Spatial analysis for regional behavior of patients with mental disorders in Japan

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Abstract

Aim

The aim of our study was to clarify the geographical movement of patients treated in psychiatric facilities, which can provide important information on the resources and health-care system of psychiatric services.

Methods

We conduct an analysis of nationwide data on psychiatric patients, collected as an additional survey to the conventional '630 survey' in 2014. For the 151 848 initially admitted inpatients during 6 months and the 144 401 outpatients on a specific day, we identified whether a patient was admitted to a psychiatric facility located in the same medical area as his/her residence. We estimated percentages of being from (i) within the medical area, (ii) within the prefecture, and (iii) outside the prefecture, using a Bayesian statistical approach for each secondary medical area.

Results

The inpatients moved across wider areas than did the outpatients. Almost all inpatients and outpatients received their medical treatment at hospitals/clinics within their prefecture of residence.

Conclusion

The current mental health medical system in Japan has been operating according to prefecture unit; thus, it may be appropriate to plan a medical system at a prefectural level.

Keywords: inpatients, medical area, outpatients, patients' behavior, spatial epidemiology

The Ministry of Health, Labour, and Welfare (MHLW) of Japan released the 'Mental Health and Welfare Reform Vision' in September 2004.[1] This report set general goals for the subsequent 10 years, in order to reform mental health and medical welfare from the 'hospital-based medical treatment to the community-based case.'[2] At the halfway point of the Reform Vision, in September 2009,[3] a government panel on future mental health and welfare put forward the recommendation that mental disorders should be a new priority for the Regional Healthcare Strategic Plan. As such, they are to provide a variety of mental health-care services and establish a collaborative system among health-care institutions.[4] Additionally, the 2009 report identified the need to set a target for the number of inpatients. To consider the context of the vision, it is important to clarify the current status of health care use in mental health.

Health service utilization is an important issue in public health, and has been discussed in various fields, such as: health problems in developing countries; health economic issues, including health insurance; and health-care policy making for health-care protection and health status.[5,6] Health disparities at the global, regional, and local scale can provide information about health problems and help improve health and well-being. Geographies of patients and health services are main sources of information, being essential components of geographic information system (GIS) applications in public health.[7] Since information is obtained through medical care contact, the understanding of health problem distributions is conditioned by the geographical distribution of health services and factors that affect their functioning and utilization. In addition to documenting geographical variations in health services access, GIS analyses have addressed issues in health services planning.[8–12]

In the mental health system of Japan, no formal catchment areas are found

and patients can choose any facility. To evaluate of the community health service in Japan, there are also a number of qualifications to consider in the Japanese context, which include the wide scope of hospital functions and the fact that expected roles of hospitals also vary in different parts of the country.[13] While certain studies report regional differences and related issues in mental health,[14,15] others discuss sociodemographic factors and clinical characteristics of psychiatric patients in Japan.[16–19] There are major differences in characteristics and behaviors of patients between urban and rural areas, and, in some studies, numerous psychiatric hospitals are located in rural areas.[20–22] However, no detailed investigations into the differences in regional behavior of patients with mental disorders all over Japan have been reported.

The current mental health medical system in Japan has been operating according to a prefecture unit. On the other hand, the medical care plan, except that on mental health, has been established based on the secondary medical area, which consists of neighboring municipalities in all 47 prefectures, according to the medical service law in Japan. Hence, it is crucial to clarify the status and regional differences for both secondary medical areas and prefectures. A nationwide exhaustive annual survey, the '630 survey,' is conducted for mental health by the MHLW every year on 30 June. Each prefecture with cities designated by government ordinance requires a report on the state of psychiatric admissions and discharges from hospitals with psychiatric beds and psychiatric clinics in their area.[23,24] However, this conventional survey has been insufficient in identifying the detailed trend of patients, because each hospital/clinic reports only aggregated numbers, not individual patients' data. Particularly, the patients' place of residence is not investigated, and we cannot identify their geographical movement based on these data. Therefore, this study examined the

geographical distribution of patients' behavior during psychiatric treatment, analyzing and visualizing their geographical behavior using maps based on new data from the nationwide additional survey.

