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Original Article

Trends in Geographic Distribution of Nursing Staff in Japan from 2000 to 2010: A Multilevel Analysis

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The aim of this study was to examine trends in the geographic distribution of nursing staff in Japan from 2000 to 2010. We examined time trends in the rates of nursing staff per 100,000 population across 349 secondary health service areas. Using the Gini coefficient as a measure of inequality, we separately analyzed the data of 4 nursing staff types: public health nurses (PHN), midwives (MW), nurses (NS), and associate nurses (AN). Then, using multilevel Poisson regression models, we calculated the rate ratios (RRs) and their 95% confidence intervals (CIs) for each type of nursing staff per 1–year change. Overall, the distribution of PHN, MW, and NS improved slightly in terms of the Gini coefficient. After adjusting for prefectural capital and population density, PHN, MW, and NS significantly increased; the RRs per 1–year increment were 1.022 (95% CI: 1.020–1.023), 1.021 (95% CI: 1.019–1.022), and 1.037 (95% CI: 1.037–1.038), respectively. In contrast, AN significantly decreased; the RR per 1–year increment was 0.993 (95% CI: 0.993–0.994). Despite the considerable increase in the absolute number of nursing staff in Japan (excluding AN), this increase did not lead to a sufficient improvement in distribution over the last decade.

Key words: health policy, inequality, Japan, multilevel Poisson model, nursing staff

According to the Declaration of Alma-Ata, fair allocation of medical resources among entire populations is a prerequisite for achieving health for all <http://www.who.int/publications/almaata_declaration_en.pdf. (World Health Organization, International Conference on Primary Health Care. Declaration of Alma-Ata, 1978) accessed September 9, 2013>. The World Health Organization and the Organisation for Economic Co-operation and Development emphasized both the importance and difficulties of measuring the performance of health systems <http://www.who.int/healthinfo/paper28.pdf (World Health Organizetion, Overall health system achievement for 191 countries) accessed September 9, 2013> <http://www.who.int/healthinfo/paper29.pdf (World Health Organizetion, The comparative efficiency of national health systems in producing health: an analysis of 191 countries) accessed September 9, 2013> <http://www.who.int/whr/2000/en/ (World Health Organization, The world health report 2000: health systems: improving performance.) accessed September 9, 2013>, <http://www.oecd-ilibrary.org/social-issues-migration-health/performance-measurement-and-performance-management-in-oecd-health-systems_788224073713 (The Organisation for Economic Co-operation and Development, Performance measurement and performance

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management in OECD health systems) accessed September 9, 2013>. To address this issue, some researchers have examined the allocation or distribution of physicians, because distribution of physicians has been a persistent policy concern [1-5]. For example, previous studies in Japan have reported a relative shortage of physicians in rural areas during the last several decades [6-8]. Other studies examined the distribution of dentists and judo therapists in Japan [9, 10], implying that both policy changes and social affairs influence the distribution of medical resources throughout the nation.

The demand for nursing staff in Japan seems to have increased in recent decades because of an unprecedented progression in societal aging. In rural areas, the rate of aging has already plateaued, necessitating the employment of both physicians and nursing staff personnel in health care systems in these regions. In contrast, overpopulation in urban areas is a mounting concern, and the demand for personnel in acute and advanced medical systems is outstripping the supply. Some recent studies have suggested that the quantity and quality not only of physicians, but also of nursing staff personnel (*e.g.*, nurse to patient ratios, nursing hours per patient, and nursing skill mix) affect the health outcomes of patients in both acute and advanced medicine and long-term care medicine [11-15].

Since the early 1990s, the Japanese government has facilitated policies to increase its medical manpower to adapt to societal aging [16]. Indeed, the number of nursing colleges increased from 11 in 1991 to 169 in 2008, and the number of individuals with newly obtained nursing licenses increased from 40,822 in 1995 to 50,224 in 2013. Consequently, the quantity of nursing staff in Japan has steadily increased in the last 2 decades (Table 1). However, because of the lack of an efficient system for allocating nursing staff in the country, as well as the adoption of a non-interventionist policy, the distribution of nursing staff has been left to the "invisible hand" of economic competition [4]. Indeed, despite increases in nursing staff personnel, no studies to date have examined time trends in the distribution of nursing staff in Japan.

