

**Short Communication**

**Seasonal Patterns of Legionellosis in Saitama, 2005–2009**

Yukie Ozeki<sup>1\*</sup>, Fumiya Yamada<sup>1</sup>, Akinobu Saito<sup>1</sup>,  
Tsuyoshi Kishimoto<sup>1</sup>, Sakiko Tanno<sup>1</sup>, and Yosikazu Nakamura<sup>2</sup>

<sup>1</sup>*Saitama Institute of Public Health, Saitama 338-0824; and*

<sup>2</sup>*Department of Public Health, Jichi Medical University, Tochigi 329-0498, Japan*

(Received October 28, 2011. Accepted May 8, 2012)

**SUMMARY:** Sporadic cases of legionellosis have increased in Saitama Prefecture. This study aimed to understand the characteristics and incidence of legionellosis in Saitama Prefecture by studying the corresponding data from Tokyo and all over Japan. We analyzed cases of legionellosis registered from 2005 through 2009 in the annual reports of the Infectious Disease Surveillance Center. There were two peaks in the incidence of legionellosis in Japan between June and November, and a trough between February and May every year. Similar seasonal characteristics were observed in both Tokyo and Saitama. Proper management of risk factors—such as cooling towers and other aerosol-generating devices, before and during the seasonal increase in these incidences—is essential as a prophylactic measure against legionellosis.

Legionellosis may occur sporadically or in large-scale outbreaks due to contaminated aerosolized water (1). The responsible organisms thrive not only in natural water, but also in man-made water systems such as cooling towers, spas, and drinking water supply (2). Legionellosis, classified as a category IV infectious disease, should be reported in accordance with the Law Concerning the Prevention of Infectious Diseases and Medical Care for Patients of Infections (enforced in 1999 in Japan). The surveillance data on legionellosis has been increasing in Japan since 2005; this is particularly evident in Saitama Prefecture where the incidence of sporadic cases is very high. Therefore, data of the pattern of legionellosis incidence in Saitama was compared with the data from Tokyo and all over Japan. Saitama is a prefecture adjacent to Tokyo, and the lifestyles of the residents in both areas are similar. The national data comprises of data from 47 prefectures, with no apparent regional differences.

Data on cases of legionellosis reported from 2005 through 2009 were obtained from the annual reports

published by the Infectious Disease Surveillance Center, National Institute of Infectious Diseases (<http://idsc.nih.go.jp/idwr/CDROM/Main.html> [in Japanese]). The incidence of legionellosis was analyzed with respect to age, sex, and the week when the diagnosis was made. The numbers of patients diagnosed every week were counted on a monthly basis. Monthly meteorological data were downloaded from the homepage of the Japan Meteorological Agency (<http://www.data.jma.go.jp/obd/stats/etrn/index.php> [in Japanese]). The correlations between meteorological factors and the patterns of legionellosis incidence were determined.

From 2005 through 2009, 3,076 cases of legionellosis were reported in Japan, including 272 from Tokyo metropolitan area and 149 from Saitama Prefecture. Of the 3,076 patients, 2,503 were men (81.4%) and 573 were women (18.6%). During the study period, the number of men affected by the disease was higher than that of women. This was observed in both Tokyo and Saitama (Table 1). The affected patients, in Saitama Prefecture as well as in Tokyo and all over Japan, were

Table 1. Cases and ratio of legionellosis by sex, 2005–2009

		No. (%) of cases				
		2005	2006	2007	2008	2009
Saitama	Male	16 (100.0)	16 (80.0)	21 (67.7)	35 (68.6)	22 (71.0)
	Female	0 (0.0)	4 (20.0)	10 (32.3)	16 (31.4)	9 (29.0)
Tokyo	Male	23 (95.8)	54 (87.1)	43 (81.1)	61 (74.4)	39 (76.5)
	Female	1 (4.2)	8 (12.9)	10 (18.9)	21 (25.6)	12 (23.5)
Japan	Male	252 (89.7)	452 (87.3)	527 (78.9)	691 (77.5)	581 (81.0)
	Female	29 (10.3)	66 (12.7)	141 (21.1)	201 (22.5)	136 (19.0)

\*Corresponding author: Mailing address: Saitama Institute of Public Health, Kami-ohkubo 639-1, Sakura-ku, Saitama 338-0824, Japan. Tel: +81-48-853-5018, Fax: +81-48-856-1809, E-mail: ozeki.yukie@pref.saitama.lg.jp

