

Projections of Psychiatrists' Distribution for Patients in Japan: A Utilization-Based Approach

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Research

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Abstract

Background: Depopulation accompanied by population aging is a major public health concern in Japan. Although adequate allocation of mental healthcare resources is needed, there have been few studies on the impact of population change on the supply-demand balance for mental illness in Japan. The aim of this study is to predict psychiatrists' distribution for patients with mental illness via a utilization-based approach.

Methods: We set patients with schizophrenia, mood disorders, vascular dementia or Alzheimer's disease as study subjects and conducted analyses for 2015, 2025, 2035, and 2045 across all prefectures. Moreover, we evaluated the regional maldistribution of demand and supply by calculating the number of psychiatrists per patient, Gini coefficients (GC), and Herfindahl-Hirschman Index (HHI).

Results: The mean number of psychiatrists per patient for patients with schizophrenia, mood disorders, vascular dementia, and Alzheimer's disease in 2025, 2035, and 2045 was significantly lower than in 2015. For all of the abovementioned diseases, both the GC and HHI will increase until 2045.

Conclusion: If psychiatrists are allocated at the current population-to-psychiatrist ratio, the shortage of psychiatrists will continue to worsen in the future. To overcome this inequity, policy makers should make plans for the adequate geographical allocation of healthcare resources or the use of information and communication technologies for the delivery of health services to rural communities.

Introduction

The increasing number of patients with mood disorders and Alzheimer's disease has increased the demand for psychiatrists in Japan [1]. In 2013, the Ministry of Health, Labour, and Welfare (MHLW) designated mental illness as the fifth priority disease for the national medical service, and all prefectures in Japan were required to start regional medical care planning for mental illness [2]. Optimizing the balance between supply and demand for the mental healthcare system is a public health issue, and psychiatrists are an essential human resource for the system.

Healthcare systems in Japan are facing the problems of depopulation accompanied by population aging. Based on 2015 national census data, the National Institute of Population and Social Security Research (IPSS) predicted that the Japanese population will decrease from 127 million to 106 million by 2045 [3]. In the same analysis, the IPSS also indicated that the elderly population (aged 65 years and over) will increase by 15.7%, while the young population (aged 0 to 14 years) will decrease by 28.6%. Because the age of onset and the prevalence in each age group differ by disease, changes in population structure could lead to different utilization patterns of healthcare services for each mental illness. Although adequate allocation of mental healthcare resources is needed, there have been few studies concerning the impact of population change on the supply-demand balance with respect to mental illness in Japan.

In this study, we employed a utilization-based approach in which current or target rates of healthcare system utilization are multiplied by future population estimates to estimate the supply-demand balance for mental illness. This approach has been widely used in Organisation for Economic Co-operation and Development (OECD) member countries [4, 5]. Although a need-based approach has been proposed for the same purpose, this approach is considered to bring about excess supply and inefficient use of healthcare resources [6]. In addition, need-based approaches require information about new treatments and diagnostic approaches, epidemiological changes, personal preferences, and socioeconomic issues as well as medical utilization. Because we could not obtain the variables required for model building under a need-based approach, this study adopted a utilization-based approach focusing on demographic changes in Japan.

The aim of this study is to predict psychiatrists' distribution for patients with mental illness and to predict the future healthcare supply-demand balance. The projections of the availability of human resources in the mental healthcare system could support policy decision-making. To the best of our knowledge, this study is the first report on the projection of psychiatrists' distribution for patients with mental illness in Japan.

Methods

Analytical parameters

Data on the number of psychiatrists per prefecture were obtained from the 2016 Survey of Physicians, Dentists, and Pharmacists (SPDP) on the MHLW website [7]. In addition, we obtained data on population projections until 2045 from the IPSS [3]. These projections took the count from the 2015 Population Census as the base population [8]. The utilization rate per 100,000 population per prefecture was obtained from the 2017 Patient Survey on the MHLW website [1], and we set patients with schizophrenia, mood disorders, vascular dementia, and Alzheimer's disease as the study subjects. The requirement for written informed consent was waived by the Ethics Committee since the study involved record review only.

To project the number of future psychiatrists, we assumed that the psychiatrist-to-population ratio in Japan would be constant from 2015 to 2045. We calculated the number of psychiatrists per population based on the 2016 SPDP and the 2015 Population Census for each prefecture. Following the abovementioned assumption, the estimation of the number of psychiatrists in 2015, 2025, 2035 and 2045 was based on the psychiatrist-to-population ratio and population projections in Japan.