The aim of this study was to comprehensively examine the trend in the geographic distribution of nursing staff in Japan from 2000 to 2010. In the Japanese qualification system, nursing staff personnel are classified into the following four categories: public health nurses (PHN), midwives (MW), nurses (NS), and associate nurses (AN). The first three categories require a national license, while AN requires a prefectural governor license. Once individuals obtain an NS license, they become eligible to take the qualifying examinations for PHN or MW.

Materials and Methods

Data sources. In Japan, the Medical Care Act directs each prefecture to establish primary, secondary, and tertiary health service areas for appropriate provision of medical services. Among the 3, secondary health service areas (SHSAs) are concerned with primary care, ordinary and specific outpatient care, usual inpatient care, and emergency medical care. Most SHSAs comprise 2 or more municipalities. In 1995, the Japanese government facilitated municipal

Table 1 Trends in rates of nursing staff per 100,000 population in Japan

	2000	2002	2004	2006	2008	2010	Percentage increase from 2000 to 2010
Total population (million)	126.9	127.4	127.7	127.8	127.7	128.1	0.9%
The number of PHNs	36,781	38,366	39,195	40,191	43,446	45,028	22.4%
The number of MWs	24,511	24,340	25,257	25,775	27,789	29,672	21.1%
The number of NSs	653,617	703,913	760,221	811,972	877,182	952,723	45.8%
The number of ANs	388,851	393,413	385,960	382,149	375,042	368,148	−5.3%
PHNs per population 100,000	29.0	30.1	30.7	31.5	34.0	35.2	21.3%
MWs per population 100,000	19.3	19.1	19.8	20.2	21.8	23.2	20.0%
NSs per population 100,000	515.0	552.4	595.4	635.5	687.0	744.0	44.5%
ANs per population 100,000	306.4	308.7	302.3	299.1	293.7	287.5	−6.2%

Data were derived from the Report on Public Health Administration and Services.
AN, associate nurse; MW, midwife; NS, nurse; PHN, public health nurse.

mergers, and many large mergers subsequently occurred, particularly between 1999 and 2006. As a result, the number of municipalities decreased from 3,252 in 1999 to 1,742 in 2013. Meanwhile, the total number of SHSAs increased from 348 to 349, and the boundaries of the SHSAs were redrawn. As has been previously discussed [6–8], it is unclear which units (*e.g.*, municipality, SHSA, prefecture) should be used to most appropriately evaluate the distribution of medical resources in Japan. Because SHSAs supply general medicine, we decided to use them to examine the geographical distribution of nursing staff in this study. Throughout the study, we used the most current (2012) SHSA boundaries.

To examine the geographical distribution of nursing staff, we calculated the absolute number of nursing staff personnel and the rate of nursing staff personnel per 100,000 population in all SHSAs in 2000, 2002, 2004, 2006, 2008, and 2010. Data on the number of nursing staff personnel in each SHSA (*i.e.*, the numerator of the rate) were obtained from yearly prefectural public health reports, which in most cases showed the number of nursing staff personnel in municipal units. According to the Act on Public Health Nurses, Midwives and Nurses, all nursing personnel who are currently working are required to report their occupational category (*i.e.*, PHN, MW, NS, and AN) to their working prefectural offices every 2 years. Prefectural offices then report the number of nursing staff in each prefecture to the Ministry of Health, Labour and Welfare (MHLW), which compiles it into a Report on Public Health Administration and Services <http://www.mhlw.go.jp/toukei/list/36-19.html (Ministry of Health, Labour and Welfare, Report on Public Health Administration and Services), accessed September 9, 2013>. Although the number of nursing staff personnel in each prefecture is known to be complete in each Report, data management in the yearly public health reports varies considerably across prefectures.

