INTRODUCTION

Scrub typhus, a vector-borne zoonosis caused by Orientia tsutsugamushi, is a disease endemic to Taiwan. This organism is transmitted by infected trombiculid mites, especially Leptotrombidium deliense in Taiwan (1,2). Scrub typhus is commonly found in Asian countries, and west to Pakistan and Afghanistan, east to Japan, and south to Australia (3,4). O. tsutsugamushi is naturally maintained in cycles of trombiculid mites and Rodentia hosts. When humans enter these infectious areas and are bitten by infectious mites, rickettsia begins to grow at the location of the bite. After 9-12 days, a characteristic skin lesion known as an eschar is formed. Other clinical common symptoms include fever (≥39°C), skin rash, lymphadenopathy, headache, back pain, chills, and sweating. If not treated promptly, the human case-fatality rate of this disease can reach up to 60%.

Scrub typhus was first described in Taiwan by Hatori and was well documented by Japanese workers prior to 1940 (5). At that time, cases were found throughout Taiwan. Since 1955, this disease has been designated as a notifiable disease (6). No cases were reported between 1965 and 1981 in local residents; however, small outbreaks in soldiers were reported from time to time, especially on Penghu Island (7-10). In 1991-1992, 102 scrub typhus cases were found in Taiwan; the most common age group among the infected individuals was 20-30 years, and the peak infection period occurred between July and October (11). Out of the total confirmed cases, 10.8% were young soldiers. Since then, no epidemiological data on scrub typhus has been reported. This paper updates the status of scrub typhus in eastern Taiwan in the years 2000-2004 to improve our understanding of the spread of this disease.

SUMMARY

The epidemiology of scrub typhus in eastern Taiwan was studied by analyzing the data from the CDC Web reporting system. A total of 1,396 cases with 403 confirmed cases were reported in the period of 2000 to 2004. The cases were commonly found in all counties with the highest number in Yuli Township, Hualien County (53 cases) and Taitung City, Taitung County (40 cases). Monthly changes in the number of cases showed epidemic periods in the spring with a peak in May, and again in the fall, with an October-November peak. The occurrence of disease varied with age, gender, and occupation. Our results showed that the infection rates in the elderly (50-69 years old), males (62.8%), and farmers (25.6%) were higher than those in other age groups, females, and other occupations. Five major clinical symptoms, fever, headache, eschar, rash, and lymphadenopathy, were observed in 90.1, 61.9, 23.1, 21.6, and 10.7% of the cases, respectively. Almost 90% (89.3%) of the cases showed 1-3 clinical symptoms and some showed 4-5 symptoms (10%). Only one patient with no symptoms (0.8%) was found. This paper reports the status of scrub typhus in eastern Taiwan, and suggests that a health education program could train individuals to self-recognize the disease symptoms.

MATERIALS AND METHODS

Study areas: Based on the surveillance data of scrub typhus, most of the confirmed cases are in eastern Taiwan in Taiwan proper. Therefore, we chose eastern Taiwan as our study area; this region was considered to include Hualien County and Taitung County, and has a total area of approximately 8,144 km² (Fig. 1). Eastern Taiwan is located between the mountains and the Pacific Ocean at 21°56'-24°22'N and 120°44'-121°45'E. The rainy season is between May and October, while the other months belong to the drought season. The average temperature is 22.6-24.5°C.

Data source: Since 1955, physicians in Taiwan have been under obligation to report scrub typhus to their local health bureau based on the clinical symptoms of fever, headache, back pain, chills, sweating, lymphadenopathy, skin rashes after 1 week, and eschar. Samples of patient blood were collected in the acute phase (within 7 days of the day of onset) and convalescent phase (14 days after the day of onset) and sent to the Center for Disease Control (CDC) laboratory or its contract laboratory for confirmation by pathogen isolation, and indirect immunofluorescence assay (IFA). A confirmed case was defined by the positive isolation of O. tsutsugamushi or a fourfold increase of antibodies by IFA testing. When the local health bureau received a report of this disease, including data on clinical symptoms, a questionnaire survey was carried out. Patients answered the questionnaire retrospectively. The questionnaire included items on patient background (age, sex, onset date, location, and occupation) and possible infection sites (activities at the time of infection, i.e., 1 month before the day of onset).

Data analysis: Data from 2000 to 2004 were analyzed using statistical software (Statistica 6.1; StatSoft, Inc., Tulsa, Okla., USA). Sometimes, data were summed up by years for the analysis because some cells are too small in the year-basis. A linear trend of cases by years, and homogeneity of cases by location and sex were tested by the chi-square test, $t$ test or paired $t$ test, respectively. A paired $t$ test was used to remove the correlation of the sex within the same year.
Prevalence (the number of cases per 100,000 people) was used for age distribution because the population of each age group was largely varied. In the analysis of clinical symptoms and occupations, only the recent questionnaires (121 cases) from January 2004 to June 2005 were used. A difference was considered statistically significant when the $P$ value was less than 0.05.