METHODS

We conducted an analysis on nationwide data for psychiatric patients, collected by the MHLW as an additional survey to the conventional '630 survey' of 2014. This was a questionnaire survey of hospitals/clinics, similar to the conventional survey. This additional survey investigated the characteristics of initially admitted psychiatric inpatients from January to June 2014 (6 months) for hospitals with psychiatric beds, and those of outpatients on 30 June (1 day) for both hospitals with psychiatric beds and psychiatric clinics. The questionnaire items included sex, year of birth, diagnosis of mental disorders, date of admission, and the names of cities, wards, towns, or villages of residence for each patient. Diagnostic information was gathered based on the criteria of the ICD-10.[25] The data was aggregated by secondary medical area: 341 areas, where two medical areas in Kawasaki city and three in Yokohama city were aggregated to one area each. We estimated the percentages of patients from: (i) within the medical area (i.e., patients who were living in the same medical area as the hospitals they were staying at or receiving treatment at); (ii) within the prefecture (i.e., patients who were living in the same prefecture as the hospitals); and (iii) outside the prefecture, for each area. When this proportion is estimated in a small geographic area, the use of percentages can yield estimates with a wide variability. To overcome this problem, a Bayesian approach has been developed for disease mapping in spatial epidemiology.[26,27] In this study, we utilized the empirical Bayes estimator for proportion, using the

binomial-beta model, $(d_i + v_1)/(n_i + v_1 + v_2)$, instead of the simple estimates d_i/n_i for i-th area, where d_i, n_i denote observed and total numbers, respectively, and parameters v_1, v_2 are calculated by maximizing the likelihood based on data from all areas. Note that this Bayes estimator has also been adopted for the report on municipal total fertility rate by the MHLW.[28]

This study was approved by the ethics committee at the National Center of Neurology and Psychiatry, Japan (A2014-112).

RESULTS

The 151 848 initially admitted inpatients within the 6 months studied here and the 144 401 outpatients in a day were reported in the survey. The 150 262 inpatients in 1364 hospitals and the 142 325 outpatients in 3159 hospitals/clinics who could specify the medical area of the hospital/clinic were selected for our analysis. We noted that the numbers of reported hospitals/clinics for both inpatients and outpatients were below those of the previous '630 survey' in 2012 (i.e., 1622 hospitals and 3743 clinics); specifically 84.1% of 1622 hospitals were reported for inpatients, while 58.9% of $1622 + 3743 = 5365$ were reported for outpatients. The percentages for males and females were 46.6% and 53.4% for inpatients, and 47.7% and 52.2% for outpatients, respectively. The percentages by diagnostic disorders, F0, F1, F2, F3, F4, F5, F6, F7, F8, F9, epilepsy except F0, others, were 21.0%, 8.5%, 36.1%, 21.4%, 5.2%, 1.0%, 1.1%, 1.6%, 1.2%, 0.4%, 0.8%, 2.0% for inpatients, while those for outpatients were 8.2%, 3.2%, 32.5%, 29.9%, 16.4%, 0.7%, 0.8%, 1.3%, 2.1%, 0.9%, 1.7%, 2.2%, respectively.

There were 29 and 10 areas without hospitals/clinics reported by inpatients and outpatients, respectively. The quartiles of the reported number of inpatients in 312

areas, excluding the above 29 areas, were: minimum, 25%, 50%, 75%, and maximum = 18, 151.5, 304, 621.5, and 4931; while those of the number of hospitals were: 1, 2, 3, 5, and 46. Both maximum numbers were reported in the Sapporo medical area. Subsequently, the number of patients per hospital was 18.0, 69.5, 97.0, 130.1, and 557.0, whose maximum was reported in Sakai city medical area, Osaka, with 2228 inpatients in four hospitals. On the other hand, the quartiles of outpatients in 331 areas, excluding the above 10 areas, were 6, 117, 267, 517.5, and 5350, while those of the number of hospitals/clinics were 1, 3, 5, 11, and 101; both maximum numbers were also reported in the Sapporo medical area. The number of patients per hospital/clinic were 5.0, 34.3, 43.9, 56.6, and 171.0, the maximum being reported in the Nichinan-Kushima medical area in Miyazaki, with 171 outpatients in a hospital.

