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ABSTRACT

Objectives A major issue in Japan's health policy is the geographical maldistribution of physicians. This study aimed to analyse temporal trends in the geographical distribution of physicians and analyse physicians in high and intermediate physician density areas and factors related to their movement to low physician density areas in Japan.

Design A longitudinal study.

Setting All physicians in 344 secondary medical districts.

Participants I analysed data from the biennial national census, conducted by the Ministry of Health, Labour and Welfare between 1996 and 2016 and divided it into two cohorts of 10 years each: 1996–2006 and 2006–2016.

Primary and secondary outcome measures I estimated the temporal trends in the number and percentages of physicians, and used logistic regression to analyse physicians in high and intermediate physician density areas and the factors related to their movement to low physician density areas.

Results The overall number of Japanese doctors increased by 31% between 1996 and 2016. The number of physicians per population in the physician high-density areas increased by 29%, while those in low-density areas increased by 32%, suggesting that the gap between areas marginally decreased. The multivariable logistic regression analyses revealed that academic hospital experience had the highest OR for predicting physician movement to low physician density areas after 10 years, both in the 1996 and 2006 cohorts. Other factors that positively correlated with physician movement were being male, being younger than 40 years, being qualified after the age of 30, urban area, intermediate physician density area and practice in a non-academic hospital.

Conclusions As less-experienced physicians demonstrate high mobility among geographic categories, and retention rates are low in low physician density areas, especially for less-experienced physicians, a new system that considers these factors would create opportunities for younger physicians to work in low-density areas.

Strengths and limitations of this study

- This study longitudinally examines the geographic distribution of physicians in Japan, focusing on physician density by secondary medical districts using individual physician data with permission from the national government.
- To improve the uneven distribution of physicians, especially for less-experienced physicians, a new system that considers these factors would create opportunities for younger physicians to work in these low-density areas.
- This study only focused on correlations and was unable to determine causality. Future studies could use interviews and questionnaires to facilitate more comprehensive research for physician migration.
- The observation period is 20 years. The effects of various environmental changes, such as the global economic crisis, policy changes for physician maldistribution, and population ageing, were not considered.

INTRODUCTION

The uneven geographical distribution of physicians is a critical issue for Japan's health policy that is perhaps related to the Japanese government's lack of restrictions on physicians' work location choices.¹ As a result, although the number of physicians is increasing, there is little improvement in geographic imbalance.^{2 3} Historically, a Japanese university's medical schools were responsible for pooling and dispatching doctors to urban and rural hospitals according to their specialties. Residency training was not previously mandatory, and medical schools would send graduates directly to practice. However, a new residency training programme for physicians was nationally launched in 2004

that requires young doctors to choose a clinical training hospital outside of their university in the first 2 years after graduation.⁴ This programme has weakened the university hospital system, as it has forced new physicians to choose specialisations, in hospitals where they can find a position, and thereby exacerbated geographic imbalances.^{5–8}

To address this geographic imbalance, several policies have been established.⁹ First, the number of medical students rose from 7625 in 2007 to 9420 in 2017, because of increased medical school capacity. Second, a system for selecting students was developed with the primary objective of recruiting physicians, mainly in rural areas. This system included 1674 medical students in 2017, 18% of the capacity of medical schools. Many medical students earn prefectural scholarships and are excluded from reimbursements if they serve at a designated medical institution for a fixed time period. Despite these policies, maldistribution persists.¹⁰ Further, a 2018 revision in the Medical Care Act encourages prefectures to take effective measures to secure the necessary number of physicians according to specialisations to remedy geographical maldistribution. Currently, a policy is being drafted that acts as a countermeasure for maldistribution. It requires hospital directors to procure work experience in low physician density areas for a certain period and thus incentivises physicians.¹¹

Several previous studies have highlighted the relationship between geographic movement and physician features such as gender, age and specialisation.^{12–14} For instance, a 2002 study found that doctors who had practiced rural care in 1980 were more likely to stay in rural care. This pattern was more pronounced among men, older doctors and/or primary care professionals.¹² As these data come from the physician population in 1980, it is difficult to apply it to recent developments, such as the rise in female physicians and the influence of new residency training systems. Many US studies have investigated male and female physicians,¹³ as well as white, black and foreign graduates of medicine,¹⁴ and found that they often move locations. For Japan, however, there have not been any studies that explore the transition from lower to higher physician density areas. Because of this gap in the literature, the purpose of the present study was to identify the factors associated with physician movement between various physician density areas in Japan. The findings can inform efforts to prevent uneven distribution of doctors, based on differences in physician density.

