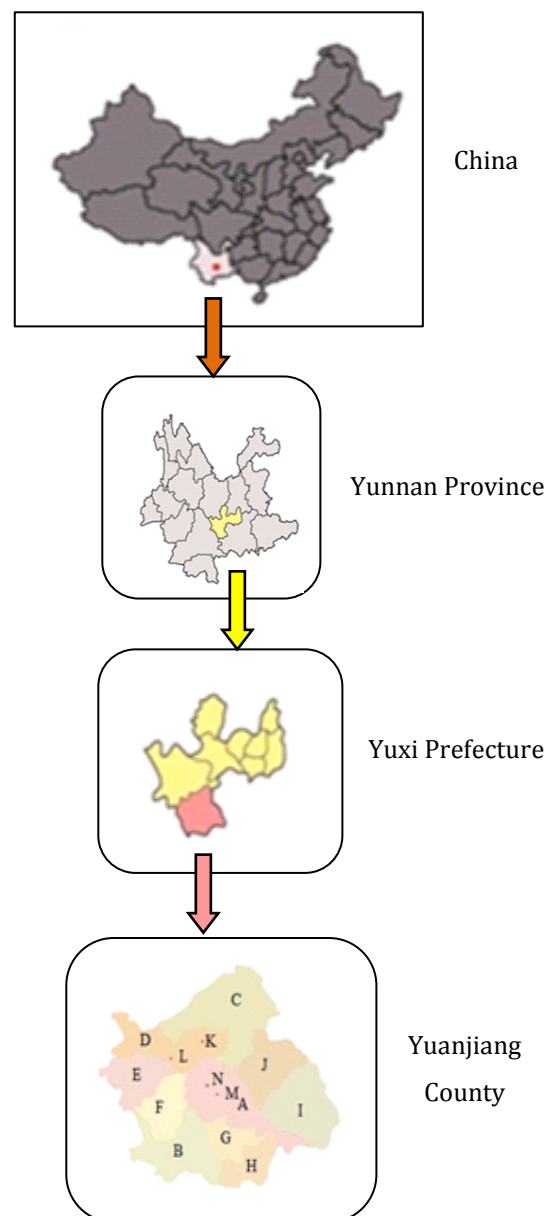


Figure 1. Geography of Yuanjiang County, Yunnan Province, China

Descriptive Epidemiology

From January through October 2010, 469 cases of paratyphoid fever who met the diagnosis categories were identified by health care institutions in Yuanjiang County. The outbreak was confirmed by comparing the cases in 2010 to the median of monthly surveillance data in last five years (2005-2009) (Figure 2). Of these 469 cases of paratyphoid fever, 370 were confirmed cases, 46 were probable cases and 53 were suspected cases.

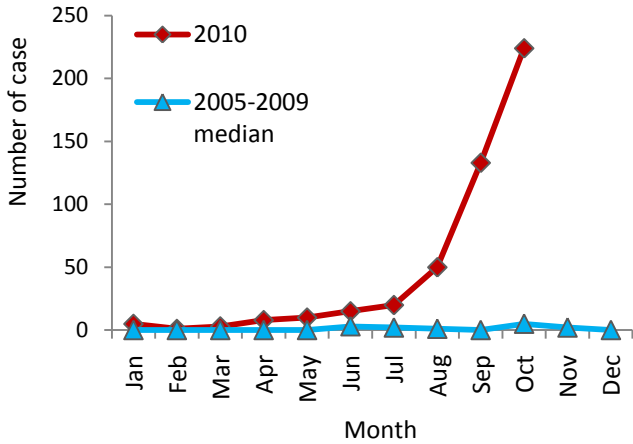


Figure 2. Number of typhoid and paratyphoid fever infection by month in Yuanjiang County, Yunnan Province, 2005-2010

The first case occurred on 8 Jan 2010 in Township A. Most paratyphoid fever patients were reported in August 2010. Over half of the cases were reported in September through October (Figure 3).

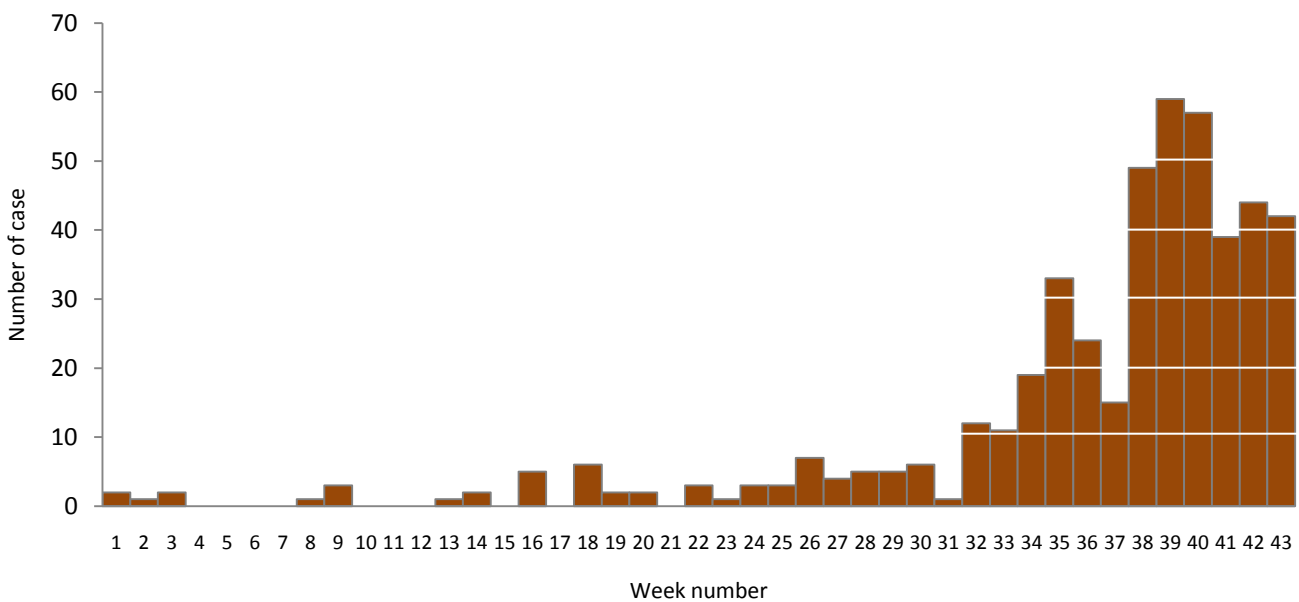


Figure 3. Number of paratyphoid fever cases by week, Yuanjiang County, Yunnan Province, China, January to October 2010 (n=469)

This outbreak spread out countywide. The cases were reported from all 14 townships; attack rates were showed in figure 4. Fifty five percent (259/469) of cases occurred in Township A, the capital of Yuanjiang County, with the highest attack rate of 0.6% (259/45,999). Cluster of cases were not identified by the local health care system.

Among 469 cases of paratyphoid fever, 207 were female, 262 were male and male to female ratio was 1.3:1. Around 80% (380/469) of cases were 20 to 49 years of age. Most of the cases (60%) were farmers, followed by workers, students and government officers. Attack rate by occupation was not calculated because the population of each occupation was not known.



Figure 4. Attack rate of paratyphoid fever by township in Yuanjiang County, Yunnan Province, China, January to October 2010

Table 1. Behavior factors associated with paratyphoid fever infection in Yuanjiang County, Yunnan Province, China, 2010 (n=155)

Behavior	Yes or No	Control (%)	Case (%)	Crude OR (95% CI)	Matched OR (95% CI)
Travel out of the county	No	144 (92.9)	138 (89.0)	1	1
	Yes	11 (7.1)	17 (11.0)	1.61 (0.7,3.6)	2.49 (0.6,10.3)
Contact with paratyphoid fever patients	No	153 (98.7)	150 (96.8)	1	1
	Yes	2 (1.3)	5 (3.2)	2.55 (0.5,13.4)	1.78 (0.2,18.4)
Drink un-boiled water	No	117 (75.5)	114 (73.5)	1	1
	Yes	38 (24.5)	41 (26.5)	1.11 (0.7,1.9)	1.16 (0.5,2.9)
Consume cold and raw food	No	80 (51.6)	46 (29.7)	1	1
	Yes	75 (48.4)	109 (70.3)	2.53 (1.6,4.0)	5.47 (2.4,12.3)

Note: conditional logistic regression adjusted by all variables

Analytic Epidemiology

Information on travel out of the county, contact with paratyphoid fever patients, drinking un-boiled water and consuming cold and raw food was collected from 155 cases and 155 matched controls. We found that consuming cold and raw food was a risk factor (matched OR 5.5; 95% CI 2.4-12.3) for paratyphoid fever infection (Table 1).