The 107 288 (71.4%) inpatients among the total 150 262 were from within the medical area, while 141 887 (94.4%) were from within the prefecture. The Bayesian estimates of percentages for both of the above groups of inpatients were calculated in each medical area (Fig. S1). The quartiles with the minimum and maximum estimated percentages for inpatients from within the medical area were 0.14, 0.62, 0.78, 0.89, and 0.99, where the lower five areas were: 0.14 in Owari-Tobu (Aichi); 0.17 in Ku-Chuo-bu (Tokyo); 0.23 in Nishi-Tama (Tokyo); 0.27 in Shibukawa (Gunma); and 0.32 in Kita-Tama-Nanbu (Tokyo). For the inpatients from within the prefecture, the quartiles were 0.64, 0.94, 0.97, 0.98, 1.00), and the lower five areas are 0.64 in Nanseibu (Saitama), 0.68 in Nanbu (Saitama), 0.69 in Ku-chuo-bu (Tokyo), 0.76 in Ryomo (Tochigi), and 0.76 in Yokosuka-Miura (Kanagawa). The maps of these percentages are shown in Figure 1. They identified that the percentages of inpatients from within the medical area varied over areas, and, in particular, the areas around Tokyo, Nagoya,

Osaka, and Fukuoka had lower percentages of below 50%. On the other hand, for the percentages of inpatients from within the prefectures, almost all areas were over 90%.

The results of outpatients are also shown in Figure 2 and Fig. S2. The quartiles were 0.30, 0.78, 0.87, 0.93, and 0.99 for the outpatients from within the medical area, and 0.76, 0.96, 0.98, 0.99, and 1.00 for the outpatients from within the prefecture. For the former group of outpatients, the five areas with the lowest percentages were 0.30 in Ku-chuo-bu (Tokyo), 0.31 in Koga-Bando (Ibaraki), 0.40 in Ku-Seibu (Tokyo), 0.44 in Shibukawa (Gunma), and 0.46 in Kamimashiki (Kumamoto); while for the latter group they were 0.76 in Ku-chuo-bu (Tokyo), 0.81 in Mito (Ibaraki), 0.82 in Ku-Seihoku-bu (Tokyo), 0.82 in Ku-Seibu (Tokyo), and 0.84 in Miyakonojo-Kita-Morokata (Miyazaki). These results show that almost all inpatients and outpatients received medical treatment at a hospital/clinic in their prefecture of residence.

Lastly, the scatter diagram between the percentages of inpatients and outpatients from within the medical area for the 310 areas where both inpatients and outpatients were reported is shown in Figure 3. The percentages of outpatients are higher than those of inpatients in almost all areas, with a Spearman's rank-order correlation of 0.86.

DISCUSSION

In this study, we analyzed the data collected by the MHLW through an additional survey on psychiatric hospitals and clinics. Investigations on patients' behavior that included psychiatric hospitals had been conducted and reported in several prefectures (e.g., Ibaraki in 2011[29] and Iwate in 2012[30]), but the additional survey was nationwide, extensive, and provided valuable results. Because of the differences in response rates, it

is difficult to find the geographical distribution of patients directly. However, our analysis reveals the patients' regional movement for medical mental health treatment all over Japan, which has not been previously analyzed in detail. Our results show that inpatients move in wider areas than outpatients. Both inpatients and outpatients receive their medical treatment at hospitals/clinics within their prefectures of residence. We also found a high correlation between the percentages of inpatients and outpatients. A number of studies have pointed out that accessibility based on travel time is an important factor in choosing a hospital for patients.[31–33] As expected, there were numerous areas with a lower percentage of patients from within the area in the urban ranges around Tokyo in Kanto area, Nagoya in Chubu area, Osaka in Kansai area, and Fukuoka in Fukuoka area for both inpatients and outpatients, where there are developed transportation networks. However, especially for inpatients, the percentages from within the area varied widely. On the other hand, these results, especially for inpatients, did not correspond to our expectations that these patients might be admitted to hospitals outside the prefecture. Although convenient transportation affects the patients' choice of hospitals/clinics, our results suggest that the choice is also affected by the prefectural boundary. The current mental health medical system in Japan is operating according to prefecture unit; thus, it may be appropriate to plan a medical system for each prefecture.