To calculate the population of each SHSA (*i.e.*, denominator of the rate), we obtained data on municipal populations from 2 resources: census data <http://www.stat.go.jp/data/kokusei/2010/ (Ministry of Internal Affairs and Communications, Census data), accessed September 9, 2013> and annual prefectural population reports. Although the former is more precise than the latter, census data were only available in 2000 and 2010. Thus, in addition to these years, we used annual prefectural population reports to obtain data on municipal populations.

Based on the Geospatial Information Authority of Japan <http://www.gsi.go.jp/KOKUJYOHO/MENCHO-title.htm (Geospatial Information Authority of Japan, Statistical reports on the land area by prefectures and municipalities in Japan), accessed September 9, 2013>, we derived data on municipal square measurements to calculate the population density in each SHSA. The population density was then categorized according to the quartile cutoff point as of 2000, and we used these categories throughout the analysis. As an indicator of rural and urban status, we also created a dichotomous variable regarding whether or not each SHSA included a prefectural capital. We assumed that all SHSAs in the 23 Tokyo metropolitan special wards (*Tokubetsu-ku*) included a prefectural capital, because these wards all have some aspect of capital function.

Statistical analysis. First, we described the summary data in detail to show changes in the number of nursing staff personnel and populations across SHSAs. As a measure of inequality, we calculated the Gini coefficient for each year. Confidence intervals (CIs) were calculated using a bootstrapping procedure with 1,000 replications. The Gini coefficient was designed to analyze inequality of income or wealth, and its value can range from 0 to 1 with higher values indicating greater inequality. The Gini coefficient has been used previously to analyze distributions of health and medical resources [1–10].

We subsequently applied multilevel Poisson regression analysis techniques to examine time trends in the rates of nursing staff. We used a two-level data structure in which 6 survey rounds (level 1) were nested within 349 SHSAs (level 2). We adjusted for the following two SHSA-level variables: prefectural capital (dichotomous) and population density category (4 categories). We calculated the rate ratios (RRs) and 95% CIs by allowing the intercept to vary across SHSAs. The multilevel Poisson regression model was specified as follows:

$\log(\pi_{ij}) = \beta_0 + \beta_1 year_{ij} + \beta_2 capital_j + \sum_{k=2}^{4} \beta_{k+1} density\_cat\_k_j + u_j$, where π_{ij} is the rate of nursing staff in the ith survey in the jth SHSA, $year_{ij}$ is an ordinal variable of year (2000 = 0 and 2010 = 10), $capital_j$ is a variable denoting whether the jth SHSA includes a capital, and *density_cat_k*$_j$ denotes the *k*th population density category in the *j*th SHSA. The SHSA-level random effect of the intercept (u_j) was assumed to be normally distributed with a mean of 0 and variance of σ_u^2.

All analyses were performed using Stata software 12.0 (Stata Corporation LP, College Station, TX, USA). A *p*-value of <0.05 (2-sided test) was considered statistically significant. For multilevel Poisson regression, we applied the *xtmepoisson* option and the 6th-order Laplace approximation, which provides very accurate estimates for all parameters [17, 18].

Results

As shown in Table 2, some data among the 349 SHSAs were missing or incomplete due to the fact that data management varied substantially across prefectures. When we performed the analysis excluding the incomplete data, however, the results did not change materially. We thus present the results with the incomplete data included.

Table 3 shows the trend in the distribution of populations in the SHSAs from 2000 to 2010. Overall, we found an increasing population gap across SHSAs; while more populated areas became larger, less populated areas became smaller. The Gini coefficient increased from 0.496 to 0.517.