Environmental Investigation

Isolation of patients faced a heavy challenge. Yuanjiang County hospital was located in Township A, which was the biggest hospital in the county with 120 beds. Although isolation for paratyphoid fever patients was suggested to all health institutions in China, the current cases were observed by the investigation team to understand the patient management in the hospital. On 8 Nov 2010, records in the county hospital showed that only seven out of 77 current patients stayed in hospital for injection treatment. Patients returned to home soon after illness relieved even though they were asked to stay in hospital for isolation.

Sewage of the county hospital was discarded without any treatment. Patients who had communicable diseases were treated at a separate building in the hospital. A public toilet of the building was used specifically by these patients. However, sewage from clinical treatment and feces of infected patients were mixed with other sewage of the hospital, and discharged out of the hospital directly without any disinfection. *Salmonella* Paratyphi A strain was isolated from waste water at a sump of the hospital by the local CDC on 28 Oct 2010.

A wide area of vegetable fields was polluted by hospital waste water. There were 175 acres of vegetable fields at one side of the hospital. The foul water of the hospital overflow across the fields and finally run into the Yuanjiang River. As such, farmers irrigated the fields and washed the vegetables with the hospital sewage prior to being commercially distributed.

The vegetables in the fields were often locally consumed. Coriander, peppermint, green onion and cordate houttuynia were planted in these fields. All of the vegetables were sold in a market of the county. The most typical food preparation was uncooked and cold food dressed with sauce.

Vegetables were eaten raw in local food habits. The investigation team visited some local restaurants where cold and uncooked food was served. This kind of menu was popular among local residents. People like to eat it not only at their own homes, but also at restaurants. Most vegetables were bought from the local market or the vegetable fields directly.

There was no sewage treatment system in the county either. The sewage of the city was discharged into sewers, which then flew into the Yuanjiang River. As some part of city sewers did not have any covers, people poured their home refuse into the open sewers.

Carrier Investigation

Carriers of paratyphoid fever infection were also detected. Stools of 124 recovering patients and 25 healthy relatives of paratyphoid fever patients were collected and tested for *Salmonella* Paratyphi A infection. Of these, 10 recovering patients (8%) and 2 healthy relatives of patients (8%) showed positive result.

Discussion

The findings of this study verified the existence of a paratyphoid fever outbreak in Yuanjiang County. The possible risk factor of the infection was identified as consuming cold and raw food. Loose management of the patients and infected sewage treatment was found in this investigation.

Since isolation was not strictly implemented, the outbreak was propagated. In recent years, Paratyphi A appears to be responsible for a growing proportion of enteric fever in a number of Asian countries.³ The majority of infection result from consuming food or water contaminated by feces of patients or carriers.⁹ In this outbreak, patients went back home soon after convalescence as Paratyphi A seems to be less severe compared to Typhi.¹⁰ Patients did not abide by the isolation requirement. Therefore, the pathogen was thrived with the patients' activities and behavior plus the unhygienic conditions. In the second phase, positive carrier was identified as another important reason for continuation of this outbreak. About 2-5% of persons infected in middle age could become chronic carriers.⁹ Quite high carrier rate, 8% in both recovering patients and healthy relatives of patients, was reported in this outbreak which also indicated inadequate antibiotic treatment and disease containment measures. In the United States, the majority of the foodborne outbreaks are caused by asymptomatic chronic carriers employed as food handlers. Treatment of carriers is also critical to prevent further spread.⁵

This outbreak reflects that consuming of contaminated food is an important transmission route. Generally, the most common modes of enteric fever transmission are through fecal contaminated water or food and person to person transmission.⁹ Family cluster of cases was rarely found in this kind of outbreak. A recent study indicated that typhoid and paratyphoid fever are associated with distinct routes of transmission. Factors in the household were important risk factors for typhoid whereas factors outside the household such as food from street vendors and flooding were major risk factors for paratyphoid fever.¹¹ In recent years, surveillance data of Yunnan Province shows that enteric fever maintains a steady decline, particularly relative to typhoid fever. Furthermore, waterborne outbreaks of enteric fever have become relatively rare. However, paratyphoid fever shows an increasing trend as the incidence of enteric fever remains at a high level in some areas of Yunnan Province. In the neighboring Guangxi province, since Vi polysaccharide typhoid fever vaccine was introduced, more than 80% of

enteric fever outbreaks have been caused by *Salmonella* Paratyphi A.¹² However, there is no licensed vaccine against Paratyphi currently available.¹³ The transmission mode of this outbreak may indicate some current hindrances to control of paratyphoid fever in Yunnan Province.

Poor sanitation maximized exposure risks. Extending benefits of improved sanitation and availability of safe water and food to the public have been achieved in industrialized countries a century ago.³ Historical surveillance data suggest that enteric fever was endemic in Western Europe, North America and Latin American, and the rates declined in parallel with introduction of municipal water treatment, pasteurization of dairy products and exclusion of human feces from food production.^{2,3} In countries with poor resources, lack of sanitation and clean water is still a cause of contamination for long periods of time.¹⁴ In this outbreak, domestic waste water from the hospital and the whole county were untreated, and directly discharged into the vegetable fields and the river respectively. The feco-oral transmission was substantially reflected in this event. As humans are the only reservoir of this pathogen, preventive measures include improvement of water supply and sanitation facilities.

There were a few limitations in this study. Direct evidence of causative bacteria of *Salmonella* Paratyphi A in vegetables and food could not be identified. Microbiological testing of drinking water supply system was not done. These may provide more evidences for outbreak control.

Conclusion

Paratyphi A as a cause of enteric fever is of great concern, particularly due to lack of availability of an effective vaccine. Public health prevention measures include purification of water supplies, sewage control, treatment of chronic carriers, and sanitary and hygiene education especially to food handlers.

Acknowledgement

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Suggested Citation

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Hand Washing as a Preventive Factor for a Chickenpox Outbreak in a Rural School, Yunnan Province, China

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Abstract

In China, usage of varicella vaccine is limited due to cost even though varicella outbreaks are common among children. On 8 Dec 2006, a varicella outbreak occurred among school children in a remote area of Yunnan Province. In this area, median annual income was less than 200 USD. We conducted an investigation to define risk factors and determine affordable control measures. A retrospective cohort study was conducted. Cases were identified through school health records and active case finding. Data on demographics, symptoms, behavior, vaccination status and previous varicella infection were obtained by questionnaire. Chickenpox cases were defined as students with generalized, vesicular pruritic rash lasting 3 or more days from 1 Sep to 14 Dec 2006. Of 604 students, 564 (93%) participated in this study. None had received chickenpox vaccination. 145 (26%) had history of past infection. Attack rates were 56% (236/419) among students without prior infection. Attack rates were higher in younger age groups (80% in 5-7 years, 75% in 8-10 years) than in the older age groups (32% in 11-13 years, 19% in 14-17 years). In multivariate analysis, close contacts with cases (Adjusted OR 2.5, 95% CI 1.6-4.0) and touching chickenpox lesions (Adjusted OR 17.8, 95% CI 4.0-78.3) were risk factors. Hand washing (Adjusted OR 0.4, 95% CI 0.2-0.7) was protective. Hand washing was promoted as an affordable control measure in this setting. Health education was implemented, emphasizing avoidance of contact with cases, especially touching lesions.

Key words: chickenpox, varicella, hand washing, China

Introduction

Chickenpox, which is also called varicella, is an acute viral infectious disease. It is caused by Varicella Zoster Virus (VZV). The disease is characterized by itchiness and skin rash with fluid-filled blisters that burst and form crusts. Onset of chickenpox rash may be preceded by fever and general malaise. The rash begins with a few small reddish bumps (papules) that are quickly filled with fluid to form small blisters (vesicles). The vesicles appear in "crops", small groupings, first on the trunk and then spread to the extremities, face and scalp over a period of two to four days.¹ It is relatively easy to diagnose as the smallpox was already eradicated.

The average incubation period is 14 days, with a range from 10 to 21 days. It is infectious 48 hours prior to onset of vesicular rash until all vesicles are crusted and the vesicles generally last four to five days. There is universal susceptibility in those whom are not vaccinated or previously infected.

