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The Community Health Level and the Distribution of Health Resources: A Case Study, Hokkaido, Japan

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Abstract

The optimal location-allocation of health resources is one of the most important tasks of regional planning in contemporary Japan. In this paper, the present states of community health level and the distribution of health resources in Hokkaido are examined as a fundamental analysis for future regional health planning. Community health level is examined by means of principal component analysis for twenty eight indices by 212 communities. These indices contain those on met and potential health care demands. The distribution of health resources is described by means of the coefficient of centrality by each health resource such as physicians and dentists as human resources, and medical establishments and beds as physical resources. As a result of those examinations, community health level and the distribution pattern are illustrated on the maps.

Key Words: Community health planning, Community health level, Potential health care demand, Coefficient of centrality, Regional distribution of health resources, Principal component analysis, Hokkaido.

1. Introduction

As it is shown in the report of the recent national survey on social life preference that the item of 'medical care and health' ranks first with overwhelming proportion of choice for both individual importance and political priority (keizai-kikakuchō 1983), adequate health and medical services supply is an indispensable basic living condition for the inhabitants' well-being in the community. It therefore becomes an important task for community/regional planning to improve and enrich health services delivery systems.

The levels of health and health care services after WWII in Japan have been remarkably elevated (Kōsei Tōkei Kyōkai 1983). The average life span is the highest in the world, and the forthcoming era of more physicians is being discussed as a politically important task also. However, these examples do not mean that the health and medical problems have been completely met with. In recent years there has been a tremendous increase in the demands for various health serivces in consonance with aging of population, change of disease structure and the

increasing concern of people for health and health care services. The national healt care cost has also shown a steep rise. And the excesses of physicians and health care services facilities in a few cities are pointed out on one hand, and on the other hand many *physicianless districts* still exist and the adjustment of health care services delivery system in the rapid population growth areas is delayed. These are the essential reasons why the necessity of establishing the efficient and rational health care services delivery system by means of optimal location and allocation of health resources based on the health needs of the community/region is emphasized.

The purpose of this paper, considering the present situation of the above-mentioned health problems in Japan, is to describe the health level and the distribution of health resources in Hokkaido as a fundamental analysis to make clear the future tasks of regional health planning.

2. Outline of the study area

Hokkaido prefecture, an island in northern Japan, consists of 212 self-governing bodies which are 32 *shi* (cities), 155 *machi/cho* (towns) and 25 *mura/son* (villages) and their total number of population is about 5.6 million (1981). Hokkaido is the fifth highest populated prefecture next to Tokyo, Osaka, Kanagawa and Aichi prefectures forming the Big Three Metropolitan Areas. However, the population density is at the lowest rank in all of 47 prefectures in Japan, that is only 70/km^2 which is under one fourth of the national average. Though capital city Sapporo with a population of 1.5 million is having the fifth place among the Big Eleven Cities in Japan, there are many depopulated areas in Hokkaido. And also *physicianless districts* amount to 209 districts in 7 cities, 64 towns and 13 villages.

According to 1980 health statistics (Hokkaido 1980 a), in comparison with the national average, mortality rate (5.82 per 1,000 persons) and infant mortality rate (8.37 per 1,000 births) are both slightly low, but corrected mortality rate (male 4.84, female 3.78) and still birth rate (37.03) are fairly high. The number of health resources per 100,000 persons such as physicians (123.7), dentists (41.0), pharmacists (88.3), clinics (54.1), and dental clinics (30.5) in 1981 are pretty lower than national average except for hospitals and total number of beds. Thus in general, the levels of health and health care services of Hokkaido are at lower rank at national level, furthermore because of geographical conditions such as scattered settlements and snowy and cold climate in winter, health problems of Hokkaido are serious (Hokkaido 1980 b).

Hokkaido prefectural government has engaged in arranging the regional health centers since 1969 to cope with health problems of Hokkaido (Hokkaido 1983), and began to prepare the regional health planning in 1975, and in 1980 *The Hokkaido Fundamental Plan For Regional Health* was presented. The main point of the Plan is to establish the hierarchical health units ranged from primary to tertiary and design to promote the levels of health and health care services of each health region as a planning unit. A primary health region is equivalent to the administrative district of a self-governing body, and the primary health regions are merged

into twenty one secondary health regions, and then they are gathered into four tertiary health regions. As in the other paper twenty one secondary health regions were examined (Oda 1984), in this paper 212 primary health regions are analysed.