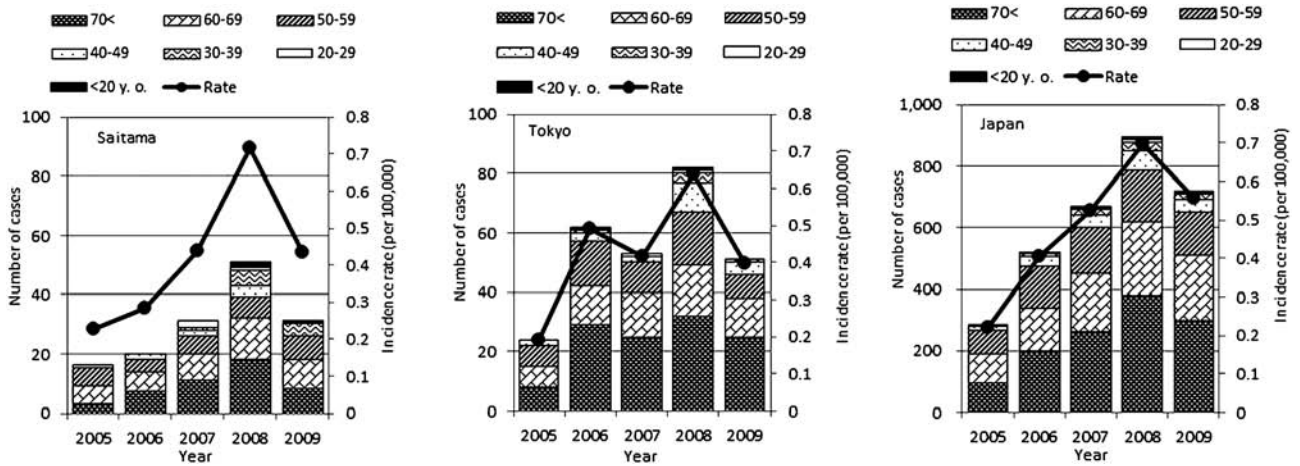


Fig. 1. Annual number of legionellosis cases by age group and incidence rate per 100,000, 2005–2009.