Furthermore, it is highly contagious and Secondary Attack Rate (SAR) can be 85%.¹ Close contact, crowding condition, lack of hand washing facility can increase the spread. Isolation of chickenpox cases has a limited role in outbreak prevention.^{2,3} Once after infected, lifelong immunity against recurrent infection is usually present.¹

Varicella infection is not a notifiable disease in China and the varicella vaccine is not included in the current Expanded Program on Immunization (EPI) due to high cost and unknown length of infection.³ According to the Department of Price from National Development and Reform Commission in China, the price of varicella vaccine was about 23 USD in 2006. Thus, usage of varicella vaccine is limited in China, especially in underdeveloped areas. Varicella outbreaks are common among Chinese children. 864 outbreaks were reported in China during 2006 and 98% of them occurred in schools. On 8 Dec 2006, a varicella outbreak in a rural school from a remote

area of Yunnan Province was reported. In this area, median annual income was less than 200 USD. As 90% of Yunnan Province is mountainous and overall development in Yunnan was still low, the conditions in this setting were by no mean rare. Therefore, we conducted an investigation to define risk factors and to determine and implement the practical and affordable control measures.

Methods

Descriptive Study

A descriptive study was carried out among students of grade 1-9 in the rural school, Yunnan Province, China. Cases were students with generalized, vesicular pruritic rash lasting three or more days from 1 Aug to 14 Dec 2006.

Primary case was defined as the first case in a classroom or dormitory. The SAR was calculated by the formula below.

$$\frac{\text{Number of chickenpox cases in the second generation (21-42 days after the primary case in each classroom or dormitory)}}{\text{Number of total students in classroom or dormitory (exclude first generation cases and students with varicella history)}} \times 100$$

A standardized questionnaire was developed to obtain information on demographic data, symptoms, behavior, vaccination history and chickenpox history. Classrooms, dormitories, cafeteria and toilets were assessed for sanitation, ventilation and crowding condition. Cases were identified through school health records and active case finding was conducted through a school teacher. Self-administered questionnaires were used to collect information from students in grades 5-9 while students in preschool and grade 1-4 were interviewed face to face by using questionnaires. Students who lived in the dormitory were defined as boarding students and the rests were non-boarding students. Varicella vaccination history was confirmed by acquiring information from teachers and local health workers. As chickenpox cases have typical and pathognomonic signs to be diagnosed by physicians, laboratory study was not performed in this investigation.

Retrospective Cohort Study

Retrospective cohort study was conducted to define the differences of having potential risk factors between ill and non-ill students. Ill students were students with generalized, vesicular pruritic rash

lasting three or more days in the rural school from 1 Aug to 14 Dec 2006 in order to trace back twice of the longest incubation period before onset of the first case. Non-ill students were those did not have generalized, vesicular pruritic rash lasting three or more days in the same school of the ill students during the same period. Univariate analyses comparing data of ill students with non-ill students on demographic, environmental, behavioral and care giving activities were calculated by chi-square test. Relative Risk (RR), Attributable Risk Fraction (ARF) and Population Attributable Risk Fraction (PARF) were calculated as well. Logistic regression models using the Stata program were employed to calculate RR and 95% CI. To control confounding factors and determine the important exposures, a multivariable model was created with significant P-value in univariate analysis (≤ 0.05), potential confounders and interaction terms. A backward elimination procedure was used to identify significant interaction terms and exposures that were the most strongly associated with incidence of chickenpox infection.

Results

There were 604 students, 16 classes and 10 dormitories in the affected rural school. Total 564 students (93.4%) participated in this study. Of which, none of them had received varicella vaccination before and 145 (25.7%) had history of past infection. There were 236 students met the case definition. The overall attack rate was 56% (236/419) among students without prior infection (Figure 1).

Symptoms included fever (55.8%), headache (48.0%) and sore throat (43.8%) (Figure 2). The mean age of the cases was 8.8 years, with SD 2.5 years. Attack rates were higher in younger age groups (80.2% in 5-7 years, 75.0% in 8-10 years) than in older groups (31.9% in 11-13 years, 18.6% in 14-17 years) (Figure 3). However, the attack rates were almost the same among boarding (56.3%) and non-boarding students (56.7%). Sex specific attack rates were 53.0% among males and 60.6% among females.

To understand transmission of the outbreak better, the cases identified during early stage of the outbreak were plotted by class and dormitory. Before 26 Oct, although most cases were from two classrooms, these cases were living in five different dormitories (Figure 4, 5, 6). SARs among students in each classroom and dormitory were calculated and the results did not show any marked difference (Table 1, 2).

In univariate analysis, close contact with cases (RR 1.6, 95% CI 1.3-2.0), touching chickenpox lesions (RR

1.8, 95% CI 1.6-2.0) and sharing towel with others (RR 1.3, 95% CI 1.0-1.6) were revealed to be risk factors. Hand washing (RR 0.7, 95% CI 0.6-0.8) was resulted to be protective. On the contrary, sharing

towel with others and touching chickenpox lesions had a low PARF of 0.03 and 0.09 respectively, comparing with close contact (0.27) and hand washing (-0.29).

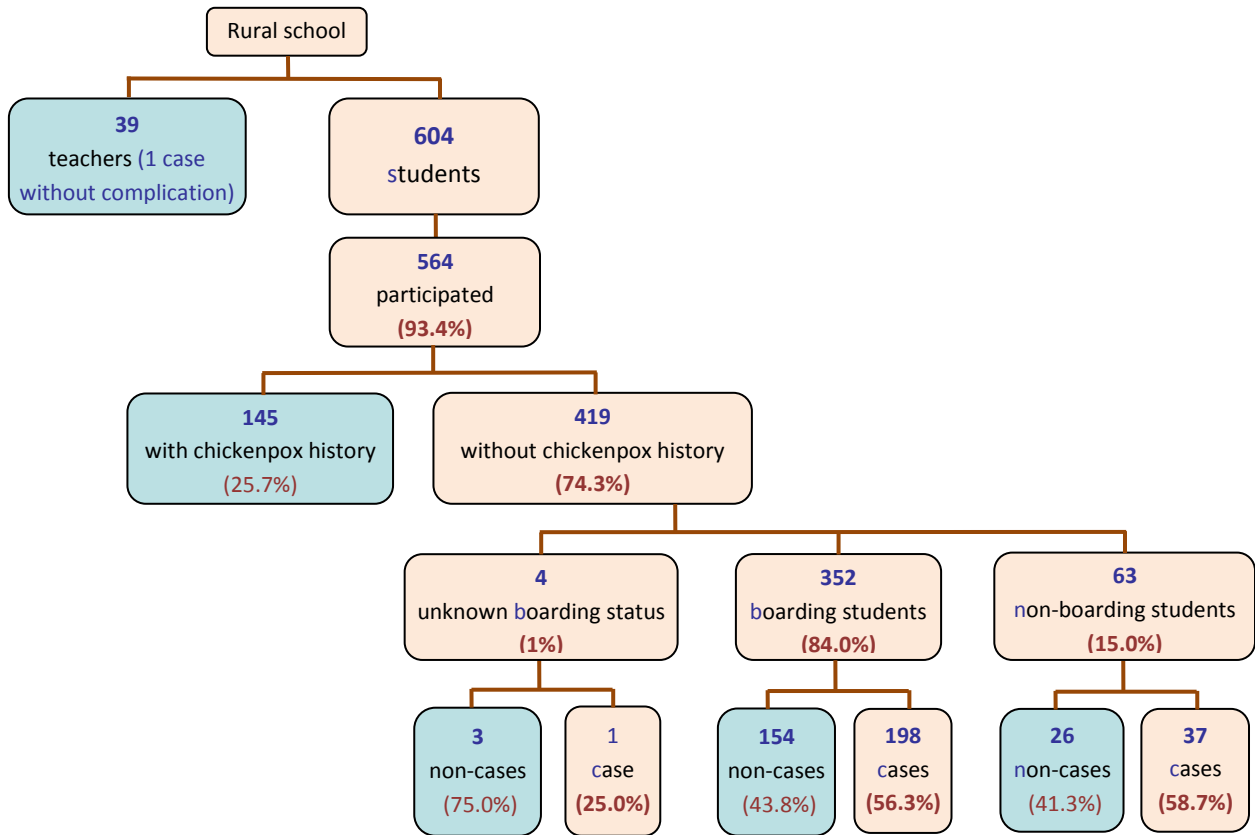


Figure 1. Number of cases and attack rates of varicella infection among students in the rural school, Yunnan Province, China, 2006