3. Methods

3.1. Indices and methods for measuring the community health level

Although various indices for measuring community/regional health level are proposed, obtainable indices which are completely equipped and officially announced on community level are limited (Sakuma 1981). In this paper, through the examination of various data collected in health statistical yearbooks and reports published by Hokkaido prefectural government, twenty eight indices are adopted, which can be regarded as typical indices for the indications of health states and health needs of the community (see Table 1). The indices prepared after processing of raw data are as follows. Corrected mortality rate (4), corrected PMI (5), potential prevalence rate (6,7), potential patient rate (8, 9, 10). Treatment days per disease (20, 23, 26), treatment fee per disease (21, 24, 27), treatment fee per day (22, 25, 28) by inpatient-care, outpatient-care and dental care for persons insured by the national health incurence (the numbers added after indices correspond with those of indices shown in Table 1).

PMI (Proportional Mortality Indicator) is a percentage of the death of fifty years old and over in total number of the death in the community. The higher is the value of PMI, the better is the health state of the community. Corrected PMI is one where the influence of age structure of population of the community is excluded. Standard group for computing corrected PMI and corrected mortality rate is national population in 1975.

$$\text{Corrected PMI} = 100 \left\{ X_{50} \cdot P_{50} / (X_{50} \cdot P_{50} + X_{49} \cdot P_{49}) \right\} .$$

X_{50}: death rate of the group of fifty years old and over.
X_{49}: death rate of the group under fifty years old.
P_{50}: population of the standard group of fifty years old and over.
P_{49}: population of the standard group under fifty years old.

Both prevalence rate and patient rate (rate of patients who received treatments) by communities does not exist so that in this paper prevalence rate and patient rate by age groups found by National Health Survey and Patient Survey are applied to the age structure of the community, and those results are defined as potential prevalence rate and potential patient rate of the community.

$$R = \sum P_i \cdot R_i / P .$$

R: potential prevalence rate (potential patient rate).
P_i: population of age group of i years old in the community.
R_i: prevalence rate (patient rate) of age group of i years old found by National Survey.
P: total population of the community $= \sum P_i$.

The computations of potential prevalence rate are executed for dental disease and the other diseases, respectively. And the computations of potential patient rate are executed for dental care and, inpatient-treatment and outpatient-treatment except for dental care, respectively.

3. 2. Method for analysis of the distribution of health resources

As recent health care services consist of various types of elements, there are many things which shoud be counted as health care related resources. However, in this paper, physicians and dentists as human resources and general hospitals, general clinics (with beds as well as without beds), dental clinics and general beds as physical resources are considered. General beds are defined in this paper as total amount of general beds of hospitals and beds of clinics.

Regional distribution of health resources is generally indicated in the form of the proportion of health resources to total population, for example the number of health resources per 1,000 persons or 100,000 persons, or the number of persons per health resource. However, in this paper, coefficient of centrality, which was deviced by urban geographer W. R. Siddal to analyse the wholesale function of a community (Otomo 1982), is applied to measure the relative magnitude of the health care service function of the community.

$$C_{ij} = R_{ij}(R_{ij}/D_{ij} - R_{Tj}/D_{Tj}) .$$

C_{ij}: coefficient of centrality of the community i on health resource j.
R_{ij}: the number of health resource j in the community i.
R_{Tj}: total number of health resource j in Hokkaido $= \sum R_{ij}$. $i = 1, 2, \cdots, 212$.
D_{ij}: the amount of health care demands of the community i.
D_{Tj}: total amount of health care demands in Hokkaido $= \sum D_{ij}$. $i = 1, 2, \cdots, 212$.

The amount of health care demands D_{ij} is defined here as the number of persons who are supposed to have potential demands for health care services supplied by health resource j. Coefficients of centrality are respectively computed in the following four cases by the type of D_{ij},

(1) $C_{Pij} = R_{ij}(R_{ij}/D_{Pij} - R_{Tj}/D_{PTj})$.

(2) $C_{Sij} = R_{ij}(R_{ij}/D_{Sij} - R_{Tj}/D_{STj})$.

(3) $C_{Oij} = R_{ij}(R_{ij}/D_{Cij} - R_{Tj}/D_{OTj})$.

(4) $C_{Iij} = R_{ij}(R_{ij}/D_{Iij} - R_{Tj}/D_{ITj})$.

