Geographic distribution of dentists in Japan: 1980-2000

Yoshikazu Okawa, DDS, PhD[1]; SoIchiro Hirata, DDS, PhD[2]; Mahito Okada, DDS, PhD[2]; Takuo Ishii, DDS, PhD[2]

1 Department of Dental Hygiene, Faculty of Health Care Science, Chiba Prefectural University of Health Sciences
2 Department of Social Dentistry, Tokyo Dental College

Keywords
dentists; health care delivery; geographic locations; population; health policy; Japan.

Correspondence
Dr. Yoshikazu Okawa, Department of Dental Hygiene, Faculty of Health Care Science, Chiba Prefectural University of Health Sciences, 2-10-1 Wakaba, Mihama-ku, Chiba 2610014, Japan. Tel.: +81 043 296 2000; Fax: +81 043 272 1716; e-mail: yoshikazu.okawa@cpuhs.ac.jp. Yoshikazu Okawa is with the Department of Dental Hygiene, Faculty of Health Care Science, Chiba Prefectural University of Health Sciences. SoIchiro Hirata, Mahito Okada, and Takuo Ishii are with the Department of Social Dentistry, Tokyo Dental College.

Received: 9/9/2009; accepted: 3/11/2011.

doi: 10.1111/j.1752-7325.2011.00255.x

Abstract

Objective: In the late 1950s and 1960s, Japan recognized that it had a shortage of dentists and that they were unevenly distributed. To solve these problems, four national and eight private dental schools were established, leading to a significant increase in the number of dental students in the 1970s and 1980s. The purpose of this study was to investigate the effects of this increased supply on the geographic distribution of dentists in Japan.
Method: We determined the number of dentists and the population in each of Japan's 3,252 municipalities. The ratio of the number of dentists to the population of an area was assessed using Gini coefficients calculated from Lorenz curves.
Results: From 1980 to 2000, the average number of dentists per 100,000 persons in Japan increased from 44 to 70. The Lorenz curve plotted for 1980-1990 appeared as a nearly diagonal line, with the Gini coefficient decreasing from 0.310 to 0.263. The Gini coefficient in the year 2000 was 0.255, indicating only a slight improvement in 10 years from 1990 to 2000.
Conclusions: The results suggest that the geographical distribution of dentists in Japan is influenced by municipalities' population size. While the number of dentists in municipalities with populations of less than 5,000 increased during the years from 1980 to 2000, 25.9 percent of these municipalities still had no dentists at the end of this period. This is an important issue that warrants prompt corrective action.

Introduction

Geographic maldistribution of dentists is recognized as an important sociopolitical concern, and several studies have been published addressing the issue (1-3). During the late 1950s and 1960s, because of increased demand for dental care in Japan, the twin problems of a shortage of dentists and their maldistribution emerged (4). In 1970, the Ministry of Health and Welfare set an immediate political goal of increasing the number of dentists per 100 000 people from 36.5 to 50 by 1985. The ratio of 50 dentists to 100,000 people was the target for the whole country, not just for areas with a shortage of dentists. Although the rationale for choosing that particular ratio in Japan was not disclosed, that goal was presumed to be based on dentist-to-population ratios in the United States and West Germany in 1970 where there were about 50 dentists for every 100,000 people (5). To achieve this goal, four national and eight private dental schools were established, which led to a significant increase in the number of dental students. The number of dental colleges/faculties of dentistry increased from seven in 1960 to 29 in 1980, while the total number of dental students enrolled annually increased from 690 to 3,360 in the same period. Accordingly, the number of dentists per 100,000 people rose to 52.2 in 1984, achieving the Ministry's goal (4).

In 1984, the Ministry of Health and Welfare reported that if the number of dental students enrolled that year (3,380) remained steady in subsequent years, the projected number of dentists per 100,000 people would be 121 in 2025 (6). The Ministry established a study committee to develop strategies to prevent an unprecedented increase in the number of dentists, aiming to ensure the establishment of a balance in the healthcare services available in a given area. The committee recommended that the number of dental students enrolled annually during subsequent years be reduced by about 20 percent through about 1995 (6). Consequently, by 1990, the number of students had decreased by approximately 19 percent.