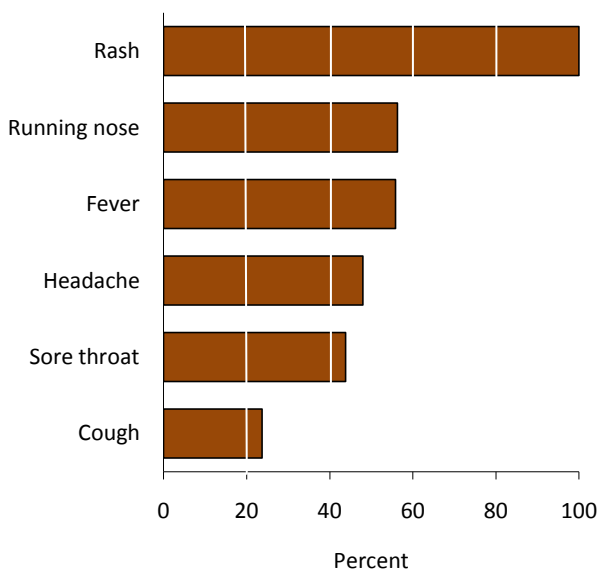


Figure 2. Clinical manifestations of varicella cases in the rural school, Yunnan Province, China, 2006 (n=563)

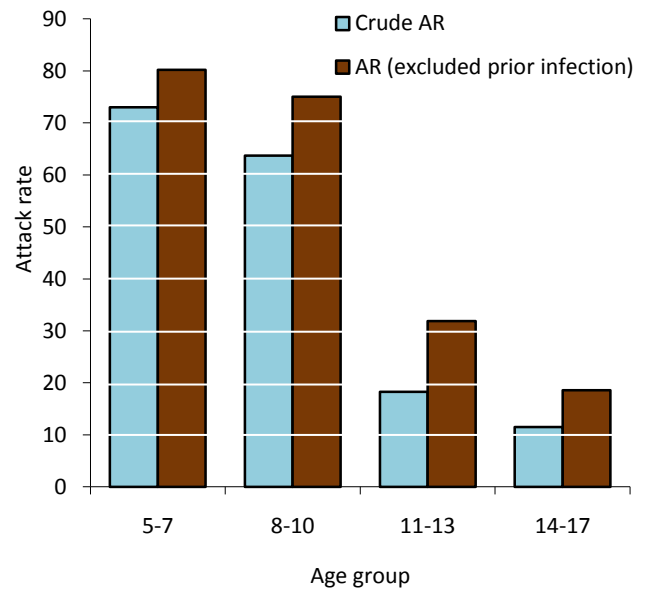


Figure 3. Attack rate by age group of varicella cases in the rural school, Yunnan Province, China, 2006 (n=563)

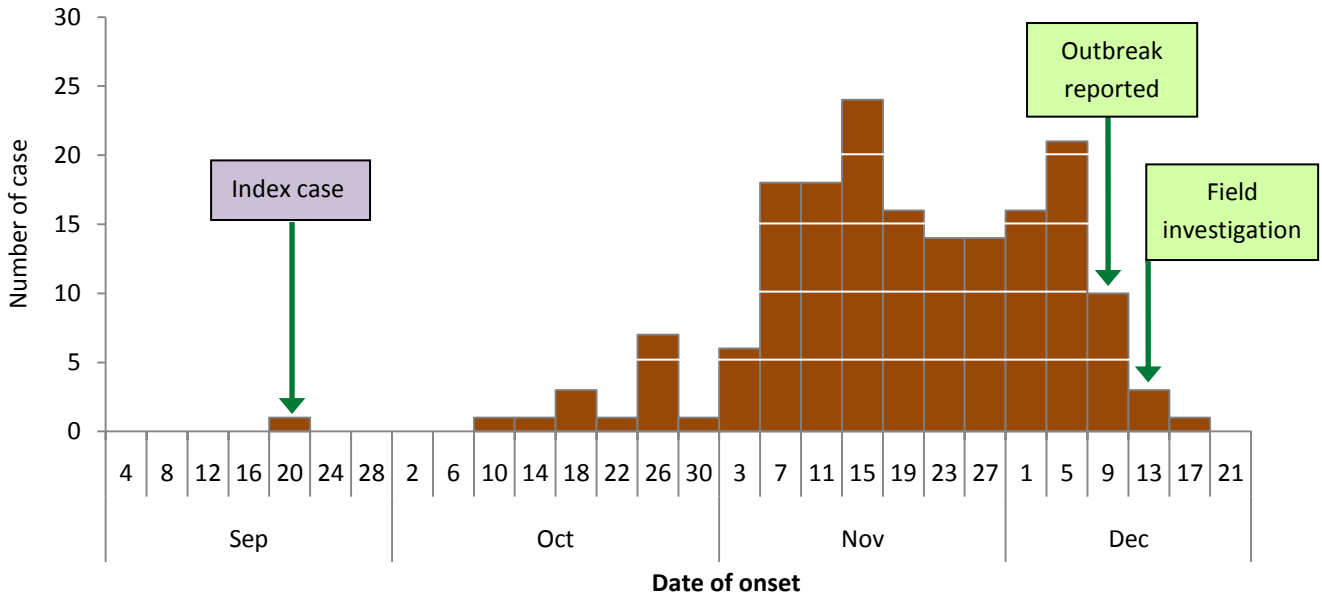


Figure 4. Number of varicella cases by date of onset in the rural school, Yunnan Province, China, 2006 (n=176)

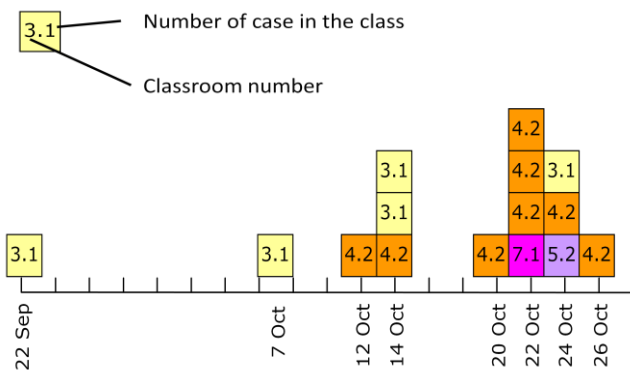


Figure 5. Distribution of varicella cases in the early stage by date of onset and classroom in the rural school, Yunnan Province, 22 Sep-26 Oct, 2006 (n=15)

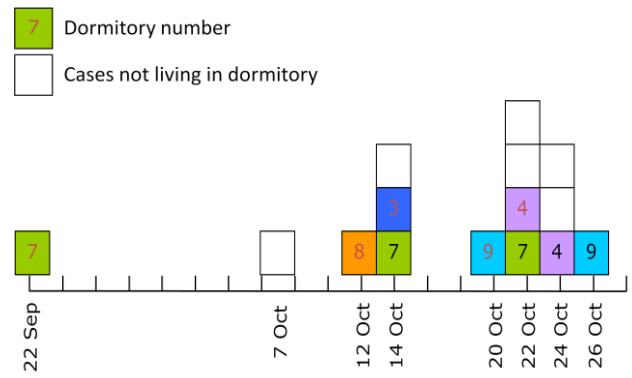


Figure 6. Distribution of varicella cases in early stage by date of onset and dormitory in the rural school, Yunnan Province, 22 Sep-26 Oct, 2006 (n=15)

Table 1. Number of varicella cases and attack rates by dormitory in the rural school, Yunnan Province, China, 2006

Dormitory	Number of case	Students without chickenpox history in dormitory			Secondary attack rate (%)
		Number (total number in dormitory)	Mean age (SD)	AR (%)	
1	4	16 (28)	14.6 (2.7)	25.0	20.0
2	4	5 (10)	9.6 (2.5)	80.0	33.3
3	7	13 (15)	11.1 (1.7)	53.9	8.3
4	10	18 (18)	10.9 (1.9)	55.6	35.7
5	20	38 (52)	10.4 (3.6)	52.6	11.1
6	17	30 (54)	11.2 (2.9)	56.7	29.2
7	20	27 (39)	8.7 (1.8)	74.1	44.0
8	10	21 (28)	9.3 (2.1)	47.6	35.0
9	20	35 (42)	10.8 (1.7)	57.1	21.9
10	10	37 (46)	11.7 (2.4)	27.0	9.1
Total	122	240 (332)	10.1 (3.0)	50.8	23.4

Table 2. Number of varicella cases and attack rates by class in the rural school, Yunnan Province, China, 2006