D_{Pij}: total population of the community i as the number of potential health care demands for health resource j.
D_{PTj}: total population of Hokkaido as the number of potential health care demands $= \sum D_{Pij}$.
D_{Sij}: The number of potential sick persons in the community i.
D_{STj}: The number of potential sick persons in Hokkaido $= \sum D_{Sij}$.
D_{Oij}: The number of potential outpatients in the community i.
D_{OTj}: The number of potential outpatients in Hokkaido $= \sum D_{Oij}$.

D_{Iij}: The number of potential inpatients in the community i.
D_{ITj}: The number of potential inpatients in Hokkaido $= \sum D_{Iij}$.

Those coefficients of centrality are expressed in the form of C_P, C_S, C_O, or C_I. When the value of C_{ij} shows positive sign, it means that the community i has surplus health resource j, and the community i has possibility to supply its surplus health services to the other communities. And conversely, the negative value of C_{ij} means that the community i must depends health care services j upon the other communities.

4. Community health level in Hokkaido

As a result of principal component analysis of twenty-eight indices on 212 self-governing bodies, ten principal components whose eigen value is more than one are extracted. They explain about eighty-four percent of total variation. Referring to the varimax rotated matrix (Table 1), each principal component can be characterized as follows.

Table 1. Virimax rotated matrix

		I	II	III	IV	V	VI	VII	VIII	IX	X
1	infant mortality rate	03	06	−03	14	81	18	06	02	−11	−02
2	perinatal mortality rate	−01	11	05	07	88	11	10	05	−07	−00
3	natural still birth	−02	−09	08	10	53	−29	−03	−08	11	−02
4	corrected mortality rate	26	−03	09	22	09	−07	−04	−00	−43	−41
5	corrected PMI	12	−07	−07	13	03	04	06	−22	−09	72
6	potential prevalence rate	12	97	13	04	06	−00	04	−03	01	−01
7	potential dental disease rate	04	−27	01	10	03	04	05	88	−02	−08
8	potential dental patient rate	03	03	03	08	03	−03	08	91	−08	−09
9	potential inpatient rate	13	96	13	02	07	01	04	−11	02	01
10	potential outpatient rate	10	97	12	03	05	−01	03	−08	00	−01
11	inpatient treatment rate per capita	36	32	55	06	01	−28	−02	28	02	38
12	inpatient treatment days per capita	44	27	39	−04	47	04	01	23	04	40
13	fee for inpatient treatment per capita	36	28	64	10	03	−09	04	21	−03	38
14	outpatient treatment rate per capita	80	18	09	18	05	−03	16	−03	10	−04
15	outpatient treatment days per capita	96	14	16	05	04	00	04	02	−02	03
16	fee for outpatient treatment per capita	55	19	74	11	02	01	10	−05	−05	−13
17	dental treatment rate per capita	04	−00	−14	10	03	18	−15	−11	89	−10
18	dental treatment days per capita	02	04	02	96	14	02	−02	07	13	03
19	fee for dental treatment per capita	10	04	−08	19	03	07	66	−02	68	−03
20	inpatient treatment days per capita	02	00	−02	−01	15	96	−03	01	12	04
21	fee for inpatient treatment per capita	−04	−02	00	03	03	96	−03	−01	11	−00
22	fee for inpatient treatment per day	−29	−23	14	11	45	−07	16	−23	−29	−17
23	outpatient treatment days per disease	84	04	17	−10	10	01	−07	05	−09	10
24	fee for outpatient treatment per disease	05	09	89	−03	07	03	−00	−05	−16	−12
25	fee for outpatient treatment per day	−68	07	63	07	01	02	07	−08	−10	−19
26	treatment days per dental disease	04	04	06	95	12	−02	00	11	−05	06
27	fee for treatment per dental disease	08	05	05	12	07	−05	94	09	−08	08
28	fee for dental treatment per day	−06	04	07	−51	−02	03	79	07	−06	01
	eigen value	5.9	2.9	2.7	2.5	2.2	1.9	1.8	1.5	1.2	1.1
	percent of variation	21.2	10.2	9.5	8.8	7.8	7.0	6.3	5.4	4.2	3.8

