Analysis of the Distribution of Community Pharmacies and Pharmacists in Miyagi Prefecture

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In Japan, the aging of the population is serious problem. The Ministry of Health, Labour and Welfare is constructing a new support system for elderly people called "Community-based integrated care system". In this system, community pharmacists are expected to play an important role as healthcare professionals for the whole community, including elderly people. Since pharmacists will be needed to manage community health in addition to their daily tasks, it is required to reassess the distribution of community pharmacies and pharmacists. In this study, we surveyed their distribution in Miyagi prefecture by using statistical data from public institutions and reevaluated the distribution to raise problems. Based on the numbers of community pharmacies and pharmacists per 1000 population in the whole Miyagi prefecture, each area was ranked to 2 categories and analyzed regarding population, aging rate and inhabitable land area. It was disclosed that the higher aging rate areas had the higher rate of category below the average of whole Miyagi prefecture, especially in the number of pharmacists. When the numbers of pharmacies and pharmacists per the inhabitable land area were used, the uneven distribution became clearer than when those per population were used. These findings suggested that it was important to characterize the areas by not only the ratios of community pharmacies and pharmacists to population numbers but also by the aging rates and inhabitable land area, which were related to the work efficiency of pharmacists and accessibility for resident to pharmacies.

Key words — community pharmacist; uneven distribution; Miyagi prefecture; community-based integrated care system

INTRODUCTION

In Japanese society, the decrement and aging of the population and increment of the medical bills are serious problems. In 2065, the population aging rate will be about 38.4% (about one in 2.6 Japanese will be over 65 years old). Since the aging of the population will progress rapidly, the Ministry of Health, Labour and Welfare is constructing a new support system for elderly people called "Community-based integrated care system" to be implemented by 2025. In this new system, community pharmacists will be one of the community healthcare classes supporting community health, and a "home healthcare pharmacist" will be expected for the community elderly people. Additionally, community pharmacies will be needed to manage personal medication information, provide 24-h support service associated with prescription drugs, provide OTC drugs, and counsel on people's health. For these reasons, community pharmacies will be needed near community people, not near a hospital. However, the Miyagi prefecture pharmaceutical administration reported that many pharmacists preferred to work in big cities like Sendai and the shortage of pharmacists and their uneven distribution were becoming a problem. Miyagi prefecture also have some problems associated with lifestyle. Actually, Miyagi prefectural government is worrying about the large number of patients and those having a high risk factors of metabolic syndrome. The rate of metabolic syndrome patients and those having a high risk factors of it from 2008 to 2013 was continuously second-worst prize in Japan. Furthermore, some previous studies reported damage to housing by Great East Japan Earthquake related to prevalence of metabolic syndrome and another study reported the prevalence of lifestyle-related diseases increased after that disaster. From these studies, we consider health level of residents in Miyagi prefecture might have decreased after Great East Japan Earthquake further. For these reasons, we focused on Miyagi prefecture as an analysis target. Health supporting by community pharmacists would be one of the factors for improving the health state of...
Miyagi prefecture better, so deploying pharmacists in each area would be important.

The shortage of doctors and their uneven distribution are recognized as serious problems, and they are often widely covered by the media. In contrast, similar problems in pharmacists have not been so emphasized. There are many scholarly papers about the problem of shortage of doctors9,10 and efforts of universities for securing doctors in local towns,11,12 but there are few papers about pharmacists. Clarifying areas that might have a problem of shortage of pharmacists is the first step to solving this problem. In this study, we analyzed the distribution of community pharmacies and pharmacists in Miyagi prefecture and performed a multifaceted analysis by using statistical data.