Grade	Class	Number of case	Students without chickenpox history in the class			Secondary attack rate (%)
			Number (total number in dormitory)	Mean age (SD)	AR (%)	
Pre-school		28	33 (33)	5.7 (0.5)	84.8	13.3
1	1	21	29 (31)	6.8 (0.8)	72.4	7.1
	2	23	29 (31)	6.1 (0.9)	79.3	/
2	1	27	34 (34)	8.4 (1.1)	79.4	10.5
3	1	27	29 (34)	9.0 (0.6)	93.1	34.6
	2	24	30 (36)	9.2 (0.9)	80.0	22.2
4	1	21	34 (36)	10.0 (0.9)	61.8	20.0
	2	18	26 (34)	9.8 (0.8)	69.2	/
5	1	10	21 (30)	11.0 (0.8)	47.6	31.3
	2	10	22 (32)	10.5 (0.5)	45.5	25.0
6	1	1	10 (20)	12.3 (0.5)	10.0	/
	2	3	14 (28)	11.6 (0.9)	21.4	/
7	1	7	27 (40)	12.9 (0.8)	25.9	9.1
	2	4	20 (40)	12.8 (1.0)	20.0	/
8	1	8	32 (54)	13.9 (1.0)	25.0	17.2
9	1	4	29 (51)	15.9 (0.9)	13.8	7.1
Total		236	419 (564)	10.1 (3.0)	56.3	13.1

Table 3. Univariate analysis of risk and preventive factors for varicella infection in the rural school, Yunnan Province, China, 2006

Factor	Expose		Non-expose		RR (95%CI)	Attributable risk fraction	Population attributable risk fraction
	Ill	Non-ill	Ill	Non-ill			
Hand washing	162	154	72	27	0.7 (0.6, 0.8)	-0.42	-0.29
Close contact	166	87	60	86	1.6 (1.3, 2.0)	0.37	0.27
Age less than 10 years	152	35	82	143	2.3(1.9, 2.7)	0.55	0.35
Sharing towel	30	13	202	163	1.3 (1.0, 1.6)	0.21	0.03
Touching chickenpox lesions	44	4	178	169	1.8 (1.6, 2.0)	0.44	0.09
Sharing clothes	12	5	218	164	1.2 (0.9, 1.7)	0.19	0.01
Sharing nail clipper	15	20	218	152	0.7 (0.5, 1.1)	-0.37	-0.02
Boarding	196	148	37	26	1.0 (0.8, 1.3)	-0.03	-0.03

Table 4. Comparison on risk and preventive factors of varicella infection by age group in the rural school, Yunnan Province, China, 2006

Factors	Number (%)		P-value
	< 10 years	≥ 10 years	
Close contact	134 (74.9)	118 (53.9)	<0.001
Hand washing	126 (68.1)	190 (83.0)	<0.001
Sharing clothes	6 (3.3)	11 (5.1)	0.37
Sharing nail clipper	9 (4.8)	26 (11.9)	0.01
Sharing towel	18 (9.7)	24 (10.8)	0.72
Touching chickenpox lesions	17 (9.7)	31 (14.2)	0.17
Boarding	150 (80.6)	193 (87.7)	0.05
Total	187	231	

It was found that the younger age group (<10 years) had higher risk than the older age group (RR 2.3, 95% CI 1.9-2.7) (Table 3). We compared risk and preventive factors among age groups. We found that the younger age group had more close contact with patients and less practice of hand washing (Table 4).

Table 5. Multivariate analysis of risk and preventive factors of varicella infection in the rural school, Yunnan Province, China, 2006

Risk Factors	Adjusted odds ratio	95% CI	
		Low	High
Close contact	2.5	1.6	4.0
Touching chickenpox lesion	17.8	4.0	78.3
Gender	0.6	0.4	1.0
Sharing towel	0.8	0.3	2.1
Hand washing	0.4	0.2	0.7

Multivariate analysis was done by using logistic regression. After we introduced convertible factors into multivariate analysis model, close contact with cases (Adjusted OR 2.5, 95% CI 1.6-4.0) and touching chickenpox lesions (Adjusted OR 17.8, 95% CI 4.0-78.3) remained as risk factors. Hand washing (Adjusted OR 0.4, 95% CI 0.2-0.7) was still a protective factor (Table 5).

Discussion

Chickenpox is not a notifiable disease in China and abnormal increase of cases cannot be detected by the case-based system of the web-based general infectious diseases surveillance system. Moreover, it is a self-limited disease and not commonly fatal. Therefore, awareness of teachers and village health providers in this chickenpox outbreak was quite low. Consequently, it was one of the reasons for delayed report and investigation. However, a chickenpox outbreak can be detected as an event and needs a rapid response once it occurs. Chickenpox outbreak in a school is defined as 10 or more cases, or one fatality of chickenpox infection occurred in a school within seven days.⁴

Chickenpox is a disease with less questionable on diagnosis as it can be diagnosed by clinical manifestations. Therefore, laboratory investigation may not be necessary in order to identify the cause of outbreak and confirm the cases. No severe case was found in this investigation probably due to no immunocompromised person in this school such as infants and elderly. Acyclovir should be administrated to both immunocompromised patients as treatment of choice and susceptible host with compromised immune system to prevent progression of the disease.⁵ Another reason was likely that unnecessary supportive treatment was not provided as in developed countries. In United States, three children died from chickenpox infection during 1997.⁶ When the children had high temperature and were admitted to hospital in developed countries, multiple drugs were given such as antibiotics, analgesics, antipyretics, steroids and antiviral medicines. Their condition could even deteriorate by doing so as intensive allopathic therapy could increase risk of developing complications. In this outbreak area, there was limited health facilities and also limited transportation.

Attack rates between boarding students and non-boarding students were similar. SAR by classroom and dormitory did not show any significant difference. Students who reported to have close contact with cases in both classroom and dormitory were observed by investigators in order to make sure the contact

among them. We could imply that transmission had occurred in both classrooms and dormitories. At the early stage of the outbreak, cases were mainly from two classes who were living in five different dormitories. All classrooms and dormitories were already affected at the time of investigation. These facts suggested that living together with infected cases in the same room could facilitate spreading of the disease.

Information bias including recall and misclassification bias might occur for the information about prior infection and preventive and risk behaviors. Even though students from grade 5-9 could misunderstand some questions in the questionnaire, we did not have any opportunity to take sample and recheck those self-reported questionnaires with parents and teachers.

Varicella vaccination had a low coverage in China, even in developed areas. Vaccine coverage was only 23% among children aged less than six years in Shanghai during 2002.⁷ It was not surprising that the affected population in this outbreak had zero coverage as the vaccine was expensive for these students and there was no support from the EPI program. Moreover, varicella vaccine might not be highly effective. Several studies reported that effectiveness of the vaccine against the infection was 72-86%⁸⁻¹⁰ and even a study reported to be only 44%.¹¹ In addition, studies in the United States showed that even 80-97% vaccine coverage still could not prevent outbreaks in schools or day care centers.^{8,10} Limited duration of protection also compromises its use for prevention of future outbreak as a study showed that its effectiveness reduced 6.7 times after five years of injection.⁸

Results of the analytic study showed that hand washing was a protective factor while close contact and touching chickenpox lesions were risk factors. Mixed living condition and behavior of young students implied that close contact among students were common. Chickenpox cases can transmit the infection even two days before skin lesions appear. Just avoiding close contact with patients could not assure the prevention. Isolation of cases was not considered as a control measure as its effectiveness was reported to be limited on outbreak control by More et al,³ and also it was difficult to implement in this setting since majority of students were living in crowded dormitories. Family isolation of chicken pox patients is recommended by some health authorities, and avoiding exposing susceptible persons especially immunocompromised host to patients was emphasized.¹² However, it is not considered as a

measure of choice in this outbreak as students' families were far from the school and there was no convenient method to contact patients' guardians and deliver necessary health education. Hand washing was more important than touching lesions as its PARF (-0.29) was greater than that of touching lesions (0.09). Since hand washing requires almost no extra resources, hand washing is a feasible and economical method to implement in schools from rural areas. Although this investigation was conducted almost near the end of school term, attack rate could be as high as more than 90% among susceptible individuals as it is highly contagious.¹ We could attribute the rapid subsidence of the outbreak to our effective control measures.

Conclusion and Recommendations

This outbreak occurred in a remote rural school where the chickenpox vaccine had zero coverage due to its cost. The outbreak report was delayed since chickenpox is not a notifiable disease, and awareness among teachers and local health care providers was rather low. Education and training was needed for teachers and health care providers in this area to raise the awareness on infectious diseases. The transmission occurred in both classrooms and dormitories. Close contact were common among young students who shared the rooms with students from other classes. Given the fact that hand washing had a higher PARF and almost no cost to implement, it was promoted as a primary control measure in this outbreak. Health education on avoidance of close contact with cases, especially touching chickenpox lesions was also implemented. The effectiveness of the control measures was proved by rapid subsidence of the outbreak. Therefore, we recommend that hand washing is an effective and affordable control measures for this setting.