RESULTS

Cases of scrub typhus and their distribution: In the period of 2000 to 2004, 1,396 cases of scrub typhus were reported. Four hundred and three cases (28.9%) were confirmed by serologic laboratory tests after the provisional diagnosis by clinicians. The cases found in all counties were not evenly distributed ($\chi^2_{28} = 285.8, P < 0.01$). The highest numbers of cases were found in Yuli Township, Hualien County (53 cases) and Taitung City, Taitung County (40 cases), respectively (Fig. 1). The reported number of scrub typhus cases in eastern Taiwan significantly ($t_4 = 14.2, P < 0.001$) increased from 2000 to 2004 (Fig. 2), while the confirmed cases significantly ($t_3 = 9.174, P < 0.05$) increased from 2001 to 2004.

Sex and age distributions of cases: Significantly more males (50.6 cases per year) were infected by the scrub typhus than females (30.0 cases per year) ($t_4 = 3.99, P < 0.05$). Among them, 253 cases (62.8%) were males and 150 (37.2%) were females. However, the sex ratios (2.6, 2.3, 1.6, 1.2, and 1.5) from 2000 to 2004 gradually equalized. The prevalences of scrub typhus in the age groups of 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, and ≥70 were 9.0, 2.9, 7.0, 17.5, 19.3, 23.5, 23.9, and 11.1 per 100,000 population, respectively. The mean peaks occurred in the age groups of 50-59 and 60-69, and these age groups mainly infected in the years of 2003 and 2004 (Fig. 3).

Seasonal differences in the rate of infection and occupations of the infected: Although the cases were found all-year round, monthly changes in the number of cases showed epidemic periods in the spring and fall. The spring epidemic period was from April to June, with a small peak in May, while the fall epidemic period was from September to January with a large peak in October and November (Fig. 4). At the time of infection, the occupations of infected persons were farmer (25.6%, 31 cases), student (9.9%, 12 cases), housekeeper (5.0%, 6 cases), part-time worker (4.1%, 5 cases), construction worker (4.1%, 5 cases), and other (13.2%, 16 cases). Occupation at the time of infection was not known for 41 cases (33.9%).
Clinical symptoms: Among the 121 cases who had recently filled out a questionnaire, 5 major clinical symptoms, fever, headache, eschar, skin rash, and lymphadenopathy, were observed in 90.1%, 61.9%, 23.1%, 21.6%, and 10.7% of the cases, respectively (Table 1). Almost 90% (89.2%) of the cases showed 1-3 clinical symptoms and some showed 4-5 symptoms (10%) (Table 2). Only one patient with no symptoms (0.8%) was found. This patient self-recognized the disease based on the presence of fever and the memory of receiving an insect-like bite during outdoor activity.

**DISCUSSION**

We have analyzed the epidemiological data and clinical features of scrub typhus in eastern Taiwan over the years of 2000-2004. The high-risk groups were the elderly, farmers, and males. Monthly changes in the number of cases showed epidemic periods in the spring, with a peak in May, and in the fall, with the peak period being between October and November. The epidemic periods are influenced by the activities of infected mites and human hosts, which are in turn affected by temperature and climate. In spring and fall, the weather is suitable for outdoor activities, which increases the likelihood of contact between infected mites and human hosts.

The occurrence of scrub typhus varied with age, gender, and occupation. Our results showed that the incidence of infection was higher in the elderly, males, and farmers. This age group and occupation differed substantially from those in a previous study in 1991-1992 (11). In that study, the age of patients ranged from 21-60 years and the peak occurred in the range of 20-30 years. This indicated that young soldiers were infected frequently. In our study, the males and the elderly of local residents had a higher incidence of infection, possibly due to increased exposure as a result of a propensity for outdoor activities. For example, in eastern Taiwan, most young people move to cities for work and the elderly are left to work as farmers on their own land. Moreover, retired persons enjoy hiking in the mountains.

Fever, skin rash, and eschar are the most common symptoms of scrub typhus, and are important in the clinical diagnosis of this disease. As expected, these symptoms were also the most commonly occurring symptoms in our study. However, the rates of these symptoms, especially eschar (23.1%), were much lower than those found in previous reports (60-92%) (12-16). Cases without eschar (76.9%) may have been easily misdiagnosed as cases of common cold or other febrile illness. Such delay in diagnosis has sometimes resulted in death (14). In endemic areas, in addition to increased awareness amongst the physicians, intensive health education on clinical symptoms such as eschar, fever, and headache is also important in order to improve the rate of self-recognition by local residents. This health education can use media to alert local residents in April, May, June, October, and November in the peaks of monthly occurrence. Reducing the risk of infection by the application of repellents to skin and clothes, avoiding contact with overgrown grass and brush, and wearing long pants, long sleeves, and long socks should be included as well. In addition, Taiwan has a well-established public health system, which includes local public health nurses in each assigned community. Hence, door-to-door health education by these nurses will be effective to reach the elderly.

In conclusion, this study has reported the epidemiological aspects and clinical features of scrub typhus in eastern Taiwan in the period of 2000-2004. The information presented in the present study should help to clarify the current status and methods of preventing this disease in Taiwan.

**ACKNOWLEDGMENTS**

We thank Judy Peng for her comments and suggestions in improving the manuscript.
REFERENCES


5. Shimada, T., Trager, L. W., Jr. and Adams, C. T. (1961): Provisional list of the medically important fauna of Taiwan (Formosa). Special report. 5th Epidemiological Flight (PACAF), San Francisco, California.


