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Short report

Increasing supply of dentists induces their geographic diffusion in contrast with physicians in Japan

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ABSTRACT

The geographical distribution of health professionals reflects behavioral characteristics of such professionals and of the health system in which they work. The spill-over hypothesis asserts that their oversupply leads to a more even geographic distribution. The current surplus of dentists in Japan is a suitable opportunity to observe such situations. This study demonstrates the transition of the geographic distribution of dentists from 1980 to 2000 in comparison with that of physicians.

Using data from the Population Census and the Physician, Dentist, and Pharmacist Census, we calculated the ratio of dentists working in clinics and hospitals per population in 1980, 1990, and 2000 and the Gini coefficients according to the municipality boundaries at the end of 2000. We also plotted the municipalities on a graph, which illustrated the ratios of the dentists by population. We did the same analysis with physician data.

The number of dentists increased by 71% during the 20 years studied. The ratios of dentists/100,000 population were 44.1, 58.3, and 69.7 in 1980, 1990, and 2000, respectively. The Gini coefficients for dentists by municipality were 0.270, 0.213, and 0.197, excluding the municipalities with a dental university or its hospital. In contrast, the Gini coefficients for physicians barely changed while the number of physicians increased by 60% during the same periods. The graphs for dentists appeared to indicate the ceiling of those ratios (approximately 100 dentists/100,000 population), but such a ceiling was not seen for physicians.

The supply of dentists might have reached a level that generated the geographic diffusion and redistribution of dentists in Japan, in contrast with the situation involving physicians. This supports some results from other countries suggesting that saturation of local markets for health professionals may result in geographical redistribution, producing a more equal pattern of provision across the national space.

Introduction

According to the location theory, or the "spill-over" hypothesis, developed specifically for physician distribution (Newhouse, 1990), the increase of physicians may induce competition among physicians and diffuse them to less competitive, typically rural areas. In Japan, previous studies using Gini coefficients did not observe correction of the geographical maldistribution as the number of physicians increased (Kobayashi & Takaki, 1992; Toyabe, 2009). Previous studies in other countries also indicated that an increase in the number of physicians did not lead to more equal distribution (Hann & Gravelle, 2004; Hoerv, Pesis-Katz, & Mukamel, 2004; Mick, Lee, & Wodchis, 2000). Possible reasons include that physician supply does not reach a level of competition sufficient to diffuse them to rural areas, or physicians choose less competitive specialties in urban areas to avoid competition, or physicians tolerate practicing in competitive urban areas because of various attractions of urban settings (Barnett, 1993).

In some countries, governments take measures to induce physicians to locate in rural areas, for example by requiring medical training in rural areas as a condition for receiving a specialist certificate, offering financial incentives for serving in rural areas, or imposing requirements for foreign physicians to work in underserved areas (Dussault & Frances, 2006). Both central and local governments in Japan, together with medical societies, have attempted to tackle the issue of maldistribution. They have provided scholarships for medical students to work in prefectures where there was a physician shortage and public clinics and hospitals have been provided for physicians who work in rural practices. However, previous studies suggested that these efforts

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were not very successful (Kobayashi & Takaki, 1992; Kousei Tokei Kyokai, 2008, pp. 189–191; Toyabe, 2009). The current surplus of dentists is a suitable opportunity to examine change in the geographical distribution of other health professionals.

There have been a few previous reports on distribution of dentists in Japan. Suetaka, Komatsuzaki, Ishii, and Iida (2002) stratified municipalities to indicate differences in the dentists/population ratios among cities, towns, and villages. (Japan has three levels of government: municipality, prefecture, and nation. Municipalities include cities, towns, and villages, and are the basic geographical units of administration.) However, they did not assess the nationwide distribution nor evaluate the dentist distribution using any index of inequality. Others (Okawa, Okada, & Miyatake, 1999; Takiguchi, Fukai, Aoyama, Ando, & Takaesu, 2005) showed the unequal distribution of dentists by prefecture.

Inequality of health professional distribution is a multidimensional concept (Rosenthal, Zaslavsky, & Newhouse, 2005) that refers to the horizontal dimension, which is based on the rate of provision of professionals' relative to the population, and the vertical dimension, which is based on provision relative to differences in demand due to varying health status. This article will focus on the horizontal dimension. For assessing health professional distribution, analysis using the unit of municipality is desirable because prefectures are too large to match the level of patient service-seeking behavior. This study first attempts to demonstrate the transition of nationwide distribution of dentists between 1980 and 2000 in comparison with physicians using both the dentists/population ratios and Gini coefficients by municipality.

