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UTILIZATION OF GEOSPATIAL INFORMATION FOR INFECTIOUS DISEASE PREVENTION: THE CASE OF INFLUENZA LOCAL SURVEILLANCE IN JAPAN

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Abstract The aim of this paper is to examine the issues of local surveillance using geospatial information related to influenza in Japan. In each specialized agency and local government, local surveillance has been carried out to prevent the spread of infectious diseases on a local scale. In this paper, we examined the distribution of local surveillance data delivery and its spatial scales. A website survey carried out by the author confirmed that specialized agencies and local governments deliver data on a local scale, which is situated below the levels of the Public Health Center or municipality in prefectures with large cities (e.g., Tokyo, Aichi, Hyogo, and Hiroshima). Following the enforcement of the Regional Health Law in 1994, regional differences have also occurred in the delivery of information related to infectious diseases, because of specialized agencies' diversification efforts. Few efforts to deliver information have been made at the local level by Public Health Centers, County and City Medical Associations. Problems such as differences in the authority of specialized agencies and in the consciousness of a crisis in the face of infectious disease prevention contribute to this issue. Hence, further discussion is needed to strengthen independent local surveillance in each region of Japan.

Keywords: geospatial information, spatial scale, specialized agencies of infectious diseases, influenza local surveillance

1. Introduction

With the development of Information and Communication Technology (ICT) in recent years, geospatial information and WebGIS have been harnessed by various fields. In the field of geography, beginning with census and other statistical data, maps and geospatial information have been used widely. Epidemiological surveillance has been carried out to collect and analyze information regarding the occurrence of common infectious diseases and approaches to prevention. In Japan, nationwide surveillance has been conducted through the National Epidemiological Surveillance of Infectious Diseases (NESID) program centered on the National Institute of Infectious Diseases (NIID) and the Ministry of Health, Labour and Welfare. Among them, disease maps have visualized influenza, and "Influenza Level Maps" have been released. On this map, one can confirm the occurrence of influenza at the levels of the prefecture and Public Health Center on a weekly basis. Today, WebGIS related to infectious diseases is being conducted throughout the world (e.g., Inoue *et al* 2003; Boulos *et al* 2004; Shuai *et al* 2006; Gao *et al* 2008; Li *et al* 2013). Following the development of ICT, it has become possible to combine data comprising geospatial information with information on healthcare, and it is also expected that the practical application of new technology utilizing Artificial Intelligence (AI) and big data will become available (Mizushima 2008).

However, while data access and application has improved due to technological innovation, issues relating to information delivery and information quality have arisen. Arahori (2017) examined examples of epidemiological surveillance and disease maps overseas as well as in Japan, analyzed the quality of the surveillance information, and discussed the issues of disease maps in health crisis management. In particular, he pointed out that differences exist in the spatial units and agencies delivering the data comprising detailed spatial units, such as school facilities, medical institutions, *chome* and *aza* (blocks in Japan) in these of local surveillance. By creating maps based on these data, information has been developed that enables us to capture geographical relationships. In specialized agencies and local governments that conduct local surveillance, it is possible to cover the entire area of jurisdiction by collecting data from hospitals, clinics, and school facilities other than sentinel medical institutions. In addition, collecting, aggregating, and delivering data in cooperation with organizations to ensure consistency within a given region has shortened delays and enabled real-time information delivery. Accordingly, it is effective for medical consultation support for local doctors, prevention of infection in school facilities, an emergency response at nighttime treatment, and so on. Local surveillance has become a tool for sharing health crisis management information in familiar areas.

Specialized agencies and local governments in each region mainly conduct local surveillance in Japan. Here, the term “specialized agencies” refers to the Public Health Institute, Public Health Center, and Medical Association. The Public Health Institute and Public Health Center are specialized agencies that address aspects of regional infectious disease control and health sanitation. The Medical Association is composed of Prefectural Medical Associations and County and City Medical Associations in various places, centering on the Japan Medical Association (JMA), a national organization of doctors. These specialized agencies cooperate with local governments (prefectures, ordinance-designated cities, special wards of Tokyo, and municipalities) across Japan.