Tables 4 to 7 show the trend in the distribution of nursing staff per 100,000 population by SHSA. Overall, the distribution of PHN, MW, and NS improved slightly in terms of the Gini coefficient. Nevertheless, compared with the increase in the absolute number of these nursing staff types, the improvement was not particularly high, with the exception of AN. The median rate of PHN increased from 38.7 in 2000 to 45.1 in 2010. The ratios of the 90th percentile/10th percentile and first quartile/third quartile decreased from 2000 to 2010. In addition, the Gini coefficient decreased from 0.259 in 2000 to 0.232 in 2010 (Table 4). The median rate of MW increased from 18.0 in 2000 to 20.6 in 2010. The Gini coefficient favorably decreased between 2000 and 2006, but increased in 2008. Although it decreased again in 2010 to 0.238, this was still higher than it had been in 2006 (Table 5). The maximum rate of NS did not

Table 2 Missing and incomplete data in 349 secondary health service areas

	2000	2002	2004	2006	2008	2010	Total number (%[a])
The number of missing data	63	39	19	5	0	8	134 (6.4%)
The number of incomplete data	6	15	6	2	2	2	33 (1.6%)

[a]The percentages were calculated by dividing each number by 2,094 (*i.e.*, 349 × 6).

Table 3 Trends in population distributions in secondary health service areas in Japan

	2000	2002	2004	2006	2008	2010
Max	2,598,774	2,619,335	2,633,685	2,635,420	2,652,099	2,665,314
90th percentile (P90)	829,636	831,229	833,409	832,142	839,695	841,966
First Quartile (Q1)	473,435	475,880	477,136	476,255	479,378	474,770
Median	229,772	227,110	224,573	227,013	223,964	219,880
Third quartile (Q3)	104,697	103,512	102,109	101,615	98,980	94,727
10th percentile (P10)	69,222	67,924	66,567	64,967	63,291	61,080
Min	25,239	24,804	24,152	23,201	22,279	21,688
Max/Min	103.0	105.6	109.0	113.6	119.0	122.9
P90/P10	12.0	12.2	12.5	12.8	13.3	13.8
Q1/Q3	4.5	4.6	4.7	4.7	4.8	5.0
Range	2,573,535	2,594,531	2,609,533	2,612,219	2,629,820	2,643,626
Interquartile range	368,738	372,368	375,027	374,640	380,398	380,043
Gini coefficient	0.496	0.500	0.503	0.508	0.512	0.517
95% confidence interval	0.468–0.524	0.472–0.527	0.475–0.532	0.479–0.536	0.483–0.541	0.487–0.547

Table 4 Trends in rate of public health nurses per 100,000 population in secondary health service areas in Japan

	2000	2002	2004	2006	2008	2010
Max	107.0	120.9	120.1	123.3	140.3	148.4
90th percentile (P90)	65.1	65.7	65.8	68.0	68.3	72.9
First Quartile (Q1)	48.7	51.3	51.8	52.4	55.9	58.1
Median	38.7	39.4	39.5	40.6	43.6	45.1
Third quartile (Q3)	26.0	27.7	28.0	30.5	32.5	34.1
10th percentile (P10)	17.9	19.4	20.1	21.7	23.4	24.2
Min	7.9	11.2	10.6	10.4	12.5	12.1
Max/Min	13.5	10.8	11.3	11.8	11.3	12.3
P90/P10	3.6	3.4	3.3	3.1	2.9	3.0
Q1/Q3	1.9	1.8	1.9	1.7	1.7	1.7
Range	99.1	109.7	109.5	112.9	127.8	136.3
Interquartile range	22.7	23.5	23.8	21.9	23.4	24.0
Gini coefficient	0.259	0.247	0.241	0.241	0.232	0.232
95% confidence interval	0.239–0.278	0.228–0.267	0.222–0.260	0.222–0.259	0.213–0.252	0.213–0.251

Table 5 Trends in rate of midwives per 100,000 population in secondary health service areas in Japan