In some countries, such as the United Kingdom, Italy, and Australia, most public mental health services are administrated via an area-based service system, where each service area generally overlaps with local municipal administrative areas to allow better service coordination.[13] On the other hand, the Japanese mental health system has no formal catchment areas for patients, and they can choose any facility or

doctor at any time with the same amount of payment. Although our work is limited to Japan, our results suggest the existence of substantial catchment areas in the mental health system of countries that formally lack one. This allows for mental health comparisons between countries having different systems.

On the other hand, patients' behavior might differ with diagnoses. For example, the patients with 'mental and behavioral disorders due to psychoactive substance use,' such as alcoholism, might require specialized hospitals from outside their prefecture for diagnosis, while the outpatients with schizophrenia could receive treatment at neighboring clinics from their residence or office. In fact, the 2012 '630 survey' reported that there are specialty hospital beds for demented patients in every prefecture, while 22 of 47 prefectures do not have specialty beds for alcoholism, where the specialty beds were defined as the number of beds in the inpatient ward in which more than 50% of the patients suffered from specific disorders. Establishing differences by diagnosis and factors affecting their behavior are also important. Furthermore, as pointed out by the 'Reform Vision,'[1,3] the transition of long-stay inpatients to the community is essential for establishing community mental health-care programs in Japan. As such, recent discussions have evaluated the need for community resources towards community placement.[34,35] However, we also need to investigate the characteristics of patients associated with their medical behavior in more detail in our further research.

We should note the limitations of our study. First, only initially admitted psychiatric inpatients during a period of 6 months were surveyed, discounting the behavior of long-term inpatients in this study. Additionally, this is a limited investigation regarding outpatients because only outpatients on a specific day were surveyed, while they might be affected by month or weekday. Second, especially for

inpatients, there is some concern that patients with recurrent hospitalization cause data duplication. Third, this survey was not conducted to identify individual patients, and did not provide information on their detailed residential addresses so as to clarify more detailed patients' behavior on a local scale (e.g., municipalities as the first medical area). Finally, there were areas with a lower response rate; for example, outpatients did not report from 10 medical areas, as previously noted, and the number of hospitals/clinics reported by outpatients was 58.9% of that in the '630 survey' in 2012.

The 'Mental Health and Welfare Reform Vision'[1] in Japan aimed to reduce the number of psychiatric hospital beds by about 70 000 over 10 years. As such, the results of the spatial analysis for regional behavior of patients could provide useful information on the mental health health-care system, including resource allocation of psychiatric services. Additionally, it will be important to clarify the status of patients after bed reduction.

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DISCLOSURE STATEMENT

The authors have no conflict of interest directly relevant to the content of this article.

AUTHOR CONTRIBUTIONS

Conception and design of the study: K.T., H.T., and T.T. Acquisition and analysis of data: K.T., H.T., C.K., and N.K. Initial drafting of the article and figures: K.T. Interpretation of data: K.T., H.T., D.N., Y.O., and T.T. All authors critically reviewed the manuscript, and the final version of the manuscript was approved by all authors.