METHODS

I used individual physician data from the Survey of Doctors, Dentists, and Pharmacists, a nationwide census survey conducted every 2 years by the Japanese Ministry of Health, Labour and Welfare (MHLW), collected over two decades (1996 through 2016). In Japan, all physicians are expected to report their status every 2 years under the Medical Practitioners' Act. As such, the response rate was around 90%.¹⁵

I analysed physician demographic data from 1996, 2006 and 2016, particularly focusing on registration numbers, gender, age, experience, type of workplace (municipal and institutional) and medical practice. I developed two cohort datasets (1996–2006 and 2006–2016) using the physician registration numbers and analysed geographical movement patterns. When creating the cohort dataset, I analysed the physicians who responded in both years. Additionally, in the original data obtained from the Ministry of Health, Labour and Welfare, there were no incomplete or missing data.

In terms of geography, I categorised the 344 secondary medical areas (SMAs) in Japan in 2016 into three groups based on the combinations of population size and density: (1) urban, (2) intermediate and (3) rural. In Japan, as in the US Office of Management and Budget, the definition of rural is not always consistent.¹⁶ The categorisations used were the MHLW classification position statements regarding the demand for physicians.¹⁷ Based on the classification used by MHLW, the first group (urban) consists of areas with a population of at least 1 million or a population density of at least 2000 people/km². The second group (intermediate) consists of areas with a population of at least 100 000 or a population density of at least 200 people/km². The third group (rural) consists of areas that do not belong to the first or second groups. The municipality borders that were altered because of mergers were adjusted based on the borders used in 2016. Physicians who were in the same SMA category during the study period were considered to be retained there.

I determined the number of physicians in each SMA group per 100 000 population by using total number of physicians and total population data. To account for the disparity in physician data years (1996, 2006 and 2016) and population data years (1995, 2005 and 2015), I applied the physician data to the previous year of population data: physician 1996 to population 1995, physician 2006 to population 2005 and physician 2016 to population 2015. Regarding the number of physicians per SMA in 1996, 2006 and 2016, the top 33.3% were classified as areas with many physicians and the bottom 33.3% as those with fewer physicians, based on the MHLW physician density classifications in 1996, 2006 and 2016.¹¹

The physicians were classified into four categories, depending on the employment agency: clinics, university hospitals, other hospitals and other (eg, public health centres, industrial physicians and unemployed physicians). In Japan, clinics are defined as medical institutions with less than 20 inpatient beds, while hospitals have more than 20 inpatient beds. To determine the relationship between specialisations and clinic forms, I identified and labelled the doctors who registered with specialties in internal medicine, general surgery or paediatrics as primary care physicians. Physicians, general surgeons and paediatricians play a significant role in primary care, as there is a lack of recognised primary care skilled physicians comparable to US family medicine physicians in the Japanese healthcare system.¹⁸

I described the distribution of physicians by their density in 1996, 2006 and 2016, based on the physician density classification in 2016. Then, I illustrated the inflow and outflow of physicians by physician density classification during the two periods (1996–2006 and 2006–2016) based on the physician density classifications in 1996, 2006 and 2016. Next, regarding low physician density areas, for the data from 1996 to 2016, I calculated the retention rate every 2 years and analysed the trends.

Subsequently, regarding the two cohorts (1996–2006 and 2006–2016), I excluded physicians who were already in the low physician density area. I then analysed physicians in high and intermediate areas and the factors related to their movement to low physician density areas after 10 years, from 1996 and 2006, through a multivariable logistic regression analysis based on the physician density classifications in 1996, 2006 and 2016. Intermediate and high physician density areas were set at three different time points (1996, 2006 and 2016). Additional information on the number of SMAs that changed classification between those time periods was also described.