On a related subject, the committee pointed out that a maldistribution of dentists and dental facilities would be a hindrance to meeting the demand for dental care. The geographic distribution of physicians has recently been studied using Lorenz curve analysis and Gini coefficients, which are common methods used in economics for studying the distribution of wealth (7-10). However, these methods have rarely been applied in the investigation of the geographic distribution of dentists.

Currently, the number of dental practitioners per 100,000 people in Japan is continuing to increase despite the government's policy change discussed above. This is because even though enrollment in departments of dentistry has decreased, the rate of increase in the number of practicing dentists exceeded Japan's slow rate of population increase during the study period. The purpose of this study was to investigate the effects of the steep increase in the number of dentists on changes in their geographic distribution during the period from 1980 to 2000 to gauge the outcome of the implementation of the Japanese government policy.

Methods

Japan is divided into 47 prefectures, each of which consists of numerous municipalities such as cities, towns, villages, and special wards. Most cities have populations of more than 50,000, but most towns and villages, located in rural areas, often have extremely small populations. Special wards are comparatively large urban areas of Tokyo that are governed like cities. The number of municipalities in 1980 was 3,278 but shrank to 3,252 in 2000 through municipal annexation. In this study, we used census population data recorded for each Japanese municipality in 1980, 1990, and 2000 (11,12). The Ministry of Internal Affairs and Communications has conducted a population census every 5 years since 1920. By law, dentists are required to report their places of work (dental clinics, hospitals, public health and administrative institutions, or institutions for education and research) to the Ministry of Health, Labour and Welfare every 2 years (in 2001, the Ministry of Health and Welfare merged with the Ministry of Labour to become the Ministry of Health, Labour and Welfare). The Ministry then officially releases data on the number of dentists practicing in each municipality. Although surveys on the population and the number of dentists have been conducted since 2001, they were not done in concurrent years; so only data up through the 2000 census were analyzed in this study. From these data, we calculated the number of dentists practicing at dental clinics or hospitals in each municipality for the years 1980, 1990, and 2000 (13).

Dentists who were engaged in research activities and those who were involved in administrative work in the government or municipalities accounted for 0.2 percent of all the dentists in Japan. These were excluded from our analysis because they rarely engage in clinical dentistry. Because clinical professors working at universities are registered as employees at university hospitals in surveys of physicians, dentists, and pharmacists, they are classified as dentists practicing at dental clinics or hospitals.

To accurately compare the population and the number of dentists engaged in dental practice for the years 1980, 1990, and 2000, the boundaries of the municipalities in 1980 and 1990 were adjusted to those existing in 2000.

To investigate changes in the geographic distribution of dentists from 1980 to 2000, a Lorenz curve was plotted, and the Gini coefficient was calculated. Lorenz curves and Gini coefficients were initially designed to analyze income inequality (14). The Lorenz curve is a curve fitted to the percentile shares of income and population. The Gini coefficient, which is derived from the Lorenz curve, is a measure of income distribution inequality. The analysis proceeded as described below.

First, the number of dentists per 100,000 people was computed for each municipality for the years 1980, 1990, and 2000. Then the density of dentists thus obtained for each municipality was arranged in ascending order, and the Lorenz curve was plotted with the cumulative population proportion (%) on the horizontal axis and the cumulative proportion of dentists (%) on the vertical axis. If the dentists were distributed equally among communities' populations, the Lorenz curve would pass through the origin as a diagonal line, but if the distribution were unequal, the curve would fall below the diagonal.

The Gini coefficient serves as a standardized value that reflects the relative unevenness of distribution of an entity over a given population. The Gini coefficient derived from the Lorenz curve plotted in the manner explained above would describe the degree of unevenness of dentist distribution. A Gini coefficient of 0 would indicate "perfect equality," implying that an equal number of dentists were distributed across all municipalities; on the other hand, a Gini coefficient of 1 would indicate "perfect inequality," indicating that all the dentists were concentrated within one municipality, while all the others had no dentist serving them.

Finally, the changes in the number of dentists per 100,000 persons were compared between municipalities bracketed by population size, and regional differentials were then investigated. Data were analyzed, and graphs were prepared using SPSS version 13.0J (SPSS Japan Inc., Tokyo, Japan) and Microsoft Excel 2007.