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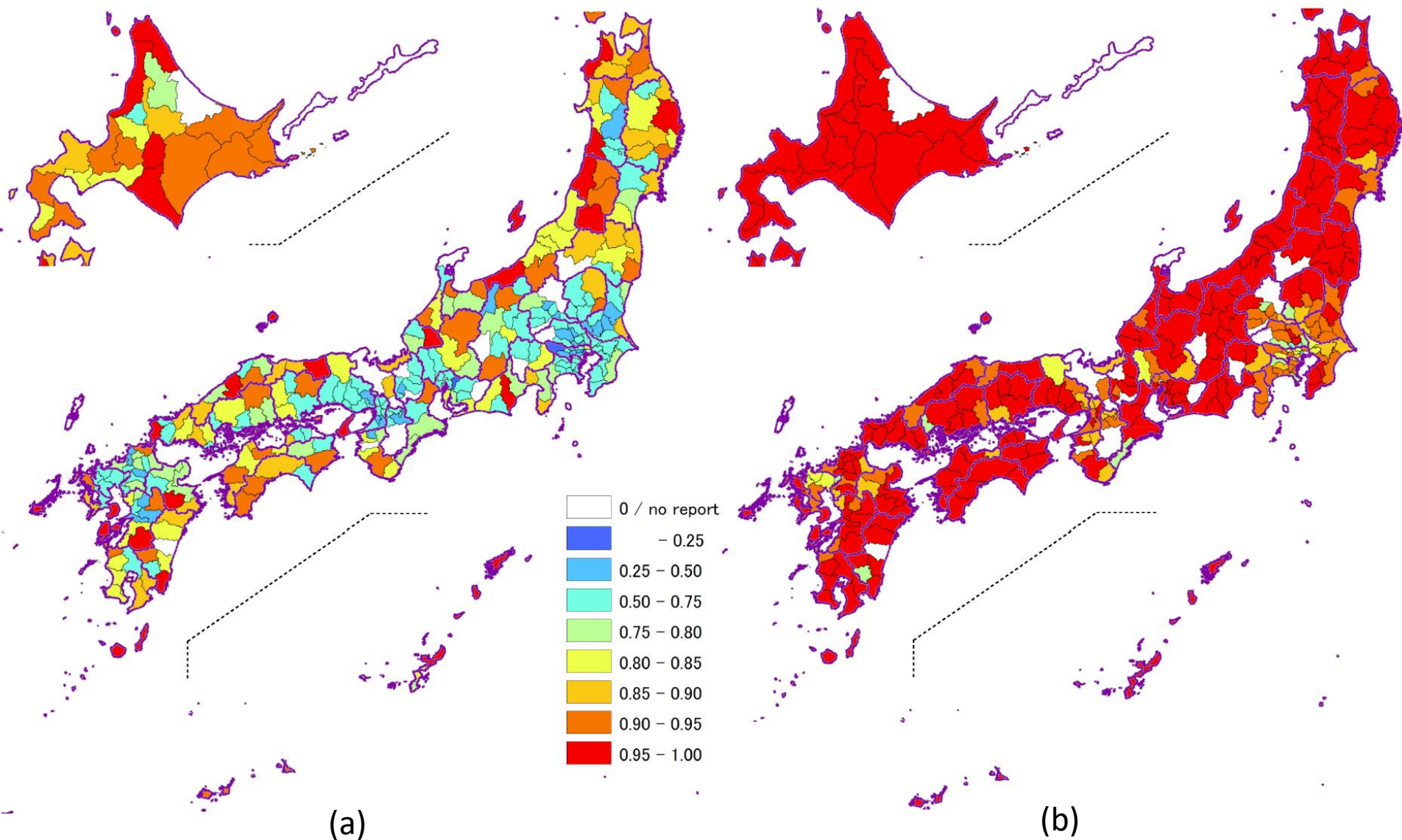
Figure 1. Maps of estimated percentages (Bayesian estimates) of inpatients from (a) within the medical