For all statistical analyses, I used STATA V.15.1 and considered p values of less than 0.05 as significant.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

In the 1996, 2006 and 2016 physician surveys, data were available for 240 396, 277 927 and 319 474 physicians, respectively. **Figure 1** shows the number of physicians per 100 000 by region in 1996, 2006 and 2016. During this period, the overall number of doctors increased by 31% (from 191.4 to 251.4). Based on physician density criteria, the number of physicians per population in high physician density areas increased by 29% (from 250.6 to 323.9), while those in low physician density areas increased by 32% (from 112.8 to 149.0).

Table 1 displays all physicians' characteristics in 1996, 2006 and 2016. Between 1996 and 2016, the number of female physicians increased 2.1-fold and the proportion of female physicians increased from 13.4% to 21.1%. Between 1996 and 2006, the number of physicians aged 40–54 increased by 39%, while between 2006 and 2016, those aged 55–69 rose by 74%. In terms of facilities, the number of doctors in university hospitals grew by 23% between 2006 and 2016. Between 1996 and 2016, the number of primary care doctors remained nearly unchanged in terms of specialties, while the proportion of primary care physicians dropped from 46.4% to 35.2%.

Table 2 describes physician relocation from high-density to low-density areas between 1996 and 2006 and between 2006 and 2016. The 1996–2006 data revealed that 82.8% of doctors operating in high physician density areas in 1996 remained in these areas. Migration from high-density to low-density areas was low (6.1%). In comparison, 68.0% of doctors in low physician density areas in 1996 also remained in these regions, while the rest relocated to high-density and intermediate-density areas. In the 2006–2016 data, 85.3% working in high physician density areas remained in these regions in 2006. Once again, there was a low migration from high-density to low-density regions (4.9%). By comparison, 70.2% of those working in low physician density areas in 2006 stayed in those regions, and the rest relocated to high-density and intermediate-density areas.

Table 3 presents our estimations of the annual retention rates. The proportion of physicians who stayed in low physician density regions between 2014 and 2016 was 83.1%. This increase is indicative of general retention over the 1996–2016 period, which slightly increased from 80.5% to 83.1%. However, physicians with less than 15 years of experience tend to have a lower retention rate, and many begin working in low physician density areas.

Table 4 first shows the logistic regression results that served to identify the variables in 1996 that predicted physicians being engaged in high and intermediate areas and the factors related to their movement to low physician

Figure 1 Distribution of physicians per 100 000 residents by geographic area in 1996, 2006 and 2016 in Japan.

Table 1 Physician demographics and professional characteristics from 1996 to 2016

