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Temporal trends of physician geographical distribution and high and intermediate physician density areas and factors related to physicians' movement to low physician density areas in Japan: a longitudinal study (1996–2016)

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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 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/km^2. The second group (intermediate) consists of areas with a population of at least 100 000 or a population density of at least 200 people/km^2. 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

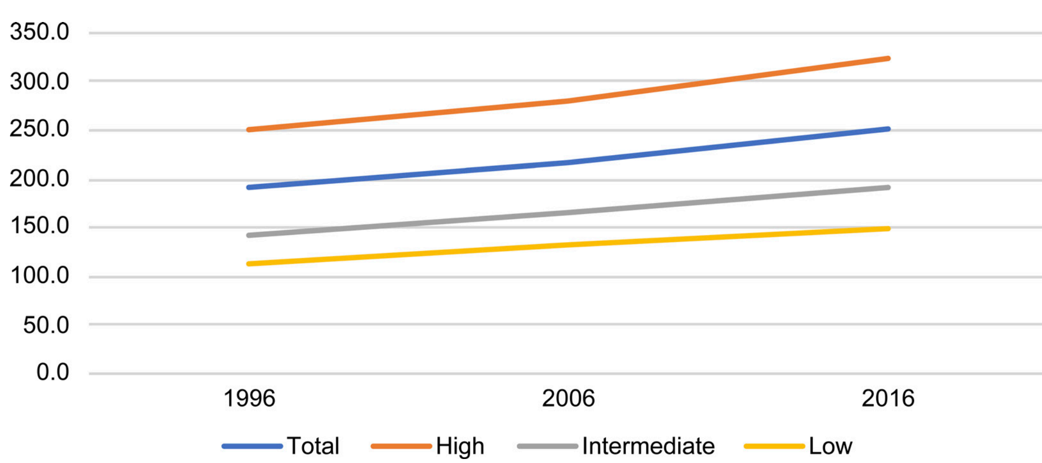

Figure 1 Distribution of physicians per 100 000 residents by geographic area in 1996, 2006 and 2016 in Japan.