area and (b) within the prefecture.
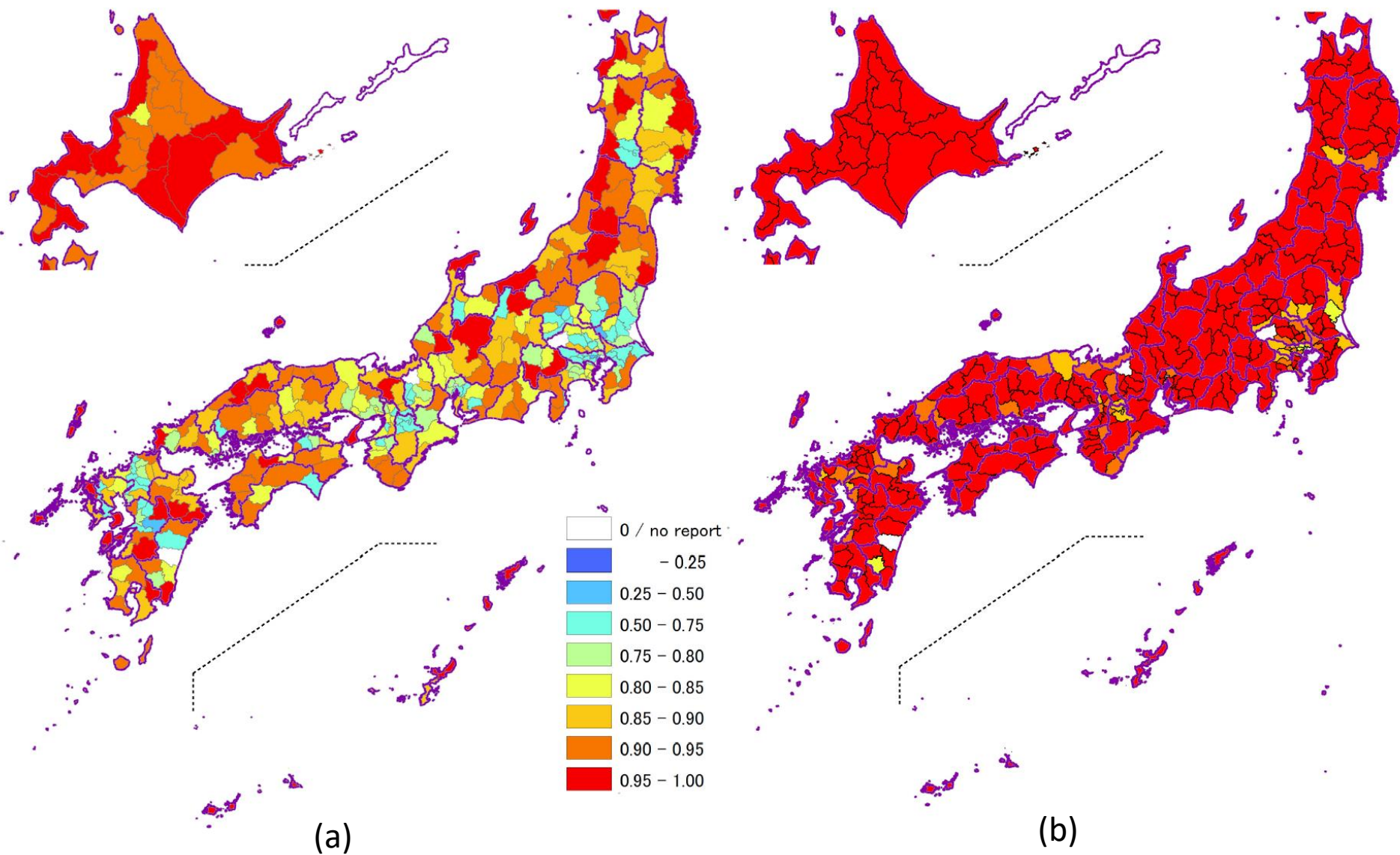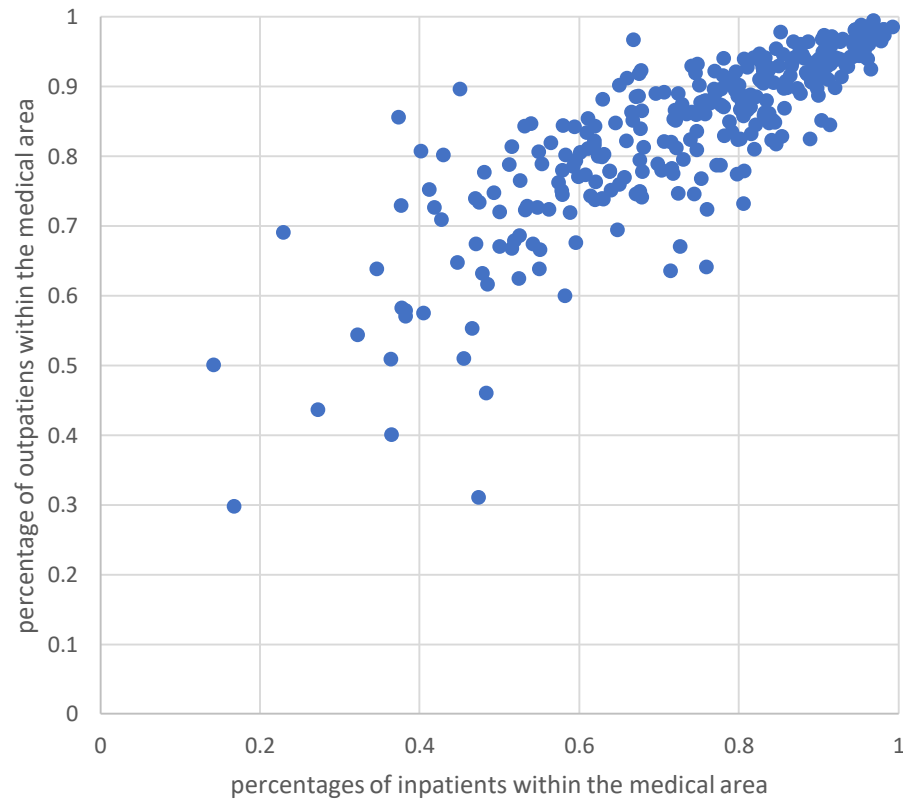
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	0.90 − 0.95
	0.95 − 1.00