	1996 survey	1998 survey	2000 survey	2002 survey	2004 survey	2006 survey	2008 survey	2010 survey	2012 survey	2014 survey	2016 survey
Total, n	240 396	248 593	253 906	261 099	270 353	277 927	286 691	295 045	303 262	311 201	319 474
Sex, n %											
Male	208 207	86.6%	217 612	85.7%	225 731	83.5%	234 695	81.9%	243 622	80.3%	251 983
Female	32 189	13.4%	36 294	14.3%	44 622	16.5%	51 996	18.1%	59 640	19.7%	67 491
Age, n %											
≤39	96 678	40.2%	93 471	36.8%	92 788	34.3%	93 409	33.6%	93 351	30.8%	94 665
40-54	72 967	30.4%	89 726	35.3%	98 870	36.6%	101 645	36.8%	107 122	35.3%	105 861
55-69	43 957	18.3%	39 323	15.5%	46 337	17.1%	50 684	18.2%	72 456	23.9%	82 273
≥70	26 794	11.1%	31 386	12.4%	32 358	12.0%	32 189	11.6%	30 333	10.4%	30 675
Years of experience, n %											
0-14	102 947	42.8%	99 835	39.3%	98 560	36.5%	97 527	35.1%	97 348	32.1%	98 930
15-29	70 546	29.3%	82 909	32.7%	96 836	35.8%	102 647	36.9%	108 890	35.9%	107 093
30-44	37 895	15.8%	41 558	16.4%	45 153	16.7%	48 358	17.4%	67 642	22.3%	74 552
≥45	29 008	12.1%	29 604	11.7%	29 804	11.0%	29 395	10.6%	29 382	9.7%	30 626
Physician density level, n %											
High	160 439	66.7%	168 074	66.2%	178 516	66.0%	183 164	65.9%	201 743	66.5%	212 293
Intermediate	50 944	21.2%	53 963	21.3%	58 065	21.5%	60 794	21.9%	64 964	21.4%	69 838
Low	29 013	12.1%	31 869	12.6%	33 772	12.5%	33 969	12.2%	36 555	12.1%	37 343
Workplace, n %											
Urban	110 813	46.1%	116 838	46.0%	125 481	46.4%	130 061	47.5%	146 895	48.4%	156 249
Intermediate	111 146	46.2%	117 682	46.3%	125 155	46.3%	128 322	46.2%	137 179	45.2%	143 969
Rural	18 437	7.7%	19 386	7.6%	19 717	7.3%	19 544	6.8%	19 188	6.3%	19 256
Type of institution, n %											
Clinic	81 888	34.1%	87 764	34.6%	92 982	34.4%	97 626	34.1%	100 540	33.2%	102 453
Academic hospital	41 103	17.1%	41 551	16.4%	43 422	16.1%	46 563	16.2%	50 404	16.6%	55 187
Other hospital	106 823	44.4%	112 149	44.2%	120 252	44.5%	127 702	44.5%	137 901	45.5%	147 115
Others	10 582	4.4%	12 442	4.9%	13 697	5.1%	14 387	5.2%	14 417	4.8%	14 719
Specialty, n %											
Primary care	111 599	46.4%	113 455	44.7%	111 975	41.4%	108 289	37.8%	110 431	36.4%	112 445
Other	128 797	53.6%	136 685	55.3%	158 378	58.6%	178 402	62.2%	192 831	63.6%	207 029

Table 2 Physician density and physician migration**1996–2006 cohort**

	Physician density in 2006			
	Low	Intermediate	High	Total
Physician density in 1996				
High	7993 6.1%	14 445 11.1%	108 023 82.8%	130 461 100.0%
Intermediate	2178 5.4%	28 103 69.7%	10 019 24.9%	40 300 100.0%
Low	16 134 68.0%	2 192 9.2%	5 399 22.8%	23 725 100.0%
Total	26 305 13.5%	44 740 23.0%	123 441 63.5%	194 486 100.0%

2006–2016 cohort

	Physician density in 2016			
	Low	Intermediate	High	Total
Physician density in 2006				
High	7364 4.9%	14 822 9.8%	129 067 85.3%	151 253 100.0%
Intermediate	2427 5.0%	35 212 72.0%	11 256 23.0%	48 895 100.0%
Low	19 751 70.2%	2 469 8.8%	5 935 21.1%	28 155 100.0%
Total	29 542 12.9%	52 503 23.0%	146 258 64.1%	228 303 100.0%

density areas in 2006. The following factors positively predicted their movement to low physician density areas: being men, hospital practice, under 40 years of age and qualified after the age of 30. However, rural and intermediate area practice in 1996 were negative predictors of low physician density area practice in 2006. Among the variables, practice in university hospitals was the strongest predictor, with an OR of 6.15 over the other variables. Table 4 also shows the analysis results that identify the variables in 2006 that predicted low physician density area practice in 2016. These variables were the same as those in the 1996–2006 cohort results. University hospital practice was again the strongest predictor, with an OR of 4.87 over the other variables.

There were 51 SMAs (15%) whose classification changed during the period between 1996 and 2006 and 62 (18%) between 2006 and 2016, as shown in table 5.

DISCUSSION

This study revealed that the increases in physicians per population in high-density areas were less than the increases in low-density areas, suggesting that the physician geographical imbalance has improved based on percentage improvements over time, although the actual increase in the physician-per-population ratio for high-density areas is greater than that for low-density areas.