	2000	2002	2004	2006	2008	2010
Max	72.3	62.9	58.1	53.9	56.1	55.7
90th percentile (P90)	30.1	28.7	29.0	29.1	31.0	32.7
First Quartile (Q1)	24.2	23.6	24.5	23.8	25.4	26.6
Median	18.0	18.0	17.8	18.1	19.3	20.6
Third quartile (Q3)	13.3	12.7	13.5	13.7	14.1	15.2
10th percentile (P10)	9.3	8.8	9.6	8.8	9.6	10.0
Min	2.1	1.5	1.7	1.1	0.9	0.9
Max/Min	34.0	41.3	33.9	48.1	60.9	59.6
P90/P10	3.2	3.2	3.0	3.3	3.2	3.3
Q1/Q3	1.8	1.9	1.8	1.7	1.8	1.8
Range	70.2	61.3	56.4	52.7	55.2	54.8
Interquartile range	10.9	10.9	11.0	10.1	11.3	11.4
Gini coefficient	0.254	0.241	0.236	0.234	0.243	0.238
95% confidence interval	0.231–0.276	0.220–0.262	0.217–0.256	0.215–0.253	0.224–0.262	0.219–0.258

Table 6 Trends in rate of nurses per 100,000 population in secondary health service areas in Japan

	2000	2002	2004	2006	2008	2010
Max	1,947.4	1,848.0	1,890.7	1,903.3	1,941.1	1,988.1
90th percentile (P90)	715.2	785.6	840.3	891.0	958.5	1,020.0
First Quartile (Q1)	602.6	657.9	715.9	771.1	829.0	882.7
Median	501.2	549.7	595.3	643.0	685.4	739.7
Third quartile (Q3)	387.3	434.5	477.8	516.5	548.2	596.3
10th percentile (P10)	305.5	343.4	383.6	411.6	457.5	487.1
Min	70.5	87.4	149.1	161.7	185.7	213.3
Max/Min	27.6	21.1	12.7	11.8	10.5	9.3
P90/P10	2.3	2.3	2.2	2.2	2.1	2.1
Q1/Q3	1.6	1.5	1.5	1.5	1.5	1.5
Range	1,876.8	1,760.6	1,741.6	1,741.6	1,755.4	1,774.8
Interquartile range	215.2	223.3	238.1	254.7	280.8	286.3
Gini coefficient	0.179	0.171	0.164	0.161	0.161	0.155
95% confidence interval	0.161–0.198	0.155–0.187	0.149–0.178	0.148–0.174	0.148–0.173	0.143–0.168

Table 7 Trends in rate of associate nurses per 100,000 population in secondary health service areas in Japan

	2000	2002	2004	2006	2008	2010
Max	1,021.6	1,046.6	903.6	982.9	965.2	974.6
90th percentile (P90)	605.3	626.6	627.7	637.1	626.7	618.5
First Quartile (Q1)	466.5	494.7	495.7	500.6	495.1	485.8
Median	337.0	357.6	367.0	369.6	367.0	356.3
Third quartile (Q3)	245.0	244.3	244.3	247.8	249.6	247.3
10th percentile (P10)	175.9	173.7	172.7	173.9	165.9	172.3
Min	72.7	81.2	71.2	73.6	73.9	70.1
Max/Min	14.1	12.9	12.7	13.4	13.1	13.9
P90/P10	3.4	3.6	3.6	3.7	3.8	3.6
Q1/Q3	1.9	2.0	2.0	2.0	2.0	2.0
Range	948.9	965.4	832.5	909.3	891.3	904.5
Interquartile range	221.4	250.3	251.5	252.8	245.5	238.6
Gini coefficient	0.248	0.253	0.254	0.257	0.256	0.257
95% confidence interval	0.229-0.266	0.236-0.270	0.237-0.271	0.240-0.273	0.239-0.272	0.240-0.275

Table 8 Multilevel Poisson regression analysis of effect of 1-year change on nursing staff rates