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	240396		248593		253906		261099		270353		277927		286691		295045		303262		311201		319474	
Sex, n %																						
Male	208207	86.6%	213591	85.9%	217612	85.7%	220281	84.4%	225731	83.5%	229998	82.8%	234695	81.9%	239149	81.1%	243622	80.3%	247698	79.6%	251983	78.9%
Female	32189	13.4%	35002	14.1%	36294	14.3%	40818	15.6%	44622	16.5%	47929	17.2%	51996	18.1%	55896	18.9%	59640	19.7%	63503	20.4%	67491	21.1%
Age, n %																						
≤39	96678	40.2%	96085	38.7%	93471	36.8%	93025	35.6%	92788	34.3%	93409	33.6%	93254	32.5%	93093	31.6%	93351	30.8%	93328	30.0%	94665	29.6%
40–54	72967	30.4%	81441	32.8%	89726	35.3%	94942	36.4%	98870	36.6%	101645	36.6%	105477	36.8%	106977	36.3%	107122	35.3%	106850	34.3%	105861	33.1%
55–69	43957	18.3%	40268	16.2%	39323	15.5%	41208	15.8%	46337	17.1%	50684	18.2%	56772	19.8%	64342	21.8%	72456	23.9%	80460	25.9%	88273	27.6%
≥70	26794	11.1%	30799	12.4%	31386	12.4%	31924	12.2%	32358	12.0%	32189	11.6%	31188	10.9%	30633	10.4%	30333	10.0%	30563	9.8%	30675	9.6%
Years of experience, n %																						
0–14	102947	42.8%	101886	41.0%	99835	39.3%	99174	38.0%	98560	36.5%	97527	35.1%	97271	33.9%	96956	32.9%	97348	32.1%	98930	31.8%	99642	31.2%
15–29	70546	29.3%	76254	30.7%	82909	32.7%	89457	34.3%	96836	35.8%	102647	36.9%	107255	37.4%	108890	36.9%	108890	35.9%	107093	34.4%	106339	33.3%
30–44	37895	15.8%	40948	16.5%	41558	16.4%	42979	16.5%	45153	16.7%	48358	17.4%	53591	18.7%	61017	20.7%	67642	22.3%	74552	24.0%	81867	25.6%
≥45	29008	12.1%	29505	11.9%	29604	11.7%	29489	11.3%	29804	11.0%	29395	10.6%	28574	10.0%	28182	9.6%	29382	9.7%	30626	9.8%	31626	9.9%
Physician density level, n %																						
High	160439	66.7%	165227	66.5%	168074	66.2%	172267	66.0%	178516	66.0%	183164	65.9%	189566	66.1%	195449	66.2%	201743	66.5%	207097	66.5%	212293	66.5%
Intermediate	50944	21.2%	52349	21.1%	53963	21.3%	55859	21.4%	58065	21.5%	60794	21.9%	61919	21.6%	63515	21.5%	64964	21.4%	67003	21.5%	69838	21.9%
Low	29013	12.1%	31017	12.5%	31869	12.6%	32973	12.6%	33772	12.5%	33969	12.2%	35206	12.3%	36081	12.2%	36555	12.1%	37101	11.9%	37343	11.7%
Workplace, n %																						
Urban	110813	46.1%	114326	46.0%	116838	46.0%	120042	46.0%	125481	46.4%	130061	46.8%	136204	47.5%	141605	48.0%	146895	48.4%	151995	48.8%	156249	48.9%
Intermediate	111146	46.2%	115140	46.3%	117682	46.3%	121380	46.5%	125155	46.3%	128322	46.2%	131100	45.7%	134168	45.5%	137179	45.2%	140105	45.0%	143969	45.1%
Rural	18437	7.7%	19127	7.7%	19386	7.6%	19677	7.5%	19717	7.3%	19544	7.0%	19387	6.8%	19272	6.5%	19188	6.3%	19101	6.1%	19256	6.0%
Type of institution, n %																						
Clinic	81888	34.1%	83832	33.7%	87764	34.6%	89815	34.4%	92982	34.4%	95213	34.3%	97626	34.1%	99462	33.7%	100540	33.2%	101881	32.7%	102453	32.1%
Academic hospital	41103	17.1%	41095	16.5%	41551	16.4%	42870	16.4%	43422	16.1%	44688	16.1%	46563	16.2%	48557	16.5%	50404	16.6%	52306	16.8%	55187	17.3%
Other hospital	106823	44.4%	111988	45.0%	112149	44.2%	115409	44.2%	120252	44.5%	123639	44.5%	127702	44.5%	132408	44.9%	137901	45.5%	142655	45.8%	147115	46.0%
Others	10582	4.4%	11678	4.7%	12442	4.9%	13005	5.0%	13697	5.1%	14387	5.2%	14800	5.2%	14618	5.0%	14417	4.8%	14359	4.6%	14719	4.6%
Specialty, n %																						
Primary care	111599	46.4%	111908	45.0%	113455	44.7%	112709	43.2%	111975	41.4%	107117	38.5%	108289	37.8%	109496	37.1%	110431	36.4%	111795	35.9%	112445	35.2%
Other	128797	53.6%	136685	55.0%	140451	55.3%	148390	56.8%	158378	58.6%	170810	61.5%	178402	62.2%	185549	62.9%	192831	63.6%	199406	64.1%	207029	64.8%