This is in opposition to the trends discovered in previous studies.^{2–3} Furthermore, the percentage of physicians continuing their practice in high physician density areas was greater than the percentage of physicians remaining in the low-density areas. In addition, the proportion of physicians who stayed in the low-density areas tended to remain the same, but the proportion of those working in high-density and intermediate-density regions who moved to low-density areas decreased. The number of physicians across all categories (low, intermediate, high) tended to increase. With regard to migration, the absolute number of physicians moving from high to low areas is actually greater than the absolute number moving from low to high areas (for both 1996 to 2006 and 2006 to 2016).

According to Newhouse's (Harvard University) indirect competitiveness theory, increasing the number of physicians decreases regional disparity by raising the number of practitioners in rural areas.¹⁹ Also based on this theory, the greater the number of doctors per capita, the greater the rivalry between them and the more standardised the geographical distribution of doctors per capita. In addition, physicians were reported to have relocated from urban to rural areas in the USA because of economic factors.²⁰ This study's results indicate that these patterns can also be found in Japan. The results show that rural practice is negatively associated with low physician

Table 3 Retention rate among physicians in low physician density areas by years of experience (%: N divided by baseline N)

	Period and number observed										
	1996-1998	1998-2000	2000-2002	2002-2004	2004-2006	2006-2008	2008-2010	2010-2012	2012-2014	2014-2016	2016
Baseline by years of experience	29676	31017	31869	32973	33772	34718	35206	36081	36555	37101	38217
0-14	11440	11452	11213	11080	10513	10261	9629	9345	9094	8934	9198
15-29	8839	9660	10657	11766	12813	13579	14072	14114	13828	13401	13165
30-44	5185	5660	5763	5887	6169	6620	7382	8477	9295	10314	11329
≥45	4212	4245	4236	4240	4277	4258	4123	4145	4338	4452	4525
Retention in low density areas over 2 years reported*	22196	22897	23739	25601	25601	26694	27765	28262	28704	29373	29373
0-14	6359	6131	6011	5784	5784	5717	5434	5069	4825	4833	4833
15-29	7859	8486	9375	11100	11100	11846	12454	12389	12149	11744	11744
30-44	4607	4964	5028	5415	5415	5896	6680	7619	8357	9328	9328
≥45	3371	3316	3325	3302	3302	3235	3197	3185	3373	3468	3468
Change in area of practice over 2 years reported†	5190	5664	5586	5820	5530	5562	5639	5521	5331	5287	5287
0-14	4321	4555	4391	4445	4017	3914	3633	3560	3714	3627	3627
15-29	601	753	834	1010	1122	1235	1470	1419	1123	1089	1089
30-44	174	277	281	270	293	310	412	425	382	448	448
≥45	94	79	80	95	98	103	124	117	112	123	123
Started to work in low density area‡	6536	6536	6625	6598	6272	6119	5024	5374	5616	5716	5866
0-14	5058	4946	4946	4825	4360	4025	3618	3753	3581	3515	3618
15-29	1029	1187	1187	1343	1434	1552	1050	1166	1441	1484	1507
30-44	341	347	347	317	370	415	268	376	460	577	603
≥45	108	145	145	113	108	127	88	79	134	140	138

*Those who were engaged in a low physician density area at baseline and were still engaged in the low physician density area 2 years after the baseline. Those who did not respond 2 years after baseline are not counted.

†Those who were engaged in a low physician density area at baseline but were engaged in a high or intermediate physician density area 2 years after baseline. Those who did not respond 2 years after baseline are not counted.

‡Those who were engaged in a low physician density area at baseline and were engaged in a high or intermediate physician density area at the time of the survey conducted 2 years ago.

Table 4 Logistic regression analysis of physicians in high and intermediate areas and factors related to their movement to low physician density areas