**MATERIALS AND METHODS**

**Statistical Data** Statistical data used for analyzing the distribution of community pharmacies and pharmacists in this study were based on the following published data: the number of health insurance pharmacies and community pharmacists: “The jurisdiction designation situation of the authorized insurance medical institution and the insurance pharmacy” (as of May 1, 2019) (Tohoku Regional Bureau of Health and Welfare), “2016 Hygiene statistics annual report” (Chapter 2: Medical and Pharmaceutical Statistics, Table 30) (Miyagi Prefecture); the population numbers: “Miyagi prefecture estimated population” (as of May 1, 2019) (Miyagi Prefecture); the rate of population aging: “Surveillance of the aging rate of population” (as of March 31, 2019) (Miyagi Prefecture); and “Overview of Sendai city in 2019” (Sendai city); the rate of inhabitable land area: “Statistical Observations of Municipalities 2019” (Statistics Bureau of Japan). We obtained these statistical data from the website of each public institution. All data used in this study are shown in supplemental Table 1. In this study, we are focusing only on the number of community pharmacists, so our results do not contain the number of hospital pharmacists.

**Analysis Methods**

**Mosaic plots** We analyzed the distribution of pharmacies and pharmacists by using mosaic plots. Mosaic plots enable the visual analysis of several indexes simultaneously. We classified the number of pharmacies and pharmacists per 1000 population into 2 categories (A, B) by using the average of the whole Miyagi prefecture (Figs. 2 and 3). We also classified the number of pharmacies and pharmacists per inhabitable land area into 2 categories (A, B) by using the average of the whole Miyagi prefecture (Fig. 4). All mosaic plots were created on EXCEL statistics ver. 7.0 (ESUMI Co., Ltd., Tokyo).

**Rate of aging** We used the rate of people older than 65 years in the total population and 28.1% is the average in Japan. We divided municipalities into 2 classes: more than 28.1%, the average in Japan, or less.

**Statistical analysis** Statistical significance was analyzed using the χ² test or Fisher’s exact test. The Bonferroni multiple comparison test was used for post-hoc testing after the χ² test or Fisher’s exact test. All statistical analyses were conducted using EXCEL statistics ver. 7.0 (ESUMI Co., Ltd., Tokyo).

**RESULTS**

**Correlation of the Numbers of Pharmacies/Community Pharmacists in Miyagi Prefecture to the Populations** We surveyed the distribution of health insurance pharmacies in each of the municipalities of Miyagi prefecture. The pharmacy rate per 1000 population in Miyagi prefecture was calculated and plotted to the population [Fig. 1(a)]. The areas with low values were mostly in the regions with a low population.

The distribution of community pharmacists showed almost the same tendency. The areas with a low rate of pharmacists per 1000 population in Miyagi prefecture were also concentrated in the regions with a low population [Fig. 1(b)].

**Analysis of the Ratio of 2 Categories by Population** To clarify the distribution, we divided the numbers of pharmacies and pharmacists per 1000 population into 2 categories, as described in the Methods section. We analyzed the ratio of the 2 categories among three regions with a population lower than 15000, 15000 or more and less than 50000, and 50000 or more. In the case of the number of pharmacies, the regions of categories under the average value of whole Miyagi prefecture was 75% of the class “lower than 15000 population” and 61.5% of the class “15,000 or more and less than 50,000 population” [Fig. 2(a)]. The ratios of the categories of pharmacists were similar to those of pharmacies [Fig. 2(b)]. Categories under the average value of whole Miyagi prefecture had a tendency to concentrate in the low population class,
but statistical significance was not observed in all regions. These findings suggested the possibility of some areas in high-population regions having shortage of pharmacies and pharmacists too.

**Analysis of the Ratio of 2 Categories by Population Aging Rate**  The aging rates were divided into 2 classes (less than 28.1% or more). The number of regions classified in the category under the value of whole Miyagi prefecture for pharmacies and pharmacists were more in the regions of higher aging rate [Figs. 3(a) and (b)]. Interestingly, the tendency was remarkable in the number of pharmacists.