In a utilization-based approach, future demand is calculated by multiplying the future population by the utilization rate for each disease. First, we obtained the utilization rate for each disease, by age and sex, as variables from the 2017 Patient Survey. Population by age and sex in the future was based on population projections from 2015 to 2045. We then multiplied these variables for estimates of the future number of

patients as the criterion for demand in each prefecture. For each disease, we calculated the number of psychiatrists per patient in Japan.

We employed the Gini coefficient (GC) as an indicator of the distribution of psychiatrists to aid in the evaluation of inequity in human resources by prefecture. In this study, Lorenz curves are drawn by plotting the cumulative proportion of psychiatrists on the vertical axis and the cumulative proportion of the estimated number of patients on the horizontal axis in ascending order by psychiatrists per patient across all prefectures. After that, we calculated the GCs based on the Lorenz curves. The GC is traditionally used to analyze the distribution of income and wealth and has a theoretical range from 0 (perfect evenness) to 1 (maximum possible unevenness). It provides a standardized value to reflect the relative unevenness of a distribution.

The Herfindahl-Hirschman Index (HHI), which has been widely used to evaluate mergers and acquisitions, was adopted as an indicator of patient concentration. In this study, the HHI for each disease is calculated as the sum of squared patient shares (percentages) across all prefectures. It approaches zero when a market is occupied by a large number of competitors of relatively equal size and reaches its maximum of 10,000 points when there is a market monopoly. In this study, the HHI was interpreted as the concentration of patients with mental illness to estimate future demand transfer.

Statistical Analysis

Because the Shapiro-Wilk test did not confirm the normality of the data distribution, the Wilcoxon Signed-Ranks Test with the Bonferroni correction was employed for comparisons between 2015 and other time points. A value of $p < 0.05$ was considered significant. The data analysis was performed using R for Windows, Version 3.6.3 (The R Foundation for Statistical Computing, Vienna, Austria) [9].

Results

Table 1 displays forecasts of the number of psychiatrists and patients with mental illness in each prefecture. The mean numbers of psychiatrists and patients with schizophrenia and mood disorders in 2025, 2035, and 2045 are significantly lower than those in 2015. In each prefecture, excluding Tokyo, the number of psychiatrists is forecasted to decrease. Similarly, the number of patients with schizophrenia or mood disorders in each prefecture, excluding Tokyo and Okinawa, will decrease by 2045. On the other hand, the mean numbers of patients with vascular dementia and Alzheimer's disease at the abovementioned three time points will be significantly higher than those in 2015. In all prefectures, the number of patients with vascular dementia or Alzheimer's disease is projected to increase by 2045. Figure 1 shows the relationship between population growth rate and patient growth rate from 2015 to 2045 in each prefecture. We also summarized the number of psychiatrists per patient (Table 2). The mean number of psychiatrists per patient for patients with schizophrenia, mood disorders, vascular dementia, and Alzheimer's disease at the abovementioned three time points is projected to be significantly lower than in 2015.

The GC and HHI for each mental illness are shown in Fig. 2 and Fig. 3, respectively. The results show that both the GC and HHI for the four mental illnesses will increase.

Discussion

In this study, we predicted psychiatrists' distribution for patients with mental illness in Japan. On the supply side, the mean numbers of psychiatrists in 2025, 2035, and 2045 are significantly lower than those in 2015. On the demand side, in line with depopulation, the mean numbers of patients with schizophrenia and mood disorders are significantly lower than those in 2015. However, regarding vascular dementia and Alzheimer's disease, the mean numbers of patients with these diseases at the abovementioned three time points are significantly higher than those in 2015. For all of the abovementioned diseases, the HHI will consistently increase from 2015 to 2045. Regarding the supply-demand balance, the mean number of psychiatrists per patient for patients with schizophrenia, mood disorders, vascular dementia, and Alzheimer's disease at the abovementioned three time points is significantly lower than in 2015. For all of the abovementioned diseases, the GC will consistently increase from 2015 to 2045.