Anthamatten and Hazen (2011) identified “spatial scale according to diseases,” “quality of data attributes,” and “data aggregation,” as important elements for creating such disease maps. They emphasized that it is necessary to select an appropriate spatial scale based on the mode of transmission of the disease to be visualized, numerical attributes, such as actual figures or ratios, and methods of visualization by considering the procedures used to handle the data. Arahori (2017) evaluated the quality of local surveillance information based on website surveys, but he did not reveal the specific distribution of the local surveillance or the regional differences of spatial scales. When considering the development of a local infectious disease monitoring system, it is necessary to investigate the distribution of local surveillance delivery and the spatial scale of the data. In this paper, we investigate the distribution of agencies and local governments utilizing local surveillance information by using a portion of the data collected by Arahori (2017). Further, we aim to consider the problem of local surveillance utilizing geospatial information in Japan.

2. Data and Methodology

In this study, we used the website survey data of Japanese specialized agencies and local governments collected by Arahori (2017). Website survey data were obtained from 3,653 agencies and local governments, including 82 Public Health Institutes, 552 Public Health Centers, 1,042 Medical Associations, and 1,977 local governments.

For survey items, we used the index related to “spatial scale” from the index set in Arahori (2017) (Table 1). This index is the size of the areal unit for numerical values such as the number of published patients. The size of the spatial scales in Japanese epidemiological surveillance is shown in Fig. 1. The index is classified into 10 spatial levels and five spatial scales, which range from the

Table 1 Survey items of the website survey

Spatial Levels (Survey Items)	Descriptions
Country level	In country level
Prefecture level	In prefecture level
Public Health Center level	In Public Health Center area level
County and City Medical Association level	In County and City Medical Association area level
Municipality level	In municipality area level
Municipal district level	Inside of municipality (district name) level
Public school district level	In public elementary and junior high school district level
Chome and *aza* (block in Japan) level	In *chome* and *aza* (block in Japan) level
School facility level	In school facility (point) level
Hospital and clinic level	In hospital and clinic level

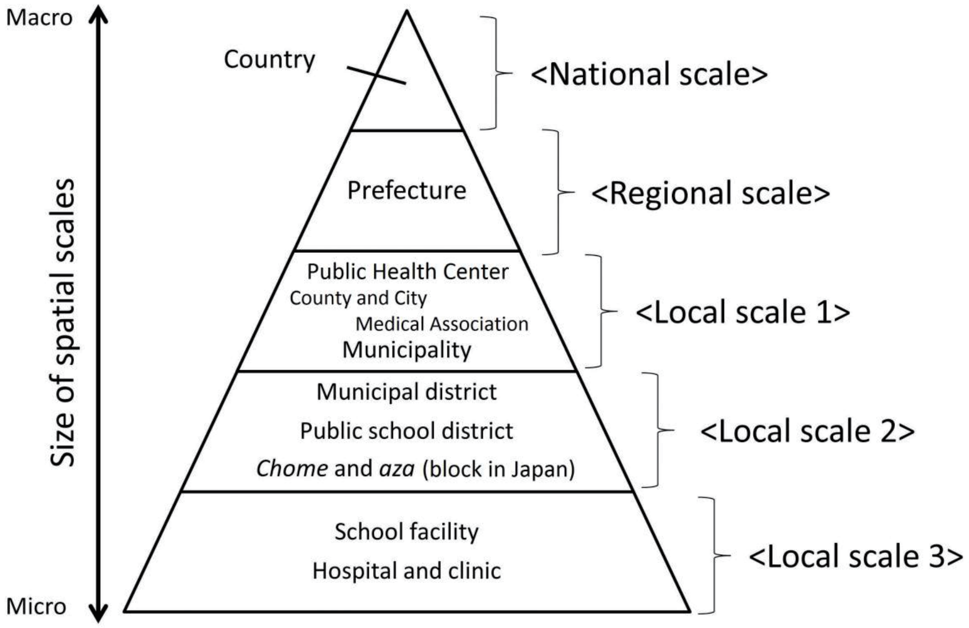

Fig. 1 Spatial scales and levels of influenza epidemiological surveillance in Japan.
Source: Website survey by the author.