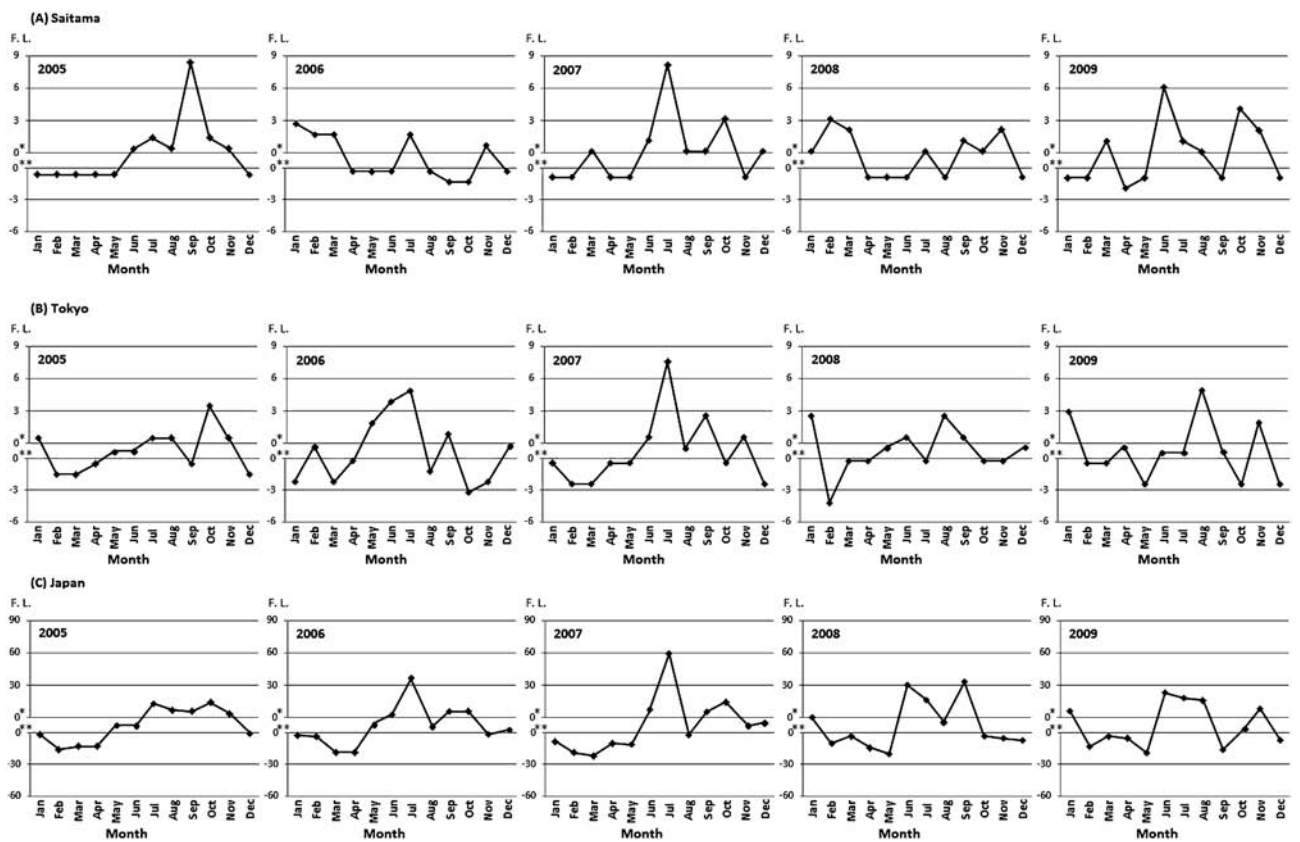


Fig. 2. Trend in legionellosis monthly number of cases, 2005–2009. It is marking in plus area, if monthly number of cases is more than  $0^*$ , in mainus area, if the number is less than  $0^*$ . (A) Saitama ( $0^{**}-0^*$ ) = 2005 (0.6–2.1), 2006 (1.3–2.0), 2007 (1.8–3.3), 2008 (3.8–4.7), 2009 (1.9–3.3). (B) Tokyo ( $0^{**}-0^*$ ) = 2005 (1.5–2.5), 2006 (4.2–6.1), 2007 (3.4–5.4), 2008 (6.2–7.4), 2009 (3.4–5.1). (C) Japan ( $0^{**}-0^*$ ) = 2005 (19.7–27.1), 2006 (38.2–48.2), 2007 (47.9–63.5), 2008 (68.0–80.7), 2009 (53.9–64.8). \*, the point is calculated to add standard error to average. \*\*, the point is calculated to subtract standard error from average. F.L., fluctuations in legionellosis.

predominantly 50 years old or older (average percentage of patients  $\geq 50$  years [95% confidence interval, 85.6% (79.8–91.4), 90.0% (85.7–94.2), and 90.8% (89.0–92.5), respectively] (Fig. 1).

The numbers of cases of legionellosis reported during the observed period are shown in Fig. 2. In Japan, two peaks of incidences were observed between June and November every year. A trough was observed between February and May every year. In Tokyo, the incidence

significantly exceeded the mean in July 2006 and 2007, and August 2009. In Saitama, the incidence significantly exceeded the mean in September 2005, July 2007, and June 2009. Two peaks were noted between June and October in 2007 and 2009. The monthly trends of the number of cases throughout the year in Tokyo and Saitama Prefecture are shown in Fig. 3. In Tokyo, the mean monthly incidence from 2005 through 2009 significantly exceeded the mean in June, July, and August;

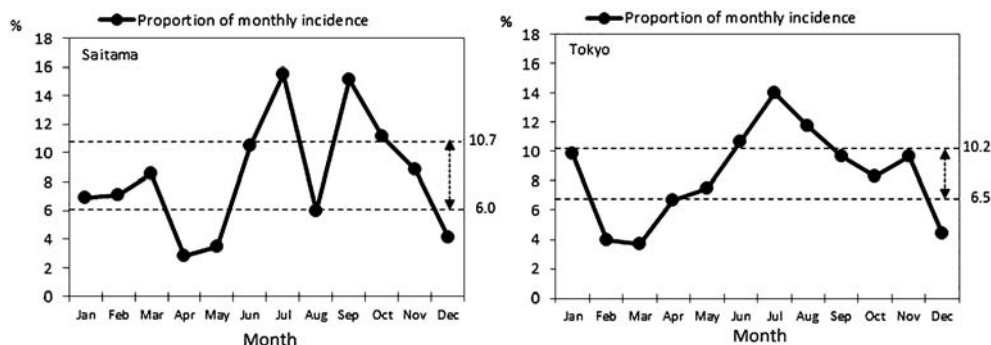


Fig. 3. Proportion of monthly incidence to annual number of legionellosis cases from 2005 through 2009. 95% confidence interval is shown as the dotted arrows indicated area. 95% confidence interval, Saitama 6.0–10.7, Tokyo 6.5–10.2.

Table 2. The correlation of meteorological factors and monthly number of legionellosis

Meteorological element	Prefecture	Observation point	Year				
			2005	2006	2007	2008	2009
Mean temperature (°C)	Saitama	Kumagaya <sup>1)</sup>	0.51	-0.55	0.44	-0.45	0.31
		Chichibu <sup>1)</sup>	0.50	-0.54	0.44	-0.45	0.30
		Saitama <sup>2)</sup>	0.51	-0.55	0.44	-0.45	0.31
	Tokyo	Tokyo <sup>1)</sup>	0.43	0.42	0.67	0.36	0.14
		Hachioji <sup>2)</sup>	0.41	0.44	0.67	0.35	0.14
Mean relative humidity (%)	Saitama	Kumagaya	0.56	-0.56	0.54	-0.54	0.55
		Chichibu	0.59	-0.60	0.58	-0.47	0.58
		Saitama	—	—	—	—	—
	Tokyo	Tokyo	0.58	0.56	0.80	0.43	0.12
		Hachioji	—	—	—	—	—
Monthly precipitation (mm)	Saitama	Kumagaya	0.31	-0.55	0.53	-0.56	0.53
		Chichibu	0.16	-0.54	0.37	-0.54	0.42
		Saitama	0.42	-0.76	0.57	-0.56	0.58
	Tokyo	Tokyo	0.56	-0.06	0.62	0.36	0.09
		Hachioji	0.53	0.24	0.72	0.49	0.10

<sup>1)</sup>: meteorological observatory.

<sup>2)</sup>: AMEDAS observatory.

—, no data collected.

whereas the mean was lower than that in February, March, and December. In Saitama, the mean monthly incidence exceeded the mean in July, September, and October, and it was lower than that in April, May, and December.

Table 2 shows the correlations between the meteorological factors and the monthly incidence of legionellosis. In 2007, the monthly incidence of legionellosis in Tokyo was correlated with the mean relative humidity and monthly precipitation (Pearson's  $r = 0.80$ ,  $P = 0.002$  and Pearson's  $r = 0.72$ ,  $P = 0.008$ , for Tokyo and Hachioji, respectively). However, no correlations were found between these parameters in Saitama.

In order to design appropriate measures to control the infection, it is important to understand the patterns of incidence. The high frequencies of legionellosis reported from 2005 through 2009 exhibit a seasonal trend. *Legionella* spp. thrive on free-living amoebae, which are present in water (3,4). Most cases of legionellosis are caused by the inhalation of aerosols containing *Legionella* spp. *Legionella* spp. proliferate between 20°C and 45°C, with the optimum temperature

being 36°C (2). Fisman et al. suggested that the high incidence of legionellosis in Philadelphia during the summer season was related to the high precipitation and humidity in that region (5). Furthermore, Hicks et al. reported that heavy rainfall was associated with the high incidence of legionellosis (6). Karagiannis et al. and Ricketts et al. analyzed meteorological elements such as temperature, humidity, precipitation, and determined whether they were possible predisposing factors that lead to an increase in the number of cases of legionellosis (7,8). Air conditioners installed in vehicles, which take in the outside air and circulate it, can also lead to infection (9). Temperature, humidity, and precipitation affect the survival of amoebae and generate aerosols that facilitate the proliferation of *Legionella* spp. Thus, these previous findings suggest that the summer season (i.e., June through August) positively affects the proliferation of *Legionella* spp., in general. However, the present study indicates a broader period of high incidence (i.e., June to November). Furthermore, no correlations were found between the meteorological factors and legionellosis incidence in the limited data set de-

scribed herein. In this study, meteorological data and the monthly cases of legionellosis at the prefectural level were used for analysis. To detect which factors significantly influence the incidence of legionellosis, it is necessary to analyze the detailed meteorological data from several days prior to the day of exposure.

In Saitama, it was unclear whether the incidence of legionellosis exhibited seasonal trends in 2006 and 2008; in these years, there were 10 and 13 sporadic cases from January through March and from February through March, respectively. However, these multiple sporadic incidences during the winter season could not be explained in the present study. To our knowledge, there is no epidemiological link between these incidences.

The occurrence of legionellosis in Japan did not exhibit any seasonal patterns from 2000 through 2004, except for outbreaks (10). This may be attributed to the small number of cases. The reported number of cases during this period was 714 (mean  $\pm$  SD,  $11.9 \pm 7.2$  cases/month) compared to 3,076 ( $51.2 \pm 26.0$  cases/month) in the present study. For insurance purposes, an enzyme immunoassay (2003) combined with an immunochromatographic assay (2004) was employed as the urinary antigen detection test. The guidelines were revised in 2005, and the Japanese Respiratory Society Guidelines for the Management of Community-Acquired Pneumonia in Adults were adopted, which recommended the urinary antigen detection test for patients with moderate or serious pneumonia (11). The system for diagnosing legionellosis is now well-established. As a result, the number of reported cases has increased since 2005 (2). Moreover, the seasonal trend has become evident.

In Japan, circulating bathwater systems were responsible for some legionellosis outbreaks (12). Water from cooling towers, used for air conditioning systems, has also been reported to be a cause of outbreaks (13,14). In Japan, the guidelines regarding the design of cooling and bathwater systems are issued by the Ministry of Health, Labour and Welfare. It is recommended that a protocol be prepared for facility management, including equipment cleaning, germicide use, and inspection for *Legionella* spp. (15). Agata and Hironaka reported the highest detection rates of *Legionella* spp. in cooling towers from June through September (16). These results suggest that executing an appropriate program before and during the period of the seasonal increase in legionellosis will reduce its incidence.

**Acknowledgments** We thank all staff members of the Tokyo Metropolitan Government Infectious Diseases Surveillance Center for their cooperation in this research.

**Conflict of interest** None to declare.

## REFERENCES

1. Fields, B.S., Benson, R.F. and Besser, R.E. (2002): *Legionella* and Legionnaires' disease: 25 years of investigation. *Clin. Microbiol. Rev.*, 15, 506–526.
2. National Institute of Infectious Diseases and Tuberculosis and Infectious Diseases Control Division, Ministry of Health, Labour and Welfare (2008): Legionellosis, January 2003–September 2008, Japan. *Infect. Agents Surveillance Rep.*, 29, 327–328.
3. Holden, E.P., Winkler, H.H., Wood, D.O., et al. (1984): Intracellular growth of *Legionella pneumophila* within *Acanthamoeba castellanii* Neff. *Infect. Immun.*, 45, 18–24.
4. Winiacka-Krusnell, J. and Linder, E. (1999): Free-living amoebae protecting *Legionella* in water: the tip of an iceberg? *Scand. J. Infect. Dis.*, 31, 383–385.
5. Fisman, D.N., Lim, S., Wellenius, G.A., et al. (2005): It's not the heat, it's the humidity: wet weather increases legionellosis risk in the greater Philadelphia metropolitan area. *J. Infect. Dis.*, 192, 2066–2073.
6. Hicks, L.A., Rose, C.E., Jr., Fields, B.S., et al. (2007): Increased rainfall is associated with increased risk for legionellosis. *Epidemiol. Infect.*, 135, 811–817.
7. Karagiannis, I., Brandsema, P. and van der Sande, M. (2009): Warm, wet weather associated with increased Legionnaires' disease incidence in The Netherlands. *Epidemiol. Infect.*, 137, 181–187.
8. Ricketts, K.D., Charlett, A., Gelb, D., et al. (2009): Weather patterns and Legionnaires' disease: a meteorological study. *Epidemiol. Infect.*, 137, 1003–1012.
9. Sakamoto, R. and Ohno, A. (2008): Uncertain transmission route of Legionellosis: is driving a car or rainy weather the risk of Legionellosis? *Infect. Agents Surveillance Rep.*, 29, 331–332 (in Japanese).
10. Kura, F., Tosaka, N. and Watanabe, H. (2007): Legionellosis Handbook. *Jpn. Med. J.*, Tokyo. p. 254–266 (in Japanese).
11. The Japanese Respiratory Society (JRS) (2005): The JRS Guidelines for the Management of Community-Acquired Pneumonia in Adults (in Japanese).
12. Okada, M., Kawano, K., Kura, F., et al. (2005): The largest outbreak of Legionellosis in Japan associated with spa baths: epidemic curve and environmental investigation. *J. Jpn. Assoc. Infect. Dis.*, 79, 365–374 (in Japanese).
13. Greig, J.E., Carnie, J.A., Tallis, G.F., et al. (2004): An outbreak of Legionnaires' disease at the Melbourne Aquarium, April 2000: investigation and case-control studies. *Med. J. Aust.* 180, 566–572.
14. Sabria, M., Alvarez, J., Dominguez, A., et al. (2006): A community outbreak of Legionnaires' disease: evidence of cooling tower as the source. *Clin. Microbiol. Infect.*, 12, 642–647.
15. Building Management Education Center Foundation (2009): Prevention Guideline of Legionellosis. 3rd ed. (in Japanese).
16. Agata, K. and Hironaka, T. (1994): Distribution of *Legionellae* in cooling tower water in Japan. *J. Jpn. Assoc. Infect. Dis.*, 68, 421–423 (in Japanese).