Table 2 Physician density and physician migration

1996–2006 cohort				
	Physician density in 2006			
	Low	**Intermediate**	**High**	**Total**
Physician density in 1996				
High	7993	14445	108023	130461
	6.1%	11.1%	82.8%	100.0%
Intermediate	2178	28103	10019	40300
	5.4%	69.7%	24.9%	100.0%
Low	16134	2192	5399	23725
	68.0%	9.2%	22.8%	100.0%
Total	26305	44740	123441	194486
	13.5%	23.0%	63.5%	100.0%
2006–2016 cohort				
	Physician density in 2016			
Physician density in 2006				
High	7364	14822	129067	151253
	4.9%	9.8%	85.3%	100.0%
Intermediate	2427	35212	11256	48895
	5.0%	72.0%	23.0%	100.0%
Low	19751	2469	5935	28155
	70.2%	8.8%	21.1%	100.0%
Total	29542	52503	146258	228303
	12.9%	23.0%	64.1%	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	100.0%	31017	100.0%	31869	100.0%	32973	100.0%	33772	100.0%	34718	100.0%	35206	100.0%	36081	100.0%	36555	100.0%	37101	100.0%	38217	100.0%
0–14	11440	38.5%	11452	36.9%	11213	35.2%	11080	33.6%	10513	31.1%	10261	29.6%	9629	27.4%	9345	25.9%	9094	24.9%	8934	24.1%	9198	24.1%
15–29	8839	29.8%	9660	31.1%	10657	33.4%	11766	35.7%	12813	37.9%	13579	39.1%	14072	40.0%	14114	39.1%	13828	37.8%	13401	36.1%	13165	34.4%
30–44	5185	17.5%	5660	18.2%	5763	18.1%	5887	17.9%	6169	18.3%	6620	19.1%	7382	21.0%	8477	23.5%	9295	25.4%	10314	27.8%	11329	29.6%
≥45	4212	14.2%	4245	13.7%	4236	13.3%	4240	12.9%	4277	12.7%	4258	12.3%	4123	11.7%	4145	11.5%	4338	11.9%	4452	12.0%	4525	11.8%
Retention in low density areas over 2 years reported*	22196	74.8%	22897	73.8%	23739	74.5%	25601	77.6%	25601	75.8%	26694	76.9%	27765	78.9%	28262	78.3%	28704	78.5%	29373	79.2%		
0–14	6359	55.6%	6131	53.5%	6011	53.6%	5784	52.2%	5784	55.0%	5717	55.7%	5434	56.4%	5069	54.2%	4825	53.1%	4833	54.1%		
15–29	7859	88.9%	8486	87.8%	9375	88.0%	11100	94.3%	11100	86.6%	11846	87.2%	12454	88.5%	12389	87.8%	12149	87.9%	11744	87.6%		
30–44	4607	88.9%	4964	87.7%	5028	87.2%	5415	92.0%	5415	87.8%	5896	89.1%	6680	90.5%	7619	89.9%	8357	89.9%	9328	90.4%		
≥45	3371	80.0%	3316	78.1%	3325	78.5%	3302	77.9%	3302	77.2%	3235	76.0%	3197	77.5%	3185	76.8%	3373	77.8%	3468	77.9%		
Change in area of practice over 2 years reported†	5190	17.5%	5664	18.3%	5586	17.5%	5820	17.7%	5530	16.4%	5562	16.0%	5639	16.0%	5521	15.3%	5331	14.6%	5287	14.3%		
0–14	4321	14.6%	4555	14.7%	4391	13.8%	4445	13.5%	4017	11.9%	3914	11.3%	3633	10.3%	3560	9.9%	3714	10.2%	3627	9.8%		
15–29	601	2.0%	753	2.4%	834	2.6%	1010	3.1%	1122	3.3%	1235	3.6%	1470	4.2%	1419	3.9%	1123	3.1%	1089	2.9%		
30–44	174	0.6%	277	0.9%	281	0.9%	270	0.8%	293	0.9%	310	0.9%	412	1.2%	425	1.2%	382	1.0%	448	1.2%		
≥45	94	0.3%	79	0.3%	80	0.3%	95	0.3%	98	0.3%	103	0.3%	124	0.4%	117	0.3%	112	0.3%	123	0.3%		
Started to work in low density area‡			6536	21.1%	6625	20.8%	6598	20.0%	6272	18.6%	6119	17.6%	5024	14.3%	5374	14.9%	5616	15.4%	5716	15.4%	5866	15.3%
0–14			5058	44.2%	4946	44.1%	4825	43.5%	4360	41.5%	4025	39.2%	3618	37.6%	3753	40.2%	3581	39.4%	3515	39.3%	3618	39.3%
15–29			1029	10.7%	1187	11.1%	1343	11.4%	1434	11.2%	1552	11.4%	1050	7.5%	1166	8.3%	1441	10.4%	1484	11.1%	1507	11.4%
30–44			341	6.0%	347	6.0%	317	5.4%	370	6.0%	415	6.3%	268	3.6%	376	4.4%	460	4.9%	577	5.6%	603	5.3%
≥45			108	2.5%	145	3.4%	113	2.7%	108	2.5%	127	3.0%	88	2.1%	79	1.9%	134	3.1%	140	3.1%	138	3.0%

*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 heterogenous 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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