(a)   (b)

Figure 2. Maps of estimated percentages (Bayesian estimates) of outpatients from (a) within the medical area and (b) within the prefecture.

Figure3. Scatter diagram showing the estimated percentages of inpatients from within the medical area, x, and that of outpatients, y, with the line $y = x$.
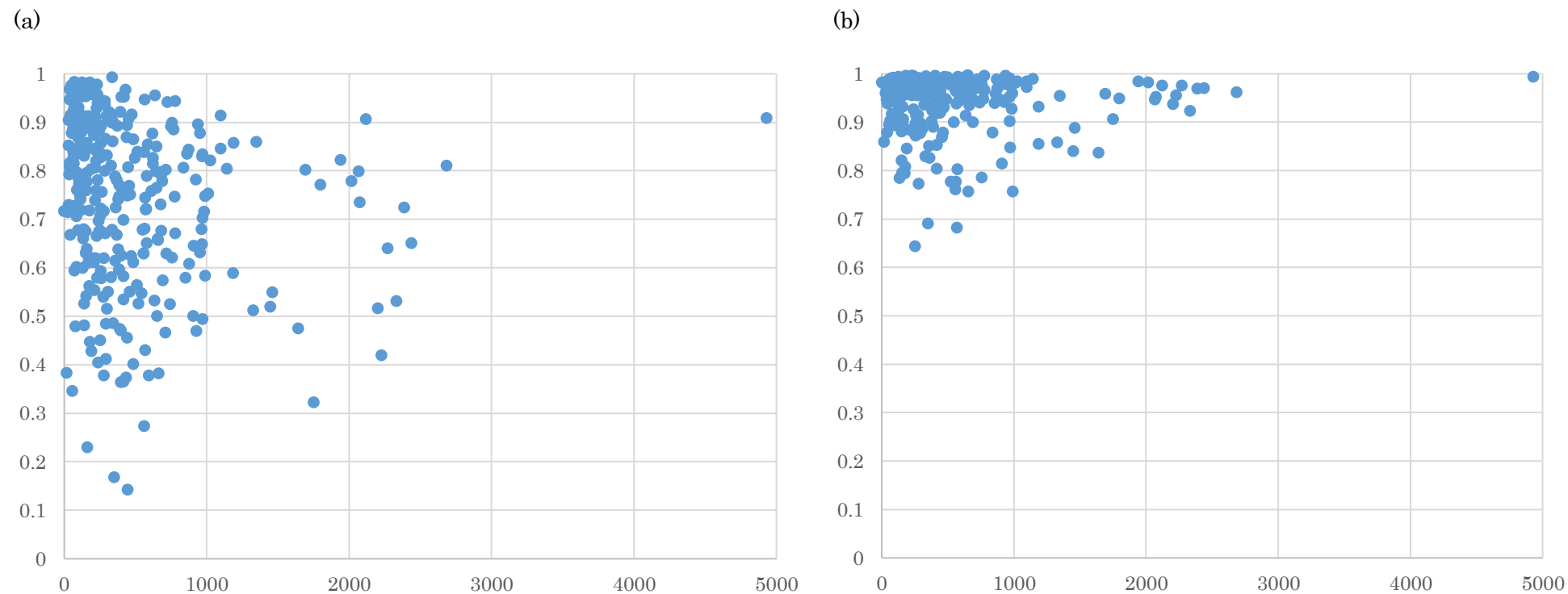
Supporting information