**Analysis of the Ratio of Pharmacies/Community Pharmacists per Inhabitable Land Area by Population**  We divided the numbers of pharmacies and pharmacists per inhabitable land area into 2 categories, as described in the Methods section. We analyzed the ratio of the 2 categories among three regions with a population lower than 15000, 15000 or more and less than 50000, and 50000 or more. The areas with low values were mostly in the regions with a low population [Fig. 4(a)]. The distribution of community pharmacists showed the same tendency [Fig. 4(b)]. When the numbers of pharmacies and pharmacists per the inhabitable land area were used, the uneven distribution became clearer than when those per population were used as shown in Fig. 2.

**DISCUSSION**

In this study, we surveyed the distribution of community pharmacies and pharmacists in Miyagi prefecture by using statistical data for assessing problems...
Fig. 3. Mosaic Plots between the Number of Community Pharmacies/Pharmacists per 1000 Population and the Population Aging Rate

Population aging rate vs. the number of community pharmacies per 1000 population (a) and the number of community pharmacists per 1000 population (b). The number in each column mean the number of municipalities. Fisher’s exact test was used for comparisons of each group. 28.1% of the population aging rate of Japan in October 1, 2018 (Cabinet Office, Government of Japan). The number of community pharmacies per 1000 population in the whole Miyagi prefecture was 0.49 and the number of community pharmacists per 1000 population was 1.43. **p < 0.01 vs. under 28.1% group.

Fig. 4. Mosaic Plots between the Number of Community Pharmacies/Pharmacists per Inhabitable Land Area and the Population

Total population vs. the number of community pharmacies per inhabitable land area (a) and the number of community pharmacists per inhabitable land area (b). The number in each column mean the number of municipalities. The number of community pharmacies per inhabitable land area in the whole Miyagi prefecture was 0.4 and the number of community pharmacists per inhabitable land area was 1. *p < 0.05, **p < 0.01 vs. under 15000 population group.

regarding their shortage and uneven distribution. We found that both community pharmacies and pharmacists tended to be lower in areas of low-population density. In addition, taking the aging rates and inhabitable land area into consideration, we disclosed areas with a risk of running short of pharmacists, especially during the operation of the “Community-based integrated care system” and disaster medicine.

In Japan, community pharmacies will be more needed to manage community health in the future. However, this might be difficult to accept for community pharmacists in areas where there are few pharmacies and pharmacists. Furthermore, if community people can only choose one community pharmacy for supporting their health, community health status and health consciousness might depend on the quality of the service of that pharmacy. Therefore, increment in community pharmacies and pharmacists is important for providing choices to inhabitants. To solve this problem, analysis of the distribution of pharmacies and pharmacists was necessary. So far, distribution
was considered related to the population.\textsuperscript{13} Our result analyzing about the rate of community pharmacists to the population in Miyagi prefecture is similar to the result analyzing about total Japan data.\textsuperscript{13} However, we found that the category under the value of whole Miyagi prefecture of the pharmacies and pharmacists per 1000 population rates was also present in the areas of high population density. Therefore, the population is not the only reason for uneven distribution.

In the “Community-based integrated care system”, community pharmacists are expected to proactively work on home healthcare, and some specific efforts were reported.\textsuperscript{14,15} We found that more than half of the areas in Miyagi prefecture have a high aging rate (Fig. 3), and the rate of community pharmacies and pharmacists per 1000 population tended to be lower in places with a higher aging rate. This tendency about community pharmacist is also similar to that of Japan total.\textsuperscript{13} On the other hand, in our present study, we further analyzed the distribution of community pharmacies and found that a significant difference was only recognized about community pharmacists [Fig. 3 (b)]. This might suggest that analyzing both the distribution of community pharmacies and pharmacists would be important to assess the burden per pharmacists. Therefore, this support system would be a burden to community pharmacists especially working in areas where the population aging rate is high and few pharmacists exist.