Results

The number of dentists engaged in dental practice increased by approximately 71 percent, from 51,597 in 1980 to 88,410 in 2000. A similar increase of 58 percent (from 44 to 70) was noted in the number of dentists per 100,000 persons. The

Table 1 Population and Numbers of Dentists

	1980	1990	2000	Percentage change 1980-2000
Population (×1,000)	117,060	123,611	126,926	8.4
Number of practicing dentists	51,597	72,087	88,410	71.3
Dentists per 100,000 population	44	58	70	58.0

increase between 1980 and 1990 was more prominent, paralleling the marked increase in the number of dental students enrolled during that period (Table 1). Figure 1 shows the Lorenz curves for dentist distribution in Japan in 1980, 1990, and 2000. The curves are plotted using data collected for all municipalities ($n = 3252$). From the Lorenz curves, it is clear that the dentist distribution in 2000 was considerably better than in 1980 but not remarkably different from 1990. The Gini coefficient was 0.310 in 1980 and 0.263 in 1990, indicating an improvement in dentist distribution (Figure 2). The Gini coefficient in 2000 was 0.255, implying that although this trend continued during the years from 1990 to 2000, there was little improvement.

Table 2 shows the median value, the 25th percentile and 75th percentile of the number of dentists per 100,000 persons in municipalities bracketed by population size for the years 1980, 1990, and 2000. In municipalities with a population of 30,000 or more, the number of dentists per 100 000 population increased by more than 20. In municipalities with a population of less than 5,000 (villages and towns), however, the increase was only about half that of municipalities with populations of 50,000 or more (cities and special wards). In 2000, less than 2 percent of municipalities with populations of 5,000 or more had no dentist engaged in clinical practice, which was a significant improvement from the situation in the year 1980. In municipalities with populations of less than 5,000, the ratio decreased from 43.7 percent in 1980 to 25.9 percent in 2000, but approximately one-fourth of these small communities still had no dentist as of 2000 (Table 3).

Discussion

Implementing the policy of increasing the number of dentists in the 1970s helped combat the shortage of dentists and their geographic maldistribution. The Lorenz curve plotted for 1980 to 1990 is a nearly diagonal line, and the Gini coefficient at the end of that period was considerably lower than at its beginning, which suggests an improvement in the maldistribution of dentists.

In a study investigating the geographic distribution of physicians in Japan, the Gini coefficients indicating the unevenness of distribution were 0.331 in 1980 and 0.340 in 1990, suggesting that there was no improvement in the unevenness of the geographic distribution of physicians (9).

In comparison, our findings regarding the distribution of dentists between 1980 and 2000 in Japan were consistent with the idea that physicians tend to move to different locations when their numbers increase in a particular area in response to increased competition. While approximately 60 percent of physicians work (practice) at hospitals, approximately 85 percent of dentists work (practice) at private dental clinics. In addition, dentists in Japan can select the locations where they establish their own clinics. These two factors might have contributed to improving the maldistribution of dentists.

The geographic distribution improved along with the increase in the number of dentists, but the degree of improvement between 1990 and 2000 was comparatively small. Although the reason for this slowed improvement is unclear, there are two likely explanations: a) the increased

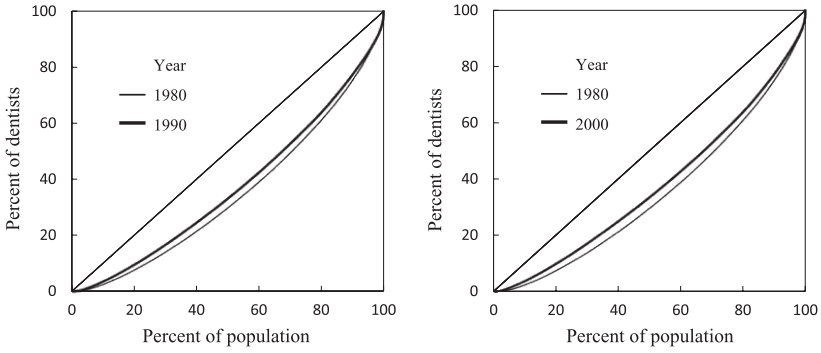

Figure 1 Lorenz curve plotted for dentist distribution.