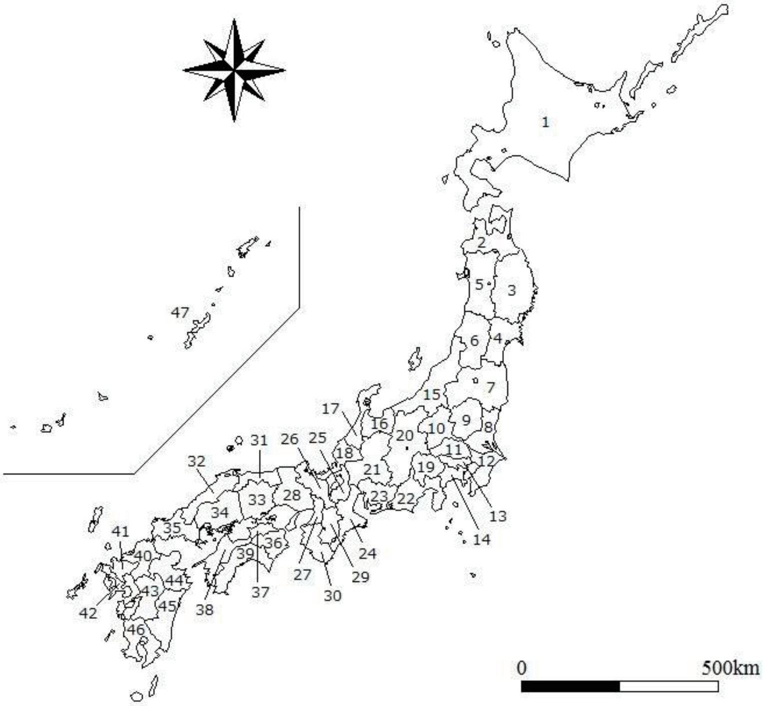

Fig. 2 Prefectures of Japan.
Numerals are corresponding to the prefecture numbers in Fig. 4.

level of the country to that of hospitals and clinics. Among these scales, the local surveillance data provided by specialized agencies and local governments correspond to 8 scales below the level of the Public Health Centers. These 8 scales indicate the epidemic situation on the local scale below the level of the prefecture and are divided into three local scales based on location and features. Local scale 1 includes the Public Health Center level and County and City Medical Association levels with larger areas than municipalities, with jurisdiction over multiple municipalities, and areas that differ from region to region. Local scale 2 includes municipalities, and the areas are ordered as follows: municipal district, public school district, and *chome* and *aza* (block in Japan). Local scale 3 includes the level of the facilities, which can be represented by a point vector layer in the latitude-longitude coordinate system when visualized as a disease map.

The local surveillance information covered in this paper is derived from the Infectious Disease Surveillance Report (IDSR). The IDSR provides the epidemic status within jurisdictions of specialized agencies and municipalities. These data are provided by each specialized agency and local government. The collected data are aggregated according to a specific spatial scale and provided online on a weekly basis as the number of patients. One can know the outline of an epidemic situation in the area by analyzing these data.

In this study, we first reconfirmed the websites of specialized agencies and local governments and updated the data. The investigation period was from June to July 2018. After performing the updates, we aggregated the data of 47 prefectures and compared the spatial scales (Fig. 2). Finally, we considered the problem of local surveillance utilizing geospatial information in Japan.