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An Outbreak of *Brucella melitensis* among Goat Farmers in Thailand, December 2009

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Abstract

Goat farming has increased substantially in Thailand as a result of government's agricultural policies in the past. On 19 Oct 2009, the Thailand Bureau of Epidemiology received a notification of a confirmed and fatal case of brucellosis in a goat farmer. An investigation was launched to identify the magnitude and risk factors of the disease. A cross-sectional study among persons in contact with goats from the same marketing chain as the fatal case was performed. Sera samples of goats from three farms associated with the fatal case were collected. The fatal case was a 79-year-old male with hypertension, gout and renal calculi. He had been raising goats since 2007 until onset of the symptoms, without any protective equipment. He developed peritonitis and acute renal failure in June 2009, and eventually died from respiratory failure on 9 Sep 2009. Hemoculture of his specimen revealed positive for *Brucella melitensis* a month after his death. Three additional cases of human brucellosis were identified from 38 contacts (AR = 10.3%) and one goat tested positive for *Brucella*. Most of the patients experienced myalgia and arthralgia. The study showed that all cases had history of unprotected exposure to goat carcasses or meat (PR undefined, P-value = 0.006). This outbreak of brucellosis among goat farmers emphasizes the importance of health education for goat farmers and the prompt sharing of data between human and animal health professionals.

Key words: brucellosis, goat farming, risk factors, animal and human health

Background

Brucellosis is an infectious disease caused by small, Gram-negative, non-motile, non-spore-forming rod-shaped bacteria in the genus *Brucella*. There are many species of *Brucella*, a facultative intracellular parasite capable of causing chronic disease. In humans, brucellosis can be caused by *B. abortus*, *B. melitensis*, *B. suis*, and rarely by *B. canis* or marine mammal *Brucella*.¹ The incubation period of brucellosis is variable in humans, with most infections become apparent within two to three weeks after transmission.² The shortest incubation period is five days, and the longest is three months or longer. For animals, the incubation period varies by species and stage of gestation.¹ In humans, the clinical picture of brucellosis is intermittent or irregular fever of variable duration, headache, weakness, profuse sweating, chills, arthralgia, depression, weight loss or

generalized aching.³ In animals, this disease mainly causes abortion, stillbirth, orchitis, epididymitis, testicular abscess, or birth of weak offspring.¹ For a confirmed diagnosis, as there are no specific signs and symptoms, laboratory test must be used.² Mode of transmission usually occurs through direct or indirect contact with infected animals and their secretions, tissues, blood, urine, vaginal discharges, aborted fetuses and especially placentas. In addition, ingestion of raw milk and dairy products such as unpasteurized cheese from infected animals can cause the infection too. Airborne infection can also occur among animals in pens and stables, and persons working in laboratories and abattoirs.³ Untreated brucellosis carries a mortality rate of less than 2-5%, usually from endocarditis, meningitis or encephalitis.²

On 19 Oct 2009, the Bureau of Epidemiology (BOE) in Ministry of Public Health, Thailand was notified from

the National Institute of Animal Health (NIAH) about one confirmed case of human *Brucella melitensis* infection. Further verification revealed that the patient was 79 years old and lived in Village 2, Thakham Sub-district, Chondan District, Phetchabun Province. He had a history of contact with goats and died on 9 Sep 2009. The teams from BOE, Office of Disease Prevention and Control 9, Phetchabun Provincial Health Office, Chondan Hospital and District Health Office collaborated and investigated on 3-6 Nov 2009, with the objectives of verifying the cause of death, determining the extent of disease spread, identifying risk factors and initiating control and prevention measures.

Method

Descriptive Study

We conducted a descriptive study by reviewing the status of human and animal brucellosis in Thailand. For the human situation, we used reports from the BOE's database and for the animal situation, we reviewed data from the passive surveillance of NIAH and active surveillance data from the project on "Goat and sheep brucellosis free farm" which was launched by the Department of Livestock Development (DLD). The goat farms registered in this project were pre-screened for brucellosis. We also reviewed the number of goat farms in Phetchabun Province from a registry listing from the Phetchabun Livestock Health Office.

We reviewed medical records of the index patient from Phetchabun Hospital and Chondan Hospital, and interviewed his doctors. Information about clinical signs, diagnosis and treatment as well as background information was also recorded from the patient's family. This included information on his signs and symptoms, history of contact with goats and other animals, movement of goats into and out of his farm, clinical manifestations of these goats and risk factors such as contact with secretions or carcass of goat, consuming raw goat meat, drinking raw goat milk, working in goat farm and knowledge about brucellosis.

A probable case was defined as a person who had at least two of the following symptoms: fever, myalgia, headache, fatigue, night sweat, arthralgia, weight lost and scrotal swelling;⁵ and had laboratory confirmation of brucellosis by Rose Bengal Agglutination and ELISA (IgM, IgG) tests.⁶ A confirmed patient was a probable case with laboratory confirmation by hemoculture for *Brucella spp.*

We conducted active case finding in those who had history of contact with goats in the same marketing

chain as the index patient or who lived near the index patient's farm in Village 2, Thakham Sub-district and who developed clinical symptoms compatible with brucellosis from January to December 2009. Face-to-face interviews were conducted to collect information about demographic data (age, gender and occupation), history of illness (underlying diseases, clinical signs and symptoms, duration of illness, onset time and treatment) and possible risk factors (raising carrier animals and type of animals; contact with animal secretions such as amniotic fluid, placenta, blood and animal carcass without any protective equipment; and history of consumption of meat or dairy products of animals that were not appropriately cooked, especially goats and sheep).

Environmental Study

We surveyed three goat farms in Village 2, Thakham Sub-district. In addition, we surveyed a cow farm that shared a grass field with a goat farm tested positive for brucellosis. We interviewed the owners of goats regarding their understanding on farm management such as characteristics of raising goats, households, cleaning methods, and source of food and water.

Laboratory Study

We collected blood samples from village residents whom had history of contact with goats from the same herd as the goats owned by the index patient. Serum samples were analyzed by the National Institute of Health (NIH) using Rose Bengal Agglutination and Enzyme-linked Immunosorbent Assay (ELISA) methods.⁵ A positive Rose Bengal Agglutination or ELISA test was defined as an IgG titer of more than 30 U/ML or IgM more than 20 U/ML. In addition, we collected blood samples from goats and other animals with potential exposure to the goats cared for by the index patient for analysis by NIAH using Rose Bengal Agglutination and Complement Fixation Tests (CFT). If an animal was tested positive by both methods, it was confirmed as an animal case.¹

Analytic Study

We conducted a cross-sectional study to identify possible factors associated with brucellosis infection. The study population was defined as any person with a history of contact with goats from the index patient's herd and living in Thakham Sub-district. A case was defined as someone with at least two of the following symptoms: fever, myalgia, headache, fatigue, night sweat, arthralgia, weight loss and scrotal swelling, with laboratory confirmation of brucellosis by Rose Bengal Agglutination and ELISA (probable case) or by hemoculture for *Brucella spp.* (confirmed

case). A non-case was a person who had negative laboratory results for brucellosis by all testing methods mentioned before.

We described median age, attack rate, symptoms and gender ratio. In addition, we analyzed possible risk factors using a univariate analysis to show potential associations by Prevalence Ratio (PR) and 95% confidence intervals using Epi Info program version 3.5.1 (US CDC).

Results

Descriptive Results

In Thailand, the first report of human brucellosis was in 2003 (nine cases from Ratchaburi Province and one case from Kanchanaburi Province).⁴ From 2003 to 2009, 121 human cases of brucellosis were reported to the BOE, including three deaths from 16 provinces. The majority of animal brucellosis cases from 2003 to 2009 were reported from Nakhon Si Thammarat and Kanchanaburi provinces (Figure 1).