Figure S1. Estimated percentages (Bayesian estimates) of inpatients from (a) within the medical area and (b) within the prefecture, where the horizontal axis is for the total reported number of inpatients in each area.

Figure S2. Estimated percentages (Bayesian estimates) of outpatients from (b) within the medical area (b) within the prefecture, where the horizontal axis is for the total reported number of outpatients in each area.

Figure S1. Estimated percentages (Bayesian estimates) of inpatients from (a) within the medical area and (b) within the prefecture, where the horizontal axis is for the total reported number of inpatients in each area.
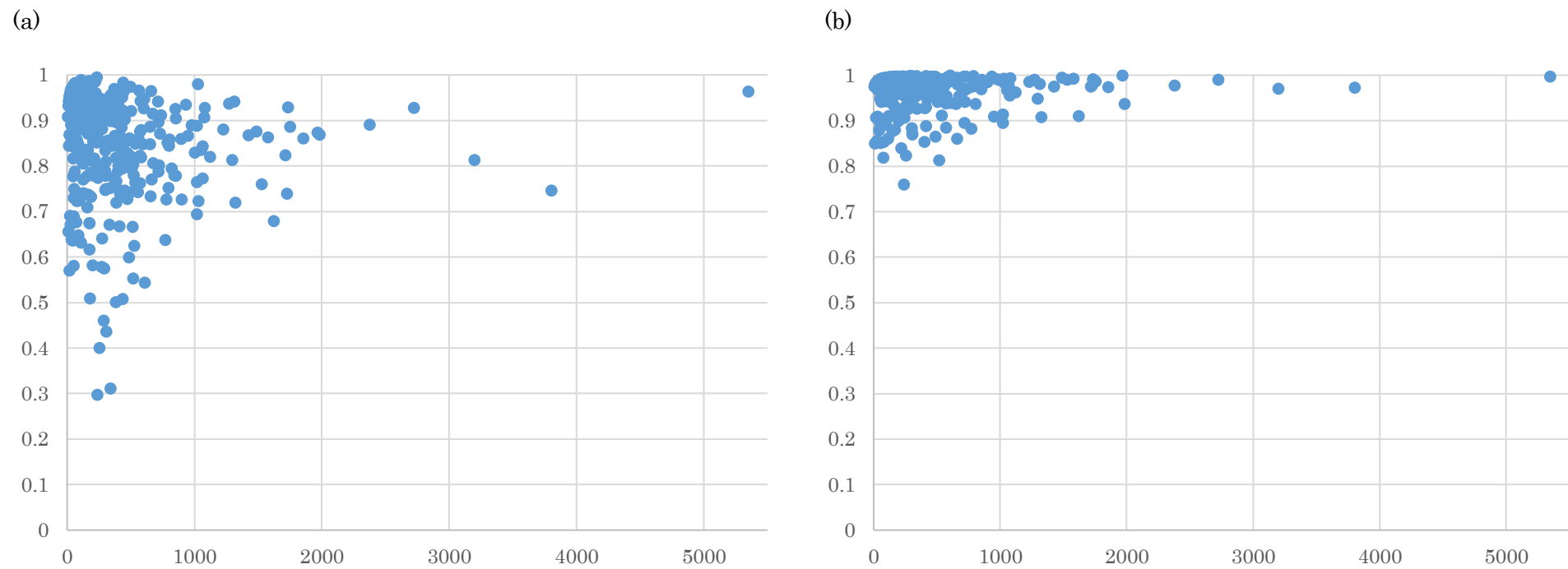
Figure S2. Estimated percentages (Bayesian estimates) of outpatients from (a) within the medical area and (b) within the prefecture, where the horizontal axis is for the total reported number of outpatients in each area.