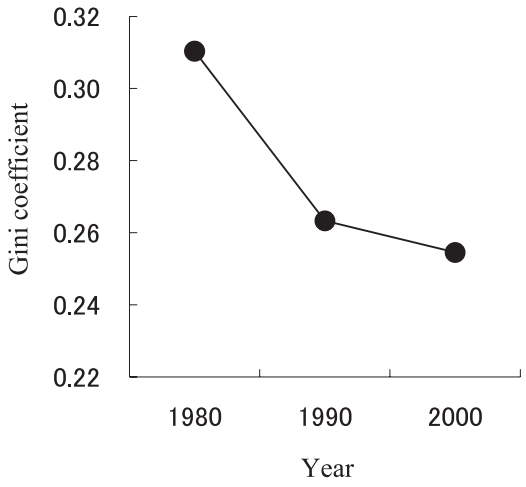

Figure 2 Gini coefficients measuring degree of dentist distribution.

competition that drove the change in dentist distribution might have gradually weakened and b) the decrease in the enrollment number of dental students since around 1990 might have had some effect on dentist distribution. In terms of population, the improvement in the distribution in municipalities with less than 5,000 people was especially slow. The goal of increasing the number of dentists to 50 per 100,000 persons was not attained in a number of municipalities with populations of less than 30,000, resulting in very few dentists being available in some areas. In the year 2000, there were still some communities with no dentist, which suggests that improvement in the geographic distribution of dentists was, to some extent, limited.

There are several plausible reasons for this unequal distribution of dentists. There are no legal restrictions in Japan on dentists' choice of location for establishing dental clinics. In other words, dentists are free to choose where they practice. In addition, the population has decreased, and life expectancy has increased in numerous small towns and villages in the countryside, while the population has tended to concentrate in urban areas. This has led to a concentration of dental practitioners in urban areas. The income of residents in urban areas is relatively higher than that of residents in rural areas. Therefore, dentists planning to provide treatments that are not covered by the national insurance scheme, such as prostheses (e.g., implants) and orthodontic treatment, would prefer to establish their clinics in urban areas. In fact, under the current healthcare insurance system in Japan, "the rule of competition" is largely inapplicable because in approximately 90 percent of the cases, the treatments provided are covered by health insurance, and the dentists' fees are determined by the stipulations of the National Health Insurance policy. Because the number of patients per dental clinic has decreased with the increase in the number of dentists, some dentists might have chosen to provide treatments that are not covered by health insurance in order to augment their income. Finally, dentists who attach importance to cultural

Table 2 Changes in the Number of Dentists per 100,000 Persons in Municipalities by Population Size from 1980 to 2000

Municipality population*	*n*	Median density of dentists (25th percentile, 75th percentile)			Change in median between 1980 and 2000
		1980†	1990†	2000	
<5,000	723	18.1 (0, 31.9)	24.2 (0, 40.8)	30.1 (0, 49.1)	11.9
5,000-10,000	834	19.8 (12.2, 31.5)	29.9 (17.4, 42.7)	35.4 (24.5, 48.9)	15.6
10,000-30,000	958	24.8 (15.9, 34.2)	38.7 (26.8, 47.5)	43.4 (33.3, 54.4)	18.6
30,000-50,000	263	28.5 (20.2, 36.7)	42.9 (33.5, 51.4)	49.6 (42.0, 60.7)	21.1
50,000-100,000	225	32.3 (25.9, 40.9)	46.7 (38.5, 54.2)	55.3 (47.5, 64.6)	23.0
100,000-300,000	172	35.8 (29.4, 46.5)	49.3 (43.5, 60.3)	60.0 (53.2, 68.1)	24.2
≥300,000	77	44.6 (39.3, 56.0)	58.8 (51.6, 74.0)	70.0 (60.3, 91.4)	25.4

* Municipal populations as of year 2000.

† Municipal boundaries in 1980 and 1990 adjusted to be the same as those in 2000.