Variables	PHN		MW		NS		AN	
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)
Fixed part								
year (per 1 year)	1.022	(1.020-1.023)	1.021	(1.019-1.022)	1.037	(1.037-1.038)	0.993	(0.993-0.994)
capital (vs. non-capital)	1.105	(1.022-1.194)	1.568	(1.383-1.779)	1.322	(1.215-1.440)	0.922	(0.813-1.046)
density category								
low middle (vs. lowest)	0.762	(0.706-0.823)	0.907	(0.799-1.028)	1.077	(0.992-1.170)	1.061	(0.938-1.199)
high middle (vs. lowest)	0.581	(0.538-0.629)	0.864	(0.760-0.982)	1.015	(0.933-1.105)	0.908	(0.801-1.029)
highest (vs. lowest)	0.378	(0.349-0.409)	0.848	(0.745-0.965)	0.845	(0.775-0.920)	0.568	(0.500-0.645)
Random part								
SHSA-level variance (SE)	0.063	(0.005)	0.166	(0.014)	0.076	(0.006)	0.168	(0.013)

AN, associate nurse; CI, confidence interval; MW, midwife; NS, nurse; PHN, public health nurse; RR, rate ratio; SE, standard error; SHSA, secondary health service area.

change noticeably over the study period. However, the 90th percentile, first quartile, median, third quartile, 10th percentile, and minimum slightly increased after 2000. Although the absolute number of NS increased about 1.45-fold from 2000 to 2010, the Gini coefficient improved only slightly during that period (Table 6). Especially between 2006 and 2008, the Gini coefficient remained constant. The median, first quartile, and third quartile values of AN peaked in 2006, and the Gini coefficient slightly increased after 2000 (Table 7). In the Appendix Table, we show the median rates of each type of nursing staff stratified by the population density of each SHSA.

The results of multilevel Poisson analysis are provided in Table 8. After adjusting for prefectural capital and population density category, we found that PHN, MW, and NS significantly increased during the study period; the RRs per 1-year increment were 1.022 (95% CI: 1.020-1.023) for PHN, 1.021 (95% CI: 1.019-1.022) for MW, and 1.037 (95% CI: 1.037-1.038) for NS. In contrast, AN significantly decreased during the study period; the RR per 1-year increment was 0.993 (95% CI: 0.993-0.994). Compared with SHSAs without a capital, SHSAs with a capital tended to have more MW and NS. Furthermore, we found a significantly inverse association between the rate of PHN and population density. All of the SHSA-level variances were statistically significant.

Appendix Table Median rates of nursing staff per 100,000 population stratified by population density of secondary health service areas

Category of SHSA	2000	2002	2004	2006	2008	2010	Changes between 2000 and 2010
Public health nurse							
Lowest	56.1	56.5	56.3	57.8	63.2	63.3	7.3
Low middle	44.4	45.7	45.7	47.1	48.8	52.4	8.0
High middle	32.1	33.3	34.4	35.6	38.9	40.4	8.3
Highest	20.1	21.4	22.7	22.7	25.8	26.7	6.7
Midwife							
Lowest	19.7	20.1	19.3	19.0	19.9	20.7	1.1
Low middle	18.9	19.0	17.5	18.3	18.8	20.4	1.5
High middle	18.7	17.6	17.5	18.3	19.3	20.7	1.9
Highest	15.3	15.8	16.7	17.6	19.2	20.6	5.3
Nurse							
Lowest	481.5	540.9	589.1	624.6	661.6	716.2	234.6
Low middle	553.7	607.6	646.0	723.9	768.0	827.9	274.3
High middle	564.3	604.7	646.4	693.5	731.3	802.7	238.4
Highest	422.0	454.7	512.2	555.4	598.4	642.7	220.7
Associate nurse							
Lowest	422.7	431.0	433.0	447.6	449.0	441.9	19.2
Low middle	392.8	424.1	437.3	437.5	420.9	406.6	13.8
High middle	351.6	362.0	367.7	373.2	376.2	364.6	13.0
Highest	229.4	221.3	227.8	221.1	222.0	211.6	−17.8

SHSA, secondary health service area.
SHSAs were classified by the quartile value in 2000.