3. Results

Distribution of local surveillance information delivery

As a result of a website survey conducted by specialized agencies and local governments, only 332 agencies and local governments (9.1%) provided IDSR among the 3,653 agencies and local governments. The breakdown by an agency and local government is as follows: 57 Public Health Institutes (1.6%), 116 Public Health Centers (3.2%), 108 Medical Associations (3.0%), and 51 local governments (1.4%). By aggregating the number of agencies and local governments by prefecture, Tokyo has the largest number (31 agencies and local governments), followed by Hokkaido (27 agencies and local governments), and then Hyogo (19 agencies and local governments) (Fig. 3). By aggregating the number of agencies and local governments by category, Tokyo has 15 Public Health Centers and 9 Medical Associations, Hokkaido has 19 Public Health Centers, and Hyogo has 13 Medical Associations (Fig. 4). In these prefectures efforts were made by Public Health Centers and Medical Associations to deliver information.

Except for Nagano and Kumamoto Prefectures, information delivery is enforced by the Public Health Institute. The Public Health Institute is positioned as a scientific and technical core agency for health crisis management in local and regional areas (Oda and Yakushiji 2006). It is established in each prefecture and ordinance-designated cities, and it conducts survey research and examinations related to health and sanitation. The Public Health Institute collects information of

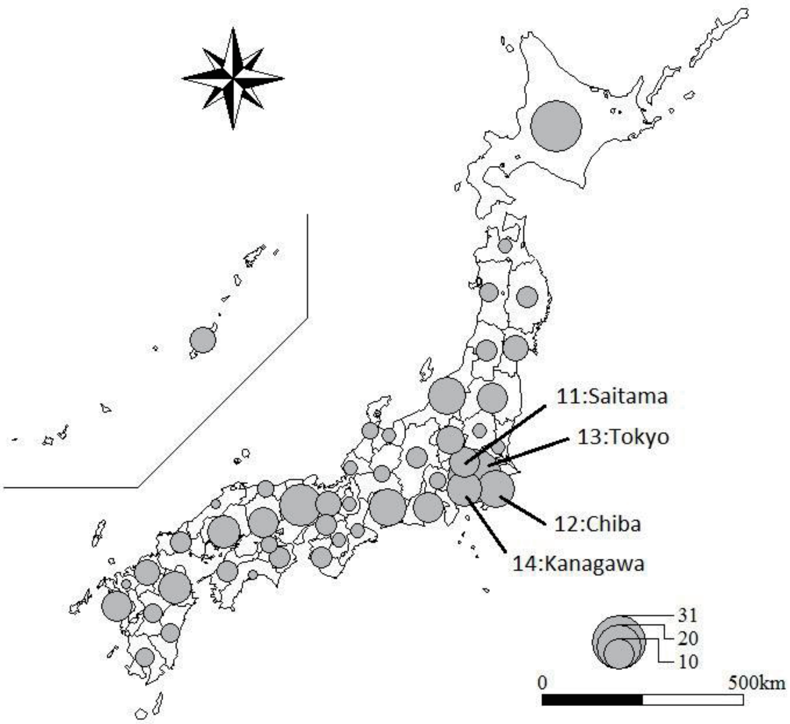

Fig. 3 Number of IDSR by prefectures in agencies and local governments.
Source: Website survey by the author.