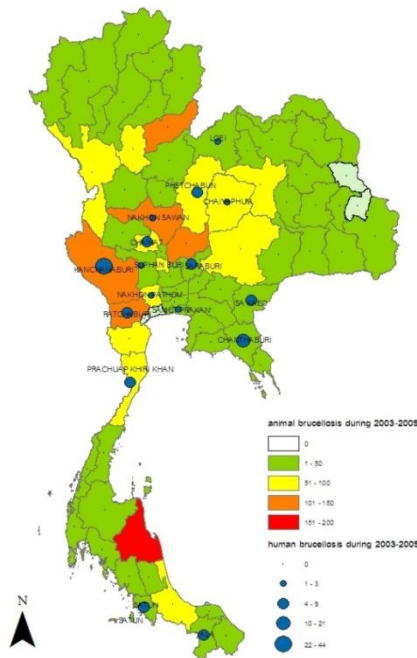


Figure 1. Map of human and animal brucellosis situation in Thailand during 2003-2009

In 2009, Phetchabun Province had 79 registered goat farms, making it the 21st most populated province in Thailand. Most of the farms are located in Chondan District (42%). Nineteen cases of animal brucellosis have been reported from Phetchabun Province (17 in 2007, one in 2008 and one in 2009 from this outbreak).

The index patient was a 79-year-old man who lived in Village 2 of Thakham Sub-district, Chondan District in Phetchabun Province. He had hypertension, gout and renal stones, and presented with backache and abdominal pain on 22 Jun 2009 to the out-patient

ward of Chondan Hospital. After receiving symptomatic care for several visits, he re-presented on 14 Aug 2009 with fever, abdominal pain, vomiting and diarrhea, and was admitted. He was later transferred to Phetchabun Hospital and diagnosed with peritonitis and acute on chronic renal failure. His blood culture grew unspecified Gram-negative cocci and was sent for confirmation at NIH. He was treated with ceftriazone and metronidazole for 12 days until 25 Aug 2009, and he improved clinically. He was later referred back to Chondan Hospital for ongoing treatments.

On 29 Aug 2009, his clinical situation worsened and he developed fever, became drowsy and experienced seizure, prompting his transfer back to Phetchabun Hospital. The Computed Tomography (CT) scan demonstrated brain atrophy. On 6 Sep 2009, he again developed drowsiness and dyspnea. His laboratory results showed anemia (Hematocrit 27%) and bilateral infiltrates were found on chest X-ray. Three days later, he died of suspected Central Nervous System (CNS) infection with additional diagnoses of hospital-acquired pneumonia, respiratory failure and catheter-induced urinary tract infection. His blood culture results from NIH and NIAH were positive for *Brucella melitensis* a month after his death.

One exposure for the index patient was goats as he started raising goats since 2007 after purchasing 20 goats from Farm J. The goats from his farm did not register with the project “Goat and sheep brucellosis free farm” of the District Livestock Health Office and therefore, these goats were not screened for brucellosis. In addition, his farm was not designated as a bio-security farm as it was located in his house compound and there were no fences or disinfection of his farm. Moreover, the goats were not screened for diseases before moving in and out. In 2008, he received an additional goat from his cousin and sold other goats to Farm P located in the same village. Later this year, Farm P discovered one of the goats from the index patient to be positive for brucellosis (by Rose Bengal Agglutination and CFT tests). In March 2009, the index patient’s goat developed seizures and died. He buried its carcass and slaughtered other sick goats before consuming them with his family. In April 2009, he decided to sell his remaining goats to Farm B. Soon afterwards, these goats experienced abortion and joint swelling. The index patient was discovered to have direct contact with goat blood, placentas and other secretion without using any protective equipment. However, he did not have history of consuming home-made goat milk (Figure 2).

Interviews with 39 persons in the study population identified three additional probable human brucellosis cases which generated attack rate of 10.3% (4/39). The median age of cases was 51.5 years, ranged from 37 to 79 years. Male to female ratio was 1:1. Most experienced myalgia (100%) and arthralgia (100%), with half of them reporting fever (50%) and fatigue (50%). All patients had a history of exposure to goats, or consuming goat meat or milk. Among 4 cases, 100% had history of contact with goat carcass;

75% of raising ruminant animals, contact animal secretion or consuming goat meat; and 50% of consuming goat milk (Table 1).

Prior to onset of the index patient's symptoms, his goats fell ill. Two probable cases, including one from Farm P, developed symptoms at the same time as the index patient. The last patient was a family member of the index patient and developed symptoms in the middle of October 2009 (Figure 3).

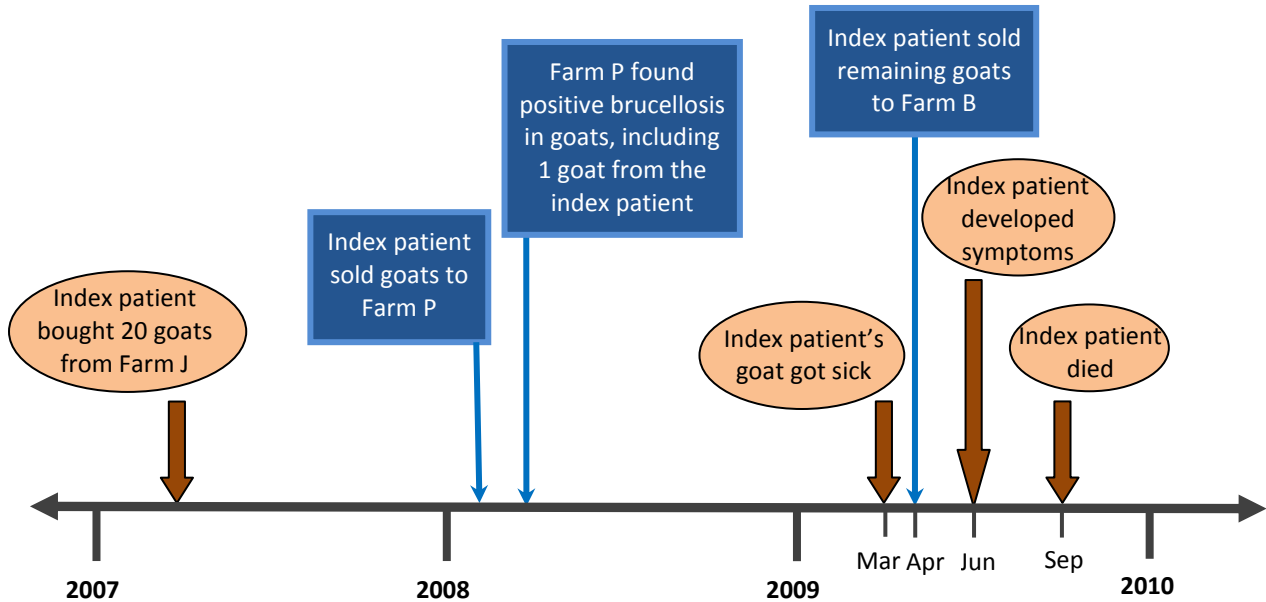


Figure 2. Diagram of possible exposure history of the index patient with brucellosis infection in Village 2, Thakham Sub-district, Chondan District, Phetchabun Province, Thailand, 2009

Table 1. Characteristics and possible exposures of brucellosis patients in Village 2, Thakham Sub-district, Chondan District, Phetchabun Province, Thailand, 2009

Patient	Demographic	Laboratory diagnosis	Sign, symptom and illness onset	History of possible exposure
Index patient	79 years, man	Hemoculture	Fever, myalgia and arthralgia in June 2009	<ul style="list-style-type: none"> - Contact with goat secretion - Consumption of goat meat - Goats were sick, but no laboratory testing of brucellosis
Patient 2	45 years, woman	Rose Bengal Agglutination and ELISA	Myalgia and arthralgia in mid of June 2009	<ul style="list-style-type: none"> - Contact with goat secretion - Consumption of home-made milk - Purchased goats from index patient's farm and found brucellosis positive
Patient 3	58 years, man	Rose Bengal Agglutination and ELISA	Fever, myalgia and arthralgia in July 2009	<ul style="list-style-type: none"> - Contact with goat secretion - Consumption of home-made milk - Consumption of goat meat - Purchased goats from index patient's farm and found brucellosis positive
Patient 4	37 years, woman (Index patient's daughter-in-law)	Rose Bengal Agglutination and ELISA	Myalgia, headache, depression, night sweat, arthralgia and weight loss in October 2009	<ul style="list-style-type: none"> - Prepared food from goat meat - Consumption of goat meat - Lived in the index patient's house