Discussion

To the best of our knowledge, this is the first comprehensive study to evaluate the trends in the distribution of nursing staff in Japan. Using public survey data, we examined the trends in geographical distributions by calculating the Gini coefficients and using multilevel Poisson regression models. Because all working nursing personnel are required by law to report their occupational condition, we believe that the quality of the data is highly reliable. We found that the inequality in the distribution of PHN, MW, and NS across SHSAs has not explicitly improved over the last decade, despite increases in their absolute numbers.

The finding that inequality in PHN, MW, and NS distribution has not improved over the last decade can be interpreted from the perspective of certain policy changes or social affairs that might have, at least partially, affected distribution and worsened equality. First, we noted that the revision of the medical payment system in 2006 established a new nurse deployment standard: when a hospital deployed 1 nurse for 7 patients, the hospital would earn a much higher fee per capita than before. Although no quantitative public data was available to us, the media reported that the new standard triggered a struggle to recruit graduating nurses into hospitals, and resulted in a relative shortage of nurses in rural areas [19]. Our finding that the Gini coefficient of NS remained at 0.161 from 2006 to 2008 is consistent with the idea that the policy change affected the distribution of NS. Second, with regard to MW, Japan has been in the throes of an obstetrics crisis since 2006. Two sensational items of medical news are relevant here [20]. In the first, an obstetrician who worked at Fukushima Prefectural Ono Hospital was arrested and indicted over the death of a pregnant woman in 2006. In the second, 19 hospitals refused to admit a woman who had lost consciousness during labor; she subsequently died 8 days after giving birth in the 20th hospital in Nara in 2006. In response to these events, the Japan Society of Obstetrics and Gynecology made a statement <http://www.jsog.or.jp/statement/pdf/seimei_17DEC07.pdf (Japan Society of Obstetrics and Gynecology), accessed September 9, 2013> and the MHLW proposed a new measure to ensure sufficient numbers of physicians and adequate medical treatment for labor and delivery <http://www.mhlw.go.jp/topics/2006/08/dl/tp-831-1d.pdf (Ministry of Health, Labour and Welfare) accessed September 9, 2013>. This measure placed emphasis on aggregating obstetricians in foundation hospitals, which may have been detrimental to the equal distribution of obstetricians by displacing them from rural to urban SHSAs. The occurrence of the obstetrics crisis corresponded with the maldistribution of MW; the Gini coefficient of MW worsened from 0.234 in 2006 to 0.243 in 2008, and the changes in the median rate of MW between 2000 and 2010 was the largest in SHSAs with the highest population density (Appendix Table). These findings imply that social affairs negatively affected their distributions. Notably, the distribution of MW was influenced to the greatest degree among the four types of nursing staff in this study.

To return to the lack of improvement in inequaltiy over the past decade, the third factor has to do with some complex issues regarding AN. The Japanese Nursing Association advocates abolishment of the AN system, but the Japan Medical Association favors its maintenance <http://www.med.or.jp/nichikara/junkan2.html (Japan Medical Association), accessed September 9, 2013>. In 1996, the MHLW council proposed integration of the NS and AN systems. However, the Japan Medical Association was opposed to this proposal. Thus, about 10,000 people are still licensed as AN annually. Although the issue is beyond the scope of this paper, we assume that political factors more strongly affected the number and distribution of AN than those of other types of nursing staff.

After adjusting for population density, whether an SHSA included a capital was associated with higher rates of nursing staff (with the exception of AN). Among the 4 categories of nursing staff, the RRs for MW and NS tended to be higher. In contrast, the point estimate of the RR for PHN was 1.105, although it was statistically significant. These results imply that urban areas attract more MW and NS. However, about two-thirds of total PHN work at municipalities or health offices, which could yield a more equitable distribution.