In Japan, the shortage of physicians, including psychiatrists, has recently become a serious public health issue [10, 11]. Several studies have indicated that the cause of this shortage is related not only to the absolute number of physicians but also to their maldistribution [12, 13]. Regarding the mental healthcare system in Japan, the absolute number of psychiatrists increased from 1996 to 2012, while the GC based on the number of physicians per population did not change during the same period [14]. Because the population decline has continued to accelerate since the population peaked at 128 million in 2008 [15], we could not predict the future demand-supply balance and equality based on this short observation period. Furthermore, different patterns of healthcare services utilization for each mental illness were not considered in the analysis, and changes in the population structure might not be consistent with the utilization patterns of patients. A study from the US [16], in which the population is predicted to increase in the future, indicated that a shortage of psychiatrists per population will occur despite the increasing number of psychiatrists. Apart from mental illness, Ishikawa and colleagues forecasted the distribution of physicians for patients with acute myocardial infarction, cerebral stroke, and all medical care in Hokkaido [5]. Their results indicated that the GCs for the abovementioned three conditions will decrease from 2015 to 2035, while the HHIs will increase in Hokkaido.

Our results indicate that the change in disease structure with the increase in patients with dementia and decrease in those with schizophrenia and mood disorders will continue until 2045. In addition, the mean number of psychiatrists per patient with mental illness, especially dementia, is predicted to decrease in the same period. The maldistribution of psychiatrists and patients with mental illness will progress in the future. To overcome this inequity, policy makers should make plans for the adequate geographical allocation of healthcare resources or the use of information and communication technologies (ICTs) for the delivery of health services to rural communities.

Several limitations of this study should be acknowledged. First, our study focuses on the number of psychiatrists as the supply side of the mental healthcare system. However, human resources in the healthcare system consist of not only psychiatrists but also nurses and other health care professionals. Furthermore, the accessibility, number and performance of medical facilities are also important factors for the supply side of the system. Analysis of supply and demand in view of these various factors is important for carrying out a more detailed analysis that will be useful for supporting policy formulation. Increasing data collection on relevant values will minimize the limitations in this area. Second, we estimated the number of psychiatrists using population projections until 2045 and psychiatrists' distribution in 2015. Our results indicate that the shortage of psychiatrists will continue to worsen if psychiatrists are allocated at the current population-to-psychiatrist ratio. However, the age distribution and the future supply of psychiatrists could affect the future number of psychiatrists. Further updating research is needed to predict the number of psychiatrists for forecasting the supply-demand balance accurately. Third, our results are limited by the fact that the utilization-based approach is based on several assumptions, as with other modeling methods. The assumption of this approach is that patients' behavior will not change during the forecast period. Several factors, such as innovations in preventive medicine, screening, and treatment or changes in medical care preferences, could affect the behaviors of patients with mental illness. Although this analysis is based on a fixed value for the utilization rate, future research with newer rates would enable us to provide more accurate results.

In conclusion, this study forecasts the psychiatrists' distribution for patients with mental illness to analyze the healthcare supply-demand balance based on a utilization-based approach. While the number of patients with schizophrenia or mood disorders in each prefecture, excluding Tokyo and Okinawa, will decrease by 2045, the number with Alzheimer's disease or vascular dementia in all prefectures is projected to increase. As long as psychiatrists are allocated at the current population-to-psychiatrist ratio, the shortage of psychiatrists will continue to worsen in the future. To overcome this inequity, policy makers should make plans for the adequate geographical allocation of healthcare resources or the use of ICTs for the delivery of health services to rural communities. Although this analysis is based on a fixed value for the utilization rate, future research with frequent model updating would yield more accurate results.

Declarations

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Author contributions

All authors conceived and designed the study. N.S. analyzed the data. N.S. and N.Y.F. drafted the article and wrote the manuscript. All authors critically reviewed the manuscript and approved the final version of this manuscript.

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Availability of data and material

The datasets used in this study are freely available from the Ministry of Health, Labor, and Welfare in Japan (contact via <https://www.mhlw.go.jp/toukei/sonota/chousahyo.html>) and the National Institute of Population and Social Security Research (contact via <http://www.ipss.go.jp/index-e.asp>) for researchers.

Disclosure statement

The authors report no conflicts of interest in this work.

Ethics approval and consent to participate

No ethical approval is required for the manuscript under the standard of the ethical review board in our university.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Due to technical limitations, table PDF is only available as a download in the Supplemental Files section.