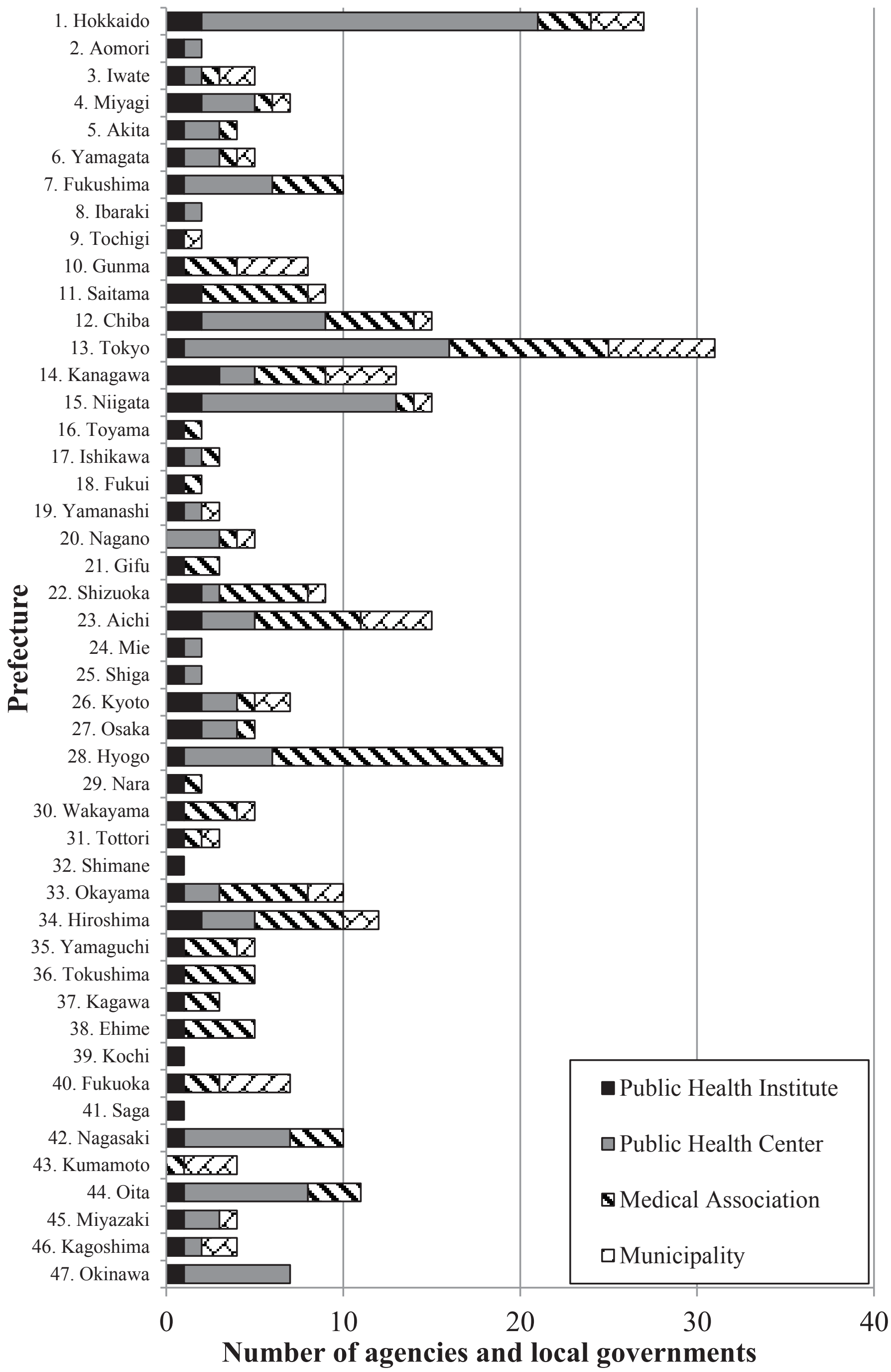

Fig. 4 Number of the type of specialized agencies and local governments by prefecture (IDSR).
Source: Website survey by the author.

the patients from each Public Health Center in the prefecture and delivers information on infectious disease surveillance centers. The information delivered by Public Health Centers and Medical Associations is similar to the information delivered by the Public Health Institute, but some Public Health Centers and Medical Associations collect and deliver information independently.