Table 3 Percentage and Number of Municipalities with No Practicing Dentist by Population from 1980 to 2000

Municipal population	*n*	1980		1990		2000	
		%	(*n*)	%	(*n*)	%	(*n*)
<5,000	722	43.7	(308)	33.8	(244)	25.9	(187)
5,000-10,000	834	15.0	(125)	4.9	(41)	1.8	(15)
10,000-30,000	958	3.4	(33)	0.4	(4)	0.2	(2)
30,000-50,000	263	1.1	(3)	0.8	(2)	0.4	(1)
≥50,000	474	0	(0)	0	(0)	0	(0)

and social factors such as having a convenient lifestyle and an environment that is conducive to their children's education may prefer to work at or establish dental clinics in urban areas.

People in Japan have universal free access to medical services under the national healthcare insurance system. However, the opportunity to receive dental treatment is actually limited in rural and remote areas, which include mountainous regions, isolated islands, and sparsely populated areas. Furthermore, dentists in these areas may find it difficult to maintain their practices because of economic constraints. Because fees for dental treatments are maintained at low levels as required by the Japanese healthcare insurance system, dentists must have a certain number of patients to make their clinics financially viable. Therefore, currently implemented peripatetic dental practices and establishment of subsidized clinics may need to be promoted in these remote areas. In areas that are not remote but have an insufficient number of dentists, providing dentists economic benefits such as increased treatment fees, scholarships, loans, and tax incentives for practicing in those areas may increase the number of dental facilities. Although such incentives may be successful in increasing the number of dental facilities being established in these areas, they do not necessarily guarantee long-term retention of dentists.

Our study has some limitations. We investigated the geographic unevenness of dentist distribution based on municipalities' populations. However, dental care needs are determined not only by the number of residents, but also by the population's age composition, the prevalence of dental diseases, the proportion of patients receiving dental care, the number of patients in a given area who receive dental care from clinics located in other localities, and other social and economic factors. These factors, in turn, can influence the distribution of dentists in a given population set. Furthermore, the geographic distribution of dentists can change over time; therefore, similar studies should be conducted in the future, taking into consideration the factors listed above. Such studies may help develop strategies for the correction of the maldistribution of dentists in the Japanese population.

References

1. Krayse DK, Frate DA, May WL. Demographics and distribution of dentists in Mississippi. *J Am Dent Assoc.* 2005;**136**:668-77.
2. Lo ECM, Wong MCM. Geographic distribution of private dentists in Hong Kong in 1989. *Br Dent J.* 1999;**186**:172-3.
3. Waldman HB. Changing number and distribution of orthodontists: 1987-1995. *Am J Orthod Dentofacial Orthop.* 1998;**114**:50-4.
4. Tokei K. *Kyokai. Health state of the nation, annual report*. Tokyo: Kosei Tokei Kyokai; 1996.
5. World Health Organization. *World Health Statistics Annual 1970. Volume III Health Personnel and Hospital Establishments*. Geneva: World Health Organization; 1972.
6. Ministry of Health and Welfare. *The future number of dentists in Japan – final report of the study committee on future demand for dentists*. Tokyo: Koku Hoken Kyokai; 1986.
7. Morrow J. Toward a more normative assessment of maldistribution: the Gini index. *Inquiry.* 1977;**14**:278-92.
8. Yang BM, Huh J. Physician distribution and health manpower policy in Korea. *Asia Pac J Public Health.* 1989;**3**: 68-85.
9. Kobayashi Y, Takaki H. Geographic distribution of physicians in Japan. *Lancet.* 1992;**340**:1391-3.
10. Chang RK, Halfon N. Geographic distribution of pediatricians in the United States: an analysis of the fifty states and Washington, DC. *Pediatrics.* 1997;**100**:172-9.
11. Statistic Bureau, Management and Coordination Agency. *1980 and 1990 population census of Japan*. Tokyo: Japan Statistical Association; 1982, 1991.
12. Ministry of Internal Affairs and Communications, Statistic Bureau. *2000 population census of Japan*. Tokyo: Japan Statistical Association; 2002.
13. Ministry of Health and Welfare. *Survey of physicians, dentists and pharmacists in 1980, 1990 and 2000*. Tokyo: Kosei Tokei Kyokai; 1982, 1992, 2002.
14. Todaro MP. *Economic development of the third world*. New York: Longman; 1989.