The first rotated varimax principal component (PC-I) links strongly with outpatient-treatment receiving rate and treatment days per capita, and outpatient treatment days per disease. Therefore PC-I can be characterised the level of the amount of outpatient treatment. Similarly, it is found that potential prevalence rate, potential inpatient rate and potential outpatient rate have the strongest relations with PC-II, so PC-II is termed potential demand. PC-III is closely related to the indices for fee for health care except for dental care. PC-IV links strongly with only treatment days of dental care per capita and per dental disease, so it implies a long term dantal care. PC-V is closely connected with infant mortality rate, perinatal mortality rate, natural still birth rate and, inpatient treatment days per capita and fee for inpatient treatment per day, so it is possible to judge that PC-V expresses the level of mother and child health. PC-VI links strongly with only inpatient treatment days and the fee for treatment per inpatient treatment, so it implies long-term and expensive inpatient care treatment.

Similarly, PC-VII can be characterized as a principal component indicating costly dental care. PC-VIII is clearly considered as a principal component implying potential dental care demand. PC-IX has strongest relation with dental care treatment rate and fee for dental care per capita, so the component can be regarded as one indicating that there are many persons who need dental care, which also can be considered as a component implying the amount of met demand for dental care. PC-X links strongly with corrected PMI, and next with corrected mortality rate which shows negative sign. This means that mortality rate is substantially low and also a percentage of dying young is small, so that PC-X can be regarded as a principal component implying longevity.

So far as principal components scores of each self-governing body are examined, the scores of both PC-IV and PC-VI show specific value only in a very few communities, which can be supposed as a reflection of accidental occurrence of patients who needed peculiar treatment in the communities in that year. Therefore PC-IV and PC-VI are excluded. And the relative health level of 212 self-governing bodies are described by means of the scores of the remaining eight principal components. Fig. 1 shows the communities whose scores are 1 and over or less than -1 by principal compoments, and Table 2 shows the highest ten and the lowest ten self-governing bodies.

4.1. Level of the amount of outpatient treatment receiving (PC-I)

The number of communities which gain the score 1 and over is twenty five (ten cities and fifteen towns and villages), and the communities of the score less than -1 are one city and thirty-four towns and villeges. Eight cities except Otaru and Hakodate in the former ten cities are coal mining cities where population decreased rapidly because of shut down of operation of mining one after another. Mikasa and Akabira among eight cities are included in the highest ten cities, towns and villages. Among rural areas, the scores of Tomari, Otaki and Asahi are especially high (Table 2). As Fig. 1-① shows, half of twenty five communities whose scores are more than 1 concentrate in the central part of inland. On the

Table 2. Princial component scorces of each community (The highest ten and the lowest ten communities)

rank	PC-Ⅰ		PC-Ⅱ		PC-Ⅲ		PC-Ⅴ	
1	Tomari v	3.8	Tomari v	3.6	Nisiokoppe v	4.4	Ōtaki v	9.0
2	Ōtaki v	2.9	Hamamasu v	2.6	Utasinai c	4.3	Horokanai	3.5
3	Otaru c	2.6	Kamoenai v	2.4	Akabira c	3.0	Akaigawa v	3.3
4	Mikasa c	2.6	Risiri	2.4	Maruseppu	2.5	Kamoenai v	3.2
5	Asahi	2.4	Masike	1.8	Mikasa c	2.2	Setana	2.1
6	Kamisunagawa	2.1	Kurisawa	1.7	Horonobe	1.9	Rusutsu v	2.1
7	Akabira c	2.1	Nisiokoppe v	1.6	Kamisunagawa	1.8	Kimobetsu v	1.8
8	Iwanai	2.1	Shakotan	1.6	Toyotomi	1.8	Sintotsukawa	1.5
9	Hakodate	1.9	Uryū	1.5	Simamaki v	1.5	Horonobe	1.5
10	Yūbari	1.9	Taisei	1.4	Kumaisi	1.5	Kenbuchi	1.5
...	.....		.....		.....		.....	
203	Sirataki v	−1.6	Nakasibetsu	−1.9	Urausu	−1.3	Akkesi	−1.1
204	Nakashibetsu	−1.6	Ebetu c	−1.9	Kunneppu	−1.3	Otoineppu	−1.1
205	Sibecha	−1.6	Kusiro c	−2.0	Tōma	−1.4	Simukappu v	−1.1
206	Turui v	−1.7	Kitami c	−2.1	Takasu	−1.4	Ikutahara	−1.1
207	Sibetsu	−1.7	Isikari	−2.2	Chūrui v	−1.4	Kamisunagawa	−1.3
208	Rausu	−1.8	Sapporo c	−2.3	Wassamu	−1.4	Nakatonbetsu	−1.3
209	Hamanaka	−1.8	Kusiro c	−2.3	Higasimokoto	−1.5	Minamifurano	−1.3
210	Higasirisiri	−1.8	Tomakomai c	−2.4	Sarufutsu v	−1.6	Hamamasu v	−1.5
211	Bekkai	−1.8	Eniwa c	−2.4	Rebun	−1.8	Atsuta v	−1.6
212	Risiri	−2.5	Chitose c	−2.8	Asahi	−5.8	Asahi	−1.8