Local surveillance and spatial scale

Figure 5 shows the spatial scales of the surveillance data of 332 specialized agencies and local governments for IDSR aggregated by prefecture. Most agencies and local governments in each prefecture provided data at the levels of the Public Health Center, County and City Medical Association, and municipality, all of which correspond to local scale 1. In prefectures that contain large cities (e.g., Tokyo, Aichi, Hyogo, and Hiroshima), agencies and local governments provided data at the levels of the municipality district, public school district, and *chome* and *aza* (block in Japan), all of which correspond to local scale 2. The number of agencies and local governments corresponding to local scale 2 in these four prefectures is as follows: Tokyo has 10 agencies and local governments, Aichi has 5 agencies and local governments, Hyogo has 6 agencies and local governments, and Hiroshima has 3 agencies and local governments. Because the delivery of information in Tokyo is conducted in the special ward, many agencies and local governments exist at the municipality and municipal district levels. In Aichi, Hyogo, and Hiroshima, a portal site related to influenza was created, in addition to the individual efforts of the Medical Association, the ordinance-designated and core cities. The special wards of Tokyo and ordinance-designated and core cities have been specified to Public Health Center at the designated city by the implementation of the Regional Health Law in 1994. As a result, Public Health Center at the designated city is able to implement independently measures to prevent infectious disease (Ahiko 2006). Information delivery is one such measure, and it is considered that the devolution of authority has caused such regional differences.

Hokkaido has the second largest number with 27 agencies and local governments, but 23 agencies and local governments exist at the municipality level. The agencies and local governments corresponding to local scales 2 and 3 are limited to four agencies and local governments. In addition, although their numbers are small, the aggregation of the *chome* and *aza* (block in Japan) level in Tokyo and Okayama, and the aggregation of the hospital and clinic level in Fukushima and Nagasaki are conducted by each agency. Tokyo, Okayama, and Fukushima have County and City Medical Associations, while Nagasaki has Public Health Centers located on separated islands. These four agencies have independently decided to aggregate the number of patients of medical institutions within their respective jurisdictions, and have consistently managed the related aspects of aggregation and provision within their region. Because the number of medical institutions in these four agencies of jurisdiction is fewer than 30, it seems that there is a system facilitating information collection on the local scale.

Table 2 illustrates the cross-tabulation of the types of specialized agencies and local governments and the spatial scale of data provided by IDSR. Public Health Institutes, Public Health Centers, and local governments provided data corresponding to the jurisdictional area of the agencies and local governments. Meanwhile, Medical Associations are provided at various levels, such as the County and City Medical Association levels, municipal district level, public school district level, *chome* and *aza* (block in Japan) level, school facility level, and hospital and clinic levels. They conduct their own surveillance operation in addition to NESID. This causes a difference among such types of specialized agencies, local governments, and spatial scales.