1996–2006 cohort	OR	95% CI	P value	2006–2016 cohort	OR	95% CI	P value
Sex				Sex			
Male	Reference			Male	Reference		
Female	0.83	0.78 to 0.89	<0.01	Female	0.81	0.77 to 0.86	<0.01
Age				Age			
≤39	Reference			≤39	Reference		
40–54	0.61	0.58 to 0.64	<0.01	40–54	0.63	0.60 to 0.66	<0.01
55–69	0.62	0.57 to 0.67	<0.01	55–69	0.63	0.59 to 0.68	<0.01
≥70	0.37	0.30 to 0.45	<0.01	≥70	0.34	0.28 to 0.42	<0.01
Qualified after age 30				Qualified after age 30			
No	Reference			No	Reference		
Yes	1.21	1.16 to 1.27	<0.01	Yes	1.13	1.08 to 1.18	<0.01
Workplace				Workplace			
Urban	Reference			Urban	Reference		
Intermediate	0.88	0.85 to 0.92	<0.01	Intermediate	0.93	0.89 to 0.97	<0.01
Rural	0.62	0.56 to 0.69	<0.01	Rural	0.67	0.60 to 0.75	<0.01
Physician density				Physician density			
High	Reference			High	Reference		
Intermediate	1.19	1.12 to 1.25	<0.01	Intermediate	1.34	1.27 to 1.41	<0.01
Type of institution				Type of institution			
Clinic	Reference			Clinic	Reference		
University hospital	6.15	5.61 to 6.74	<0.01	University hospital	4.87	4.47 to 5.30	<0.01
Other hospital	3.89	3.56 to 4.24	<0.01	Other hospital	3.37	3.11 to 3.64	<0.01
Others	4.72	4.16 to 5.35	<0.01	Others	3.69	3.27 to 4.17	<0.01
Specialty				Specialty			
Primary care	Reference			Primary care	Reference		
Others	1.02	0.97 to 1.06	0.45	Others	1.04	1.00 to 1.10	0.05

*Control variables are all based on the start of the time period.

density areas. This is related to the smaller populations in rural communities, which increases the physician-to-population density due to the denominator rather than the numerator. This might be worth exploring further.

Moreover, initial clinical practice in university hospitals was the strongest predictor for commencing work in

low physician density communities. Although a previous report found that a Japanese university's medical school had the capacity to deploy doctors to low-density community care,⁴ the method of physician placement at university faculties declined after the implementation of mandatory clinical training in 2004, and the geographical disparity

Table 5 The number of secondary medical areas that changed classification between the time periods

Physician density in 2006					Physician density in 2016				
	Low	Intermediate	High	Total		Low	Intermediate	High	Total
Physician density in 1996					Physician density in 2006				
High	0	11	103	114	High	0	13	101	114
	0%	10%	90%	100%		0%	11%	89%	100%
Intermediate	15	90	10	115	Intermediate	18	84	13	115
	13%	78%	9%	100%		16%	73%	11%	100%
Low	100	14	1	115	Low	97	18	0	115
	87%	12%	1%	100%		84%	16%	0%	100%

of physicians has further deteriorated.^{5–8} Accordingly, in recent years, the number of doctors working in university hospitals has increased. Therefore, further review of the ways in which this process affects the potential listings of physicians is required. As the mobility of less-experienced physicians is high among all geographic categories, and the retention rate is low, especially for less-experienced physicians in low-density areas, a new system should be devised to create opportunities for younger physicians to work in low-density areas.

As I mentioned in the background section, the Medical Care Act revision draft took effective measures for geographical maldistribution. It requires hospital directors to procure those with work experience in low physician density areas for a certain period.¹¹ This study's results would support this policy's effects.

There are some limitations to this report. First, the workplace was self-reported, which may have resulted in misclassifications. Second, this analysis only focused on correlations and was unable to determine causality. Future studies could use interviews and questionnaires to facilitate more comprehensive research. Third, I divided the SMAs into three groups according to population density, but changes in classification may cause variation in the results. Fourth, the observation period was 20 years. The effects of various environmental changes, such as the global economic crisis, policy changes for physician maldistribution, and population ageing, were not considered. Fifth, the 'other' physician category includes public health centres, industrial physicians and unemployed physicians. A heterogeneous category may affect the results. Sixth, tables 2 and 4 analyse the whereabouts of physicians at two points, 1996 and 2006, or 2006 and 2016, and do not consider changes during the period.

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Patient consent for publication Not required.

Ethics approval I received the MHLW's approval to use the data set, and this research was approved by the Harvard T.H. Chan School of Public Health institutional review board (No. 18-1422). The requirement for informed consent was waived by the review board as the original surveys were mandatory.

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Data availability statement No data are available.

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