rank	PC-Ⅶ		PC-Ⅷ		PC-Ⅸ		PC-Ⅹ	
1	Simamaki v	2.7	Simukappu v	4.1	Nakasatsunai v	5.0	Ikutahara	3.3
2	Urausu	2.5	Asahi	3.6	Memuro	5.0	Takinoue	2.4
3	Hamamasu v	2.4	Yūbari c	2.7	Ikeda	2.4	Utasinai c	2.2
4	Takasu	2.0	Hidaka	2.5	Setana	2.4	Hokuryū	2.1
5	Atsuma	2.0	Kamisunagawa	2.5	Makubetsu	2.0	Sirataki v	2.0
6	Atsuta v	1.9	Akabira	2.2	Sarabetsu v	1.8	Engaru	2.0
7	Aibetsu	1.7	Mukawa	2.0	Takinoue	1.7	Maruseppu	2.0
8	Niki	1.7	Otoineppu	2.0	Fūren	1.6	Toyotomi	1.9
9	Kenbuchi	1.6	Utasinai	2.0	Yūbetu	1.6	Abuta	1.8
10	Shosanbetsu v	1.6	Mikasa	1.8	Rikubetsu	1.5	Hayakita	1.6
...	.....		.....		.....		.....	
203	Rankosi	−1.3	Higasirisiri	−1.6	Wakkanai c	−1.5	Ōmu	−1.6
204	Sawara	−1.3	Uryū	−1.6	Mori	−1.6	Niseko	−1.8
205	Samani	−1.3	Kitami c	−1.7	Matsumae	−1.8	Simokawa	−1.8
206	Erimo	−1.4	Toyotomi	−1.7	Masike	−1.8	Tsurui	−1.9
207	Simokawa	−1.5	Kuromatsunai	−2.0	Oshamanbe	−1.8	Nakasatunai v	−1.9
208	Kamoenai v	−1.6	Tōya v	−2.0	Akkesi	−1.9	Atsuma	−2.1
209	Risiri	−1.7	Setana	−2.1	Nemuro c	−2.1	Simamaki	−2.1
210	Sibetsu	−1.8	Sinsinotsu	−2.2	Tomari v	−2.3	Rusutsu v	−2.3
211	Setana	−2.0	Onbetsu	−3.2	Hamanaka	−2.3	Mitsuisi	−2.4
212	Bekkai	−4.1	Tomari	−3.4	Toyotomi	−2.7	Nisiokoppe v	−5.6

Note. c: city, v: village, others: town.

contrary, in remote islands Rishiri and Higashi-Rishiri, and northern part as well as the communities in the east such as Bekkai, Hamanaka and Rausu, the score of PC-I is fairly low.

4. 2. Level of potential health care demand except for dental care (PC-II)

One city and twenty nine towns and villages gain the score more than 1. These communities has high proportion of the aged, and they are widely distrubuted at the west coast of Hokkaido (Fig. 1-②). And conversely, eighteen cities and seventeen towns and villages gain the score less than 1, that is the level of potential health care demand is fairly low, which contain almost of major cities in Hokkaido such as Sapporo, Kushiro, Tomakomai and Kitami as well as the population increasing communities such as Ebetsu, Eniwa, Chitose and Kushiro-cho sited around the major cities (Table 2).

4. 3. Level of fee for health care treatment (PC-III)

It is four cities and twenty five towns and villages that the level of fee for health care is considerably high. They are dispersed in northern part, central part and sourthern part (Fig. 1-③), among them, the level of fee for health care of Nishiokkope-mura, Utashinai and Akabira is especially high (Table 2). All of the four cities showed the high score also for PC-I (the level of the amount of outpatient treatment). Therefore these cities can be regarded as the communities with the most amount of actual health care demand among the communities in Hokkaido. On the contrary, it can be found that in inland there are many communities which the level of fee for health care is relatively low (Fig. 1-③).