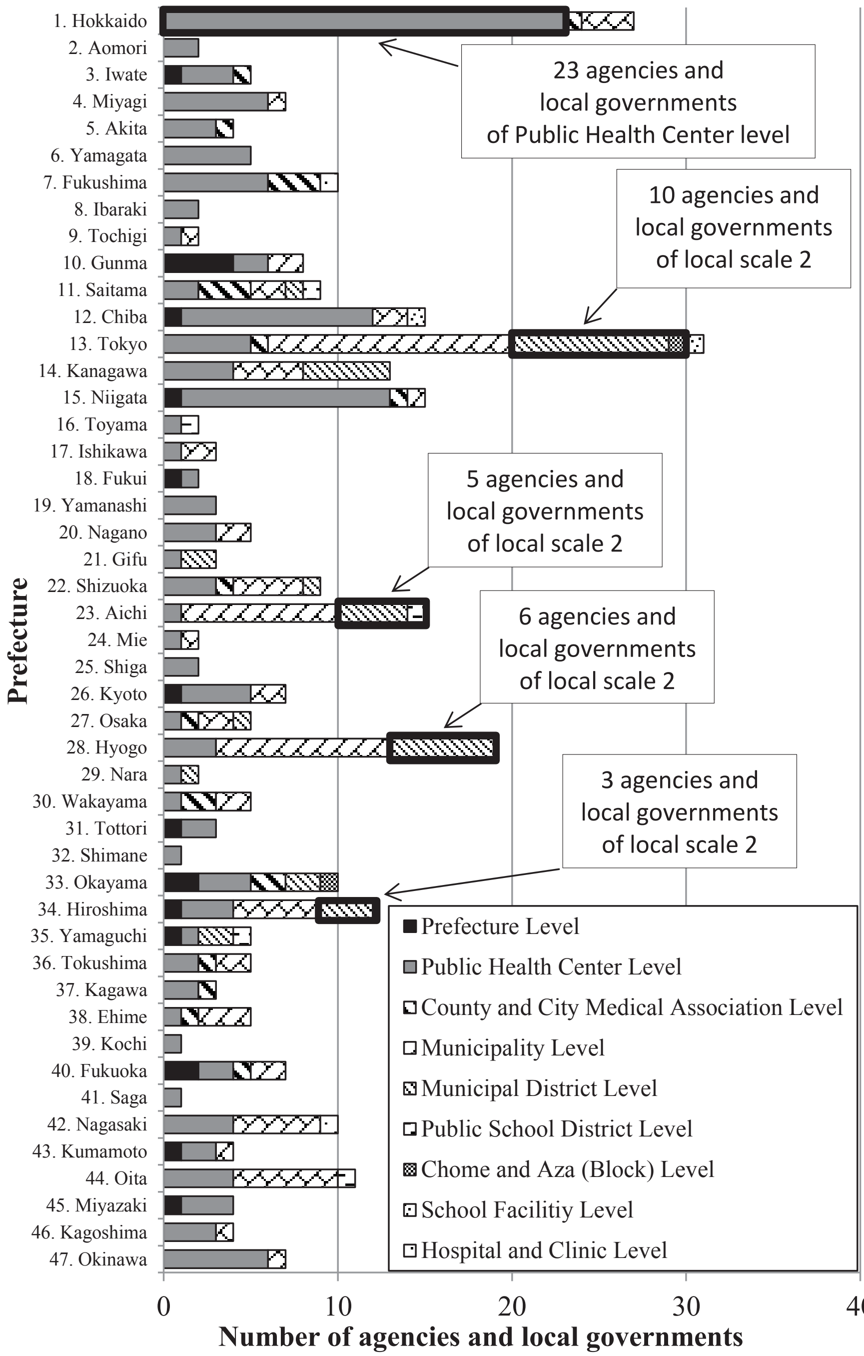

Fig. 5 Number of the spatial levels of specialized agencies and local governments by prefecture (IDSR).
Source: Website survey by the author.

Table. 2 Cross-tabulation of spatial levels of data provision and the types of specialized agencies and local governments category (IDSR).

Spatial levels	Public Health Institute	Public Health Center	Medical Association	Local Government	Total
Prefecture	0	0	7	11	18
Public Health Center	47	80	14	14	155
County and City Medical Association	0	0	21	0	21
Municipality	9	29	29	23	90
Municipal district	1	5	28	3	37
Public school district	0	0	5	0	5
Chome and *aza* (block in Japan)	0	1	1	0	2
School facility	0	0	2	0	2
Hospital and clinic	0	1	1	0	2
Total	57	116	108	51	332

Source: Website Survey by the author

4. Conclusion

In this study, we examined the distribution of local surveillance data delivery and spatial scales of these surveillance data in Japan. The findings obtained are summarized as follows.

From the results of the website survey, we found that local surveillance in some Medical Associations and Public Health Centers is conducted at various levels, such as the County and City Medical Association level, municipal district level, public school district level, *chome* and *aza* (block in Japan) level, school facility level, and hospital and clinic levels. In addition, these specialized agencies work on their own local surveillance.