Figures

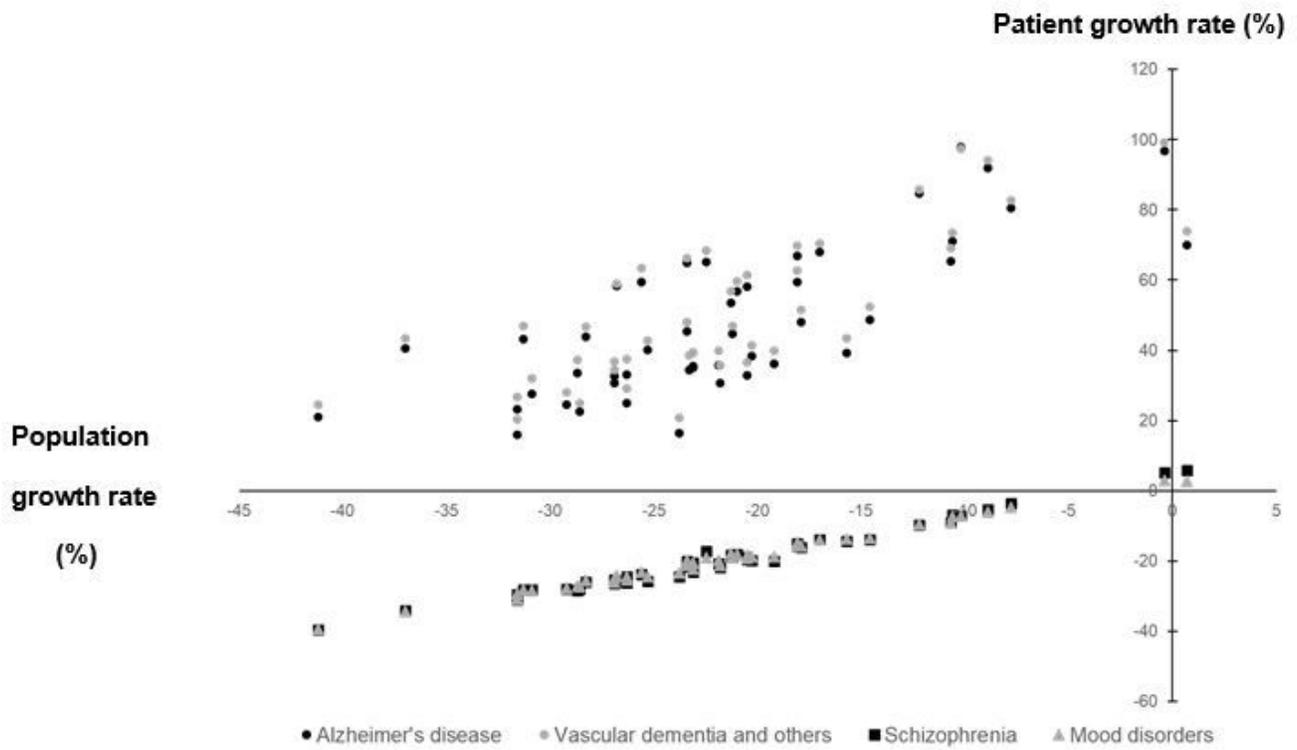


Figure 1

The relationship between population and patient growth rate from 2015 to 2045 in each prefecture