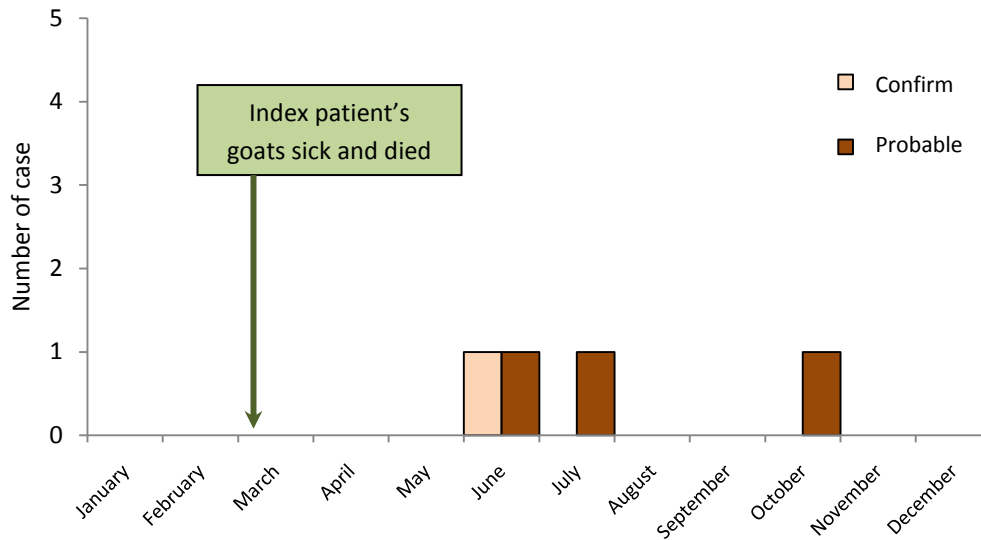


Figure 3. Number of brucellosis patients by month in Village 2, Thakham Sub-district, Chondan District, Phetchabun Province, Thailand, 2009

Environmental Results

The index patient’s goat farm and other goat farms in Thakham Sub-district that bought or sold goats from the index patient’s farm were surveyed during the outbreak investigation. We found that most of the farms did not take bio-security measures such as separating owners’ houses and goat farms, having disinfecting system of goats before bringing them into the farms, and providing areas for disease screening and quarantine (Figure 4 and 5).



Figure 5. Picture showing that goat farms did not have a disinfectant system in place for goats entering the farm in Thakham Sub-district, Chondan District, Phetchabun Province, 2009



Figure 4. Pictures showing that other animals had access to the goat farms and farms were close to owner’s houses in Thakham Sub-district, Chondan District, Phetchabun Province, 2009

Laboratory Results

Thirty eight human blood samples were collected for testing brucellosis antibody. Three (7.9%) were tested positive of brucellosis by Rose Bengal Agglutination and ELISA tests (probable cases), including one family member of the index patient (33.3%), and two persons living and working in Farm P (66.7%).

Blood samples of animals that had contact with the index patient’s goat were also collected. Total 18 animal specimens were tested for brucellosis which included 10 from goats (55.6%), two from cows (11.1%), one from dog (22.2%) and two from cats (11.1%). The result revealed that one goat from Farm B (10%) and one dog from the index household were tested positive for brucellosis (Table 2).

Table 2. Results of animal laboratory testing for brucellosis in Thakham Sub-district, Chondan District, Phetchabun Province, 2009

Farm	Type of animal	Number of sample	Laboratory Result	Percent of positive samples
Index farm	Dog	2	1 negative and 1 suspected*	50
Farm J (Index patient bought goats)	Goat	5	All negative	0
	Dog	1	Negative	0
Farm B (Index patient sold goats)	Goat	5	1 sample positive	20
	Dog	1	Negative	0
Farm P** (Index patient sold goats)	Cat	1	Negative	0
Cow farm near Farm P ***	Cow	2	All negative	0

* One dog sample tested positive by Rose Bengal Agglutination and CFT, but brucella species could not be identified.

** Goat samples from Farm P were collected by Provincial Livestock Office and were found positive for brucellosis by Rose Bengal Agglutination and CFT tests

*** Cow herd that shared grass field with goats from Farm P

Table 3. Risk factors for brucellosis in Village 2, Thakham Sub-district, Chondan District, Phetchabun Province, 2009 (n=39)

Risk	Exposed		Non-exposed		Crude PR (95% CI)	P-value
	Case	Non-case	Case	Non-case		
Exposed to goat carcass without protective equipment	4	8	0	27	Undefined	0.006
Ate goat meat or drank home-made goat milk	4	11	0	24	Undefined	0.020
- Ate goat meat	3	11	1	24	5.4 (0.6-46.8)	0.120
- Drank home-made goat milk	2	2	2	33	8.8 (1.7-46.2)	0.040
Helped with parturition	3	12	1	23	4.8 (0.6-42.0)	0.140
Contacted with goat secretions	3	16	1	19	3.2 (0.4-27.8)	0.280
Worked in a goat farm	3	27	1	8	0.9 (0.1-7.6)	0.660

Analytic Results

A univariate analysis showed an association between brucellosis infection and a history of contact with goat carcass, or consuming goat meat or milk. However, we could not calculate strength of association with exposure to goat carcass because there were no cases in non-exposed population. The significant association was identified for goat milk or meat consumption, with crude PR 8.8 (95% CI 1.7-46.2). Other variables of helping parturition, contact with goat secretions and working in a goat farm were not statistically significant (Table 3).

Conclusion and Discussion

This was the first brucellosis death reported by Phetchabun Province and the fourth death reported in

Thailand. In spite of the cause of death being reported as hospital-acquired pneumonia, brucellosis was likely an exacerbating factor. Possible sources of infection for the index patient were direct contact with goat secretions or blood, especially the history of contact goat carcass without any protective equipment and goat meat consumption. The findings were similar to studies that identified risk factors for human brucellosis in Thailand⁴ and Kyrgyzstan⁷. A person who drank goat milk and did not use protective equipment is possibly at higher risk for developing brucellosis infection from contaminated goat secretions and milk. Although other factors such as parturition assistance might be a risk factor, these were undetected by this study due to small sample size of this study.

The proportion of human brucellosis cases among persons with exposure to goats was 10.3 % (4/39), a finding similar to the previous report on brucellosis outbreak in Thailand during 2003 which found 8.1%.⁴

Chondan District of Phetchabun Province had a high frequency of reports on human and animal cases of brucellosis. This might be due to the fact that Chondan District has more goat farms (majority were unregistered) and many of them did not have screening systems for brucellosis before goats move in and out the farms. The people in this area also had little knowledge about risk factors for brucellosis and usually helped with parturition of goats without using personal protective equipment. In addition, lack of strong collaboration between livestock health officers and public health officials might have been a barrier for sharing information about brucellosis cases in both animals and humans. This might have prevented effective disease monitoring, and disease prevention and control efforts for brucellosis.

There were several limitations to our investigation such as information bias from a retrospective study design potentially causing recall bias. In addition, the disease has a long and varied incubation period and therefore, can cause challenges with collecting accurate data. Outcome identification was another limitation as we could not identify specific pathogens from a serologic study that used Rose Bengal Agglutination and ELISA (IgM, IgG) tests for antibody detection (only *Brucella spp* were identified). However, as *Brucella melitensis* is the most common cause of brucellosis in goats and we only collected data from those whom had exposure to goats, we assume that positive serology results were to *Brucella melitensis* species. This analysis could not control potential confounding factors such as underlying diseases or patient's age due to its small sample size. In addition, we could not control each factor by multivariate analysis.

For actions taken, we provided health education about brucellosis and its prevention measures to goat farmers and the public as well as provided brucellosis brochures for public distribution to Chondan Hospital. We recommended the Provincial and District Health Offices to organize regular meetings in order to provide health education about brucellosis to high risk groups such as goat farmers, butchers and consumers who prefer raw goat milk or goat meat. Our team encouraged the animal health officers from Chondan District to collaborate with the public health office and as a result, they shared information on follow-up laboratory findings of the goat farms.

Recommendations

For public and animal health authorities, recommendation is to strengthen collaboration between public health officers and livestock health officers through sharing of disease information in order to facilitate the planning and implementation of prevention efforts and control measures. In addition, we recommend strengthening the existing brucellosis surveillance system by including it in the national communicable disease surveillance (506) to increase the number of reported cases from the local level and raise awareness about brucellosis in medical doctors and public health officers from high risk areas. Recommendations for treating brucellosis from the WHO Expert Committee in 1986 are to use doxycycline 200 mg/day orally plus rifampicin 600-900 mg/day orally for six weeks. Goat farmers, including those practicing legally or illegally, should be notified of positive laboratory results on goat brucellosis immediately in order to prevent further spread. Finally, health education is needed for goat farmers to raise their awareness about farm management practices and bio-security efforts that can be taken in farms (i.e. screening goats for brucellosis before moving into farms and improvement on personal protective methods) so that spread of infectious diseases could be reduced.

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