Japan is now facing a super-aged society combined with a declining birthrate, which threatens the sustainability of the Japanese health system. The Japanese government has promoted a policy that aims to increase medical personnel resources to deal with this aging society, as it estimates the demands of medicine and long-term care will only increase in the future. Although we observed an overall increase in the number of nursing staff personnel, the ultimate goal of this policy would be to provide sufficient nursing staff to the people who need medicine and care. Efficient resource allocation for overcoming this crisis is one of the most crucial health care policy issues. To achieve this ultimate goal, we must keep medical resources in better working order by accurate monitoring of these resources, as well as of regional medical and care demands. In addition, an efficient system of nationwide allocation of nursing staff is required. In this regard, it may be worthwhile to note that MHLW sets a quota on the number of new medical doctors in each prefecture in order to achieve a reasonably equal distribution <http://www.mhlw.go.jp/stf/shingi/2r98520000025292-att/2r985200000252bk.pdf (MHLW), accessed October 28, 2013>. We are also aware that the states of Victoria (Australia) and California (USA) have set a nurse-to-patient ratio in acute care hospitals [21]. In line with these examples, we here propose 2 possible solutions by: a) setting a quota on the number of new nursing staff in each SHSA or prefecture; and/or b) limiting the new nurse deployment standard to eligible acute care hospitals.

Our study focused on nursing staff distribution across SHSAs; we did not assess this distribution across smaller municipalities. Although SHSAs are appropriate units of analysis for the distribution of the medical system, municipalities might be also appropriate units. However, there are some potential problems associated with analysis of distributions across municipalities. Despite the massive municipal merger that took place during the last decade, about one-fourth of municipalities had populations of less than 10,000 in 2009, and the proportion of municipalities with small populations is not necessarily low. This implies that residents do not necessarily access medical care within their municipality, and that rural residents tend to go out of their communities to gain access to care in neighboring municipalities. Thus, considering the fact that SHSAs are defined to supply general medicine, we decided to examine the distribution of nursing staff across SHSAs *a priori*. Conversely, many residents are more likely to seek long-term care within their own neighborhood, and the MHLW has facilitated a policy to supply long-term care in neighborhoods, for example, within a school district. Thus, further analysis of distributions across municipalities is warranted from the perspective of long-term care for the elderly.

There are several limitations to this study. First, as stated above, our data included only the absolute number of nursing personnel in each SHSA. More detailed data, such as place of work and age distribution of nursing staff, would have allowed us to more fully examine distribution and inequality. Indeed, trends in geographic distributions could substantially vary by some demographic factors of nursing personnel. For example, it is assumed that young nurses working in hospitals were particularly influenced by the revision of the health insurance payment system in 2006.

Second, although we used public data, there were 134 missing data (6.4%) and 33 incomplete data (1.6%) because of the substantial variation in data management across prefectures. However, when applying multilevel analysis to longitudinal data, a complete dataset is not required. In addition, it has been shown that multilevel analysis is very flexible in terms of handling missing data. It is also known that applying multilevel analysis to an incomplete dataset is preferable to applying imputation methods [22]. However, the availability of consistent, valid information about health care resources is of great significance when analyzing the equity and efficiency level of a health care system [23]. Therefore, we believe that this will be an important future issue.

Third, we used a single measure, the Gini coefficient, to calculate the distribution of nursing staff personnel across SHSAs. Although this measure has often been used to study the distribution of health resources, consideration of inequality based on a single measure may yield misleading results because every measure has strengths and weaknesses. Relatively equal distributions of nursing staff personnel are not necessarily equitable and *vice versa* [24]. Relevant information in terms of judging equity would be required for further analysis. Finally, even in our multilevel analysis, we used a very limited number of variables at the SHSA level. Previous studies have shown that various factors, such as community income or age distribution, affect the allocation of physicians [1, 25]. It should be also noted that the number of medical facilities or hospital beds could influence the distribution of nursing staff.

In conclusion, our findings suggest that despite a considerable increase in the absolute number of nursing staff (excluding AN) in Japan, this increase did not lead to an improvement in the distribution of staff over populations in the last decade. Our findings can be interpreted from the perspective of related policy changes and social affairs, and imply that the Japanese government lacks an efficient system with which to allocate nursing staff personnel. Although further studies are necessary to fully evaluate the distribution of nursing staff in Japan, it is imperative to establish an efficient allocation system by elucidating the appropriate distribution and equity.

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