4. 4. Level of mother and child health (PC-V)

The problems of mother and child health are main subject of community health activity. The communities with the high score for PC-V, that is low level of mother and child health, are all rural communities. They are dispersed in Hokkaido (Fig. 1-④). Otaki-mura occupies special position in the score of PC-V (Table 2), and also Horokanai, Akaigawa and Kamoenai are especially low level of mother and child health (Table 2).

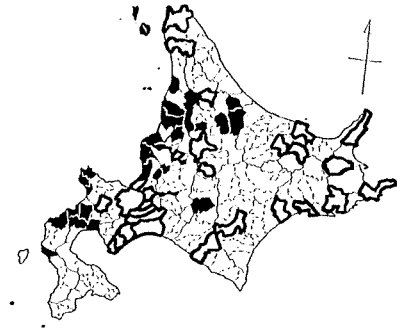
4. 5. Level of fee for dental care treatment (PC-VII)

The high score for PC-VII is observed in five cities and twenty five towns and villages. These communities are distributed mainly in central part and western part in Hokkaido (Fig. 1-⑤). Though they contain major cities such as Sapporo and Asahikawa, higher ranking communities are all small towns and villages (Table 2). On the contrary, low level communities for fee for dental care are widely distrubuted in eastern half of Hokkaido (Fig. 1-⑤), and the level of fee for dental care of Bekkai-cho is especially low (Table 2).

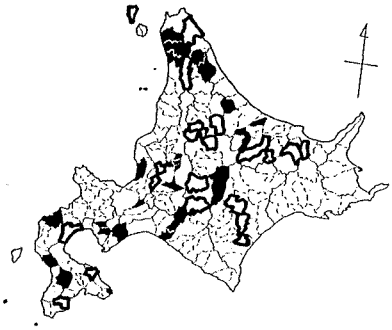
4. 6. Level of potential dental care demand (PC-VIII)

As Fig. 1-⑥ shows clearly, high level communities for potential demands for dental care concentrate in central part as well as inland part of the east. Five cities and twenty-three towns and villages correspond to those communities and the

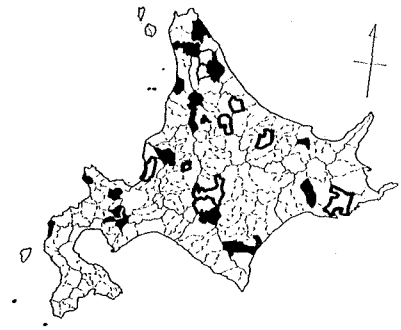
① Level of the Amount of Outpatient Treatment Receiving



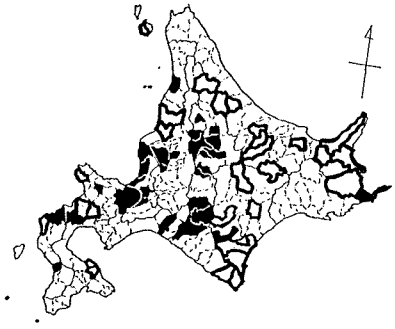
② Level of Potential Health Care Demand except Dental Care



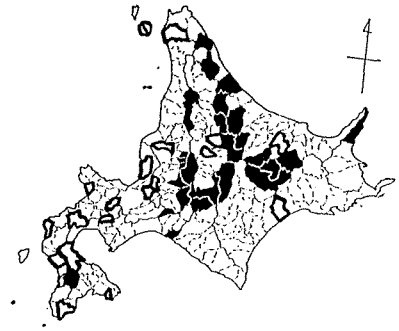
③ Level of Fee for Health Care Treatment



④ Level of Mother and Child Health



⑤ Level of Fee for Dental Care



⑥ Level of Potential Dental Care Demand

⑦ Level of the Amount of Dental Care Treatment Receiving

⑧ Level of Longevity

■ Principal Component Score>1 □ Principal Component Score<−1

Fig. 1. Levels of Community Health.

five cities are all coal mining cities with small population. Yubari, Akabira, Utashinai and Mikasa are included in the highest ten communities (Table 2). And conversely, the communities of low level are dispersed mainly in western part and the number