Methods

Data for the current study included the numbers of dentists and population within all municipalities in Japan in 1980, 1990, and 2000. The data were extracted from the Social and Demographic Statistics for Whole Nation Municipality-level Area Data (Statistical Information Institute for Consulting and Analysis, Tokyo, Japan), which were compiled based on various national censuses. In the Social and Demographic Statistics, population data were originally from the National Population Census, conducted every five years by the Ministry of Internal Affairs and Communications, and data on the number of dentists were compiled from the Physician, Dentist, and Pharmacist Census, conducted every two years by the Ministry of Health, Labour, and Welfare. For accuracy, we checked the analyzed data against the original published data by the ministries.

This study utilizes the operational definition of a dentist as follows, "dentists practicing for hospitals or clinics". We excluded dentists who were basic medical researchers or government officials. We excluded one island municipality from which all residents evacuated following the eruption in 2000. Since several of the municipalities merged during the study periods, we readjusted the numbers of both dentists and the population according to the boundaries at the end of the year 2000.

We adopted Gini coefficients for evaluating the inequality of dentist distribution. The Gini coefficient has traditionally been used to show the extent of income inequality among the members of a society; however, the index has also been used to analyze the inequality of physician distribution (Donald, 2006; Kobayashi & Takaki, 1992). First, we determined the order of the population of each municipality and calculated the cumulative proportion of dentists according to the ascending order of the population. Second, the data were plotted as a Lorenz curve, which indicates the cumulative proportions of dentists plotted against a total cumulative population. Finally, we calculated the Gini coefficient, which is the area between the Lorenz curve and the diagonal line, divided by the triangle under the diagonal line (Donald, 2006) using the lag operator in the SAS statistical package (SAS Institute Inc., 1999). We drew the Lorenz curves for dentist distribution in 1980 and 2000 using Microsoft Excel (Microsoft Corporation, 2006). The Gini coefficient rises up to 1.0 according to the degree of variation in dentists/population ratios among the communities. The smaller the Gini index, the more equal the distribution. We also carried out a sensitivity analysis in which we calculated the Gini coefficients by municipality, excluding 29 municipalities where dental universities and/or their hospitals were located, since dentists on working in universities have clinically different characteristics, university hospitals are not affected by local competition, and municipalities with both small populations and a university dental school tend to be outliers in the analysis in terms of the dentist/population ratios.

During the study period in Japan, population in rural areas decreased and in urban areas increased. Even if the distributions of dentist and physician were geographically stable, the structural change of population may affect the Gini coefficients. We calculated the Gini coefficients using dentist and physician distributions in 1990 and 2000 and population distribution in 1980 in order to estimate the Gini coefficients if the population distribution had remained similar to that in 1980.

We plotted the municipalities on a graph, which illustrated the ratios of dentists/population (the vertical axis) by population (the horizontal axis) in order to illustrate the dentist diffusion throughout the country. Finally, by repeating the above calculation using the physician data in the same periods, we plotted the data on a graph to present the distribution of physicians as well.

Results

Table 1 displays the demographics and Gini coefficients for dentists and physicians in Japan from 1980 to 2000. The numbers of dentists were 51,593, 72,086, and 88,409 in 1980, 1990, and 2000,

Table 1
Geographic distribution of dentists and physicians in Japan between 1980 and 2000.

	1980	1990	2000
All municipalities (3250 municipalities)[a]			
Population	117,008,523	123,562,074	126,883,247
Dentists			
Number of dentists	51,593	72,086	88,409
Dentists/100,000 population	44.1	58.3	69.7
Gini coefficient	0.310	0.261	0.255
Gini coefficient (fixed population in 1980)		0.262	0.266
Physicians			
Number of physicians	152,239	203,793	243,201
Physicians/100,000 population	130.1	164.9	191.6
Gini coefficient	0.334	0.340	0.327
Gini coefficient (fixed population in 1980)		0.336	0.328
Municipalities without a dental university or its hospital (3217 municipalities)[a]			
Population	97,312,200	102,348,902	104,938,523
Dentists			
Number of dentists	36,462	51,586	62,604
Dentists/100,000 population	37.5	50.4	59.7
Gini coefficients	0.270	0.213	0.197

[a] One island municipality was excluded because of resident evacuation by the eruption in 2000.