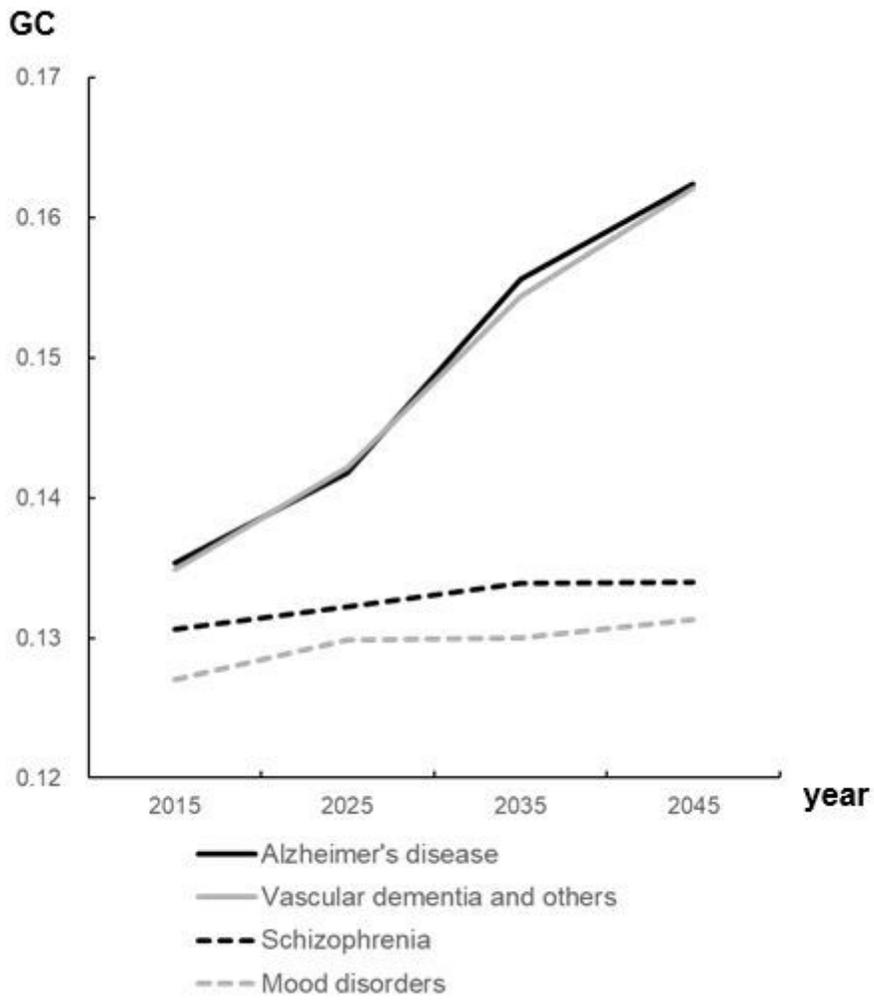


Figure 2

Forecasted Gini coefficients GC; Gini coefficient

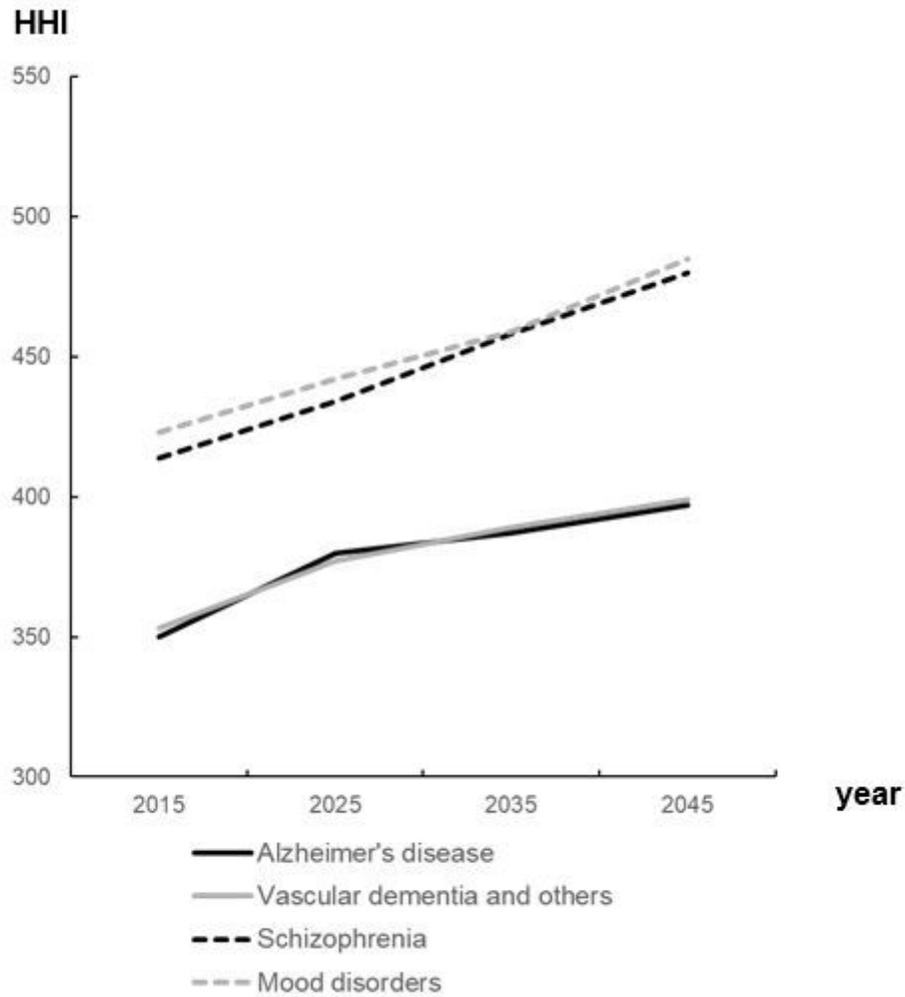


Figure 3

Forecasted Herfindahl-Hirschman Index HHI; Herfindahl-Hirschman Index

Supplementary Files

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