Inhabitable land area is the total land area minus the area of forests, fields, lakes, and marshes,\textsuperscript{16} and the rate of doctors to inhabitable land area is used for analyzing the areas covered by doctors.\textsuperscript{17} We used this statistical data and found that the number of community pharmacies and pharmacists were affected by the inhabitable land area. Namely, the areas with low value were mostly observed in regions with low population. Furthermore, when the numbers of pharmacies and pharmacists per the inhabitable land area were used, the problems became clearer than when those per population were used. Therefore, not only the population but also the landform might affect the number of community pharmacies and pharmacists. Although social institutions such as providing incentives to pharmacists and improving infrastructures are one of solutions for the uneven distribution of pharmacists, we consider introducing remote medication instruction system also would be urgent necessity. Furthermore, financial aid system for pharmacy students in return for working in the designated areas after graduation would be effective.

Our findings suggest that some areas in Miyagi prefecture might have a severe shortage of community pharmacists, and this problem may cause harmful effects on the operation of the “Community-based integrated care system” and disaster medicine. The rate of metabolic syndrome patients and those having a high risk factors of it in Miyagi prefecture is recognized as a severe health problem. Interestingly, the rate of these are significantly lower in Sendai city.\textsuperscript{5} Although we cannot explain the relationship between the number of community pharmacists and the level of the health in Miyagi prefecture, we consider enriching the number of community pharmacists especially in coastal areas as a health support worker would be one of key factors for solving health problems related to the Great East Japan Earthquake. As the act of pharmacists in the Great East Japan Earthquake is reported,\textsuperscript{18} the role of community pharmacies and pharmacists during a disaster is important. Therefore, it is important to clarify areas that could easily run short of pharmacists and establish a system each area can support each other quickly in emergencies. Furthermore, since the “Community-based integrated care system” requires service providers, including pharmacists, to provide their service within about 30 min, it is pivotal to improve geographical conditions such as transportation networks in addition to the number of community pharmacies and pharmacists.

In this study, we analyzed the distribution of community pharmacies and pharmacists for several aspects and identified areas that have a risk of running short of pharmacists, especially during the operation of the “Community-based integrated care system” and disaster medicine. Thus, to characterize the area by not only the ratios of pharmacies and pharmacists to the populations but also the aging rates and inhabitable land area was important to assess the uneven distribution of pharmacies and pharmacists. Furthermore, a previous study focused on the relationship between community pharmacists and doctors\textsuperscript{13} and other previous study analyzing the number of pharmacists in Shimane prefecture showed the change of the number of pharmacists over time.\textsuperscript{19} In our study, we were only focusing on the distribution of community pharmacies and pharmacists only
at a single point in time. It would be important to analyze continually about the distribution of all medical workers since there might be some municipalities already have been running short of medical workers, especially in coastal areas where were damaged by giant tsunami caused by the Great East Japan Earthquake. Since community pharmacies will be needed to provide not only pharmaceutical care but also healthcare, community pharmacists will be more involved in community life.\(^{20,21}\) In this perspective, we are planning to inquire community people about awareness on health, medication, and the need for community pharmacists. We would also like to construct a breakthrough system for securing community pharmacists around towns by cooperating with the Miyagi Prefectural Government. Finally, we hope our study will be useful for solving the problem of pharmacist shortage in Japan.

In conclusions, community pharmacies and pharmacists in Miyagi prefecture tend to be lower in the low-population density areas. In addition, it would be important to characterize the areas by not only the ratios of community pharmacies and pharmacists to population numbers but also by the aging rates and inhabitable land area, which are related to the work efficiency of pharmacists and accessibility for resident to pharmacies. These results bring to attention the possibly serious problems that could arise from the shortage of community pharmacies and pharmacists in Miyagi prefecture, such as the increment in work burden for pharmacists and harmful effects on the operation of disaster medicine.

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Conflict of Interest The authors declare no conflict of interest.

Supplementary Materials The online version of this article contains supplementary materials.

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