These diversified functions of specialized agencies are caused by the transfer of authority concerning health sanitation of assignment at Public Health Centers, and the increase of independent surveillance operation at County and City Medical Associations. At the designated city of Public Health Center, the authority on health and sanitation was transferred from prefectures by the enforcement of the Regional Health Law in 1994, and its functions were diversified (Ahiko 2006). On the other hand, there are no systems for monitoring local infectious diseases besides the current NESID in the case of prefectural Public Health Centers (Sasaki 2006). The County and City Medical Association has developed an independent surveillance project, from the viewpoint of the raising awareness of the crisis caused by the influenza pandemic in 2009 and the weakness of the rapidity of the information distribution possessed by current NESID (Arahori 2017). Based on these circumstances, it is considered that independent surveillance on the local scale should be strengthened by specialized agencies and local governments throughout the country.

Regional differences also occur in information distribution of infectious diseases as functions of specialized agencies diversify. However, there are only a few cases of the efforts to conduct local surveillance in the Public Health Center and County and City Medical Association. It seems that some problems exist, such as differences in authority by specialized agencies, and differences in crisis consciousness against infectious disease prevention. Hence, more discussions are needed to strengthen independent local surveillance in each region of Japan.

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References

Ahiko, T. 2006. Organizational structure and enhancement of public health centers with a viewpoint of health crisis management: A consider of organizational structure of public health centers. *The Journal of Public Health Practice* **70**(3): 180–184.*

Anthamatten, P., and Hazen, H. 2011. *An Introduction to The Geography of Health*. New York: Routledge.

Arahori, T. 2017. Utilization of disease maps and issues of health crisis management in influenza surveillance. *Map : Journal of the Japan Cartographies Association* **55**(2): 1–16.**

Boulos, M. N. K. 2004. Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom. *International Journal of Health Geographics* **3**(1). http://www.ij-healthgeographics.com/content/3/1/1 (last accessed 16 December 2018)

Gao, S., Mioc, D., Anton, F., Yi, X., and Coleman, D. J. 2008. Online GIS services for mapping and sharing disease information. *International Journal of Health Geographics* **7**(8). http://www.ij-healthgeographics.com/content/7/1/8 (last accessed 16 December 2018)

Inoue, M., Hasegawa, S., Suyama, A., and Meshitsuka, S. 2003. Automated graphic image generation system for effective representation of infectious disease surveillance data. *Computer Methods and Programs in Biomedicine* **72**: 251–256.

Li, Y-P., Fang, L-Q., Gao, S-Q., Wang, Z., Gao, H-W., Liu, P., Wang, Z-R., Li, Y-L., Zhu, X-G., Li., X-L., Xu, B., Li, Y-J., Yang, H., De Vlas, S-J., Shi, T-X., and Cao, W-C. 2013. Decision Support System for the Response to Infectious Disease Emergencies Based on WebGIS and Mobile Services in China. *PLoS ONE.* **8**(1): e54842. doi:10.1371/journal.pone.0054842 (last accessed 16 December 2018)

Mizushima, H. 2018. Current status and issues of ICT in health care. *Journal of the National Institute of Public Health* **67**(2): 144–149.**

Oda, H., and Yakushiji, M. 2006. Health crisis management system of public health institutes. *The Journal of Public Health Practice* **70**(3): 189–191.*

Sasaki, R. 2006. Organizational structure and enhancement of public health centers with a viewpoint of health crisis management: A consider of function of public health centers. *The Journal of Public Health Practice* **70**(3): 177–179.*

Shuai, J., Buck, P., Sockett, P., Aramini, J., and Pollari, F. 2006. A GIS-driven integrated real-time surveillance pilot system for national West Nile virus dead bird surveillance in Canada. *International Journal of Health Geographics* **5**(17). http://www.ij-healthgeographics.com/content/5/1/7 (last accessed 16 December 2018)

(*: in Japanese, **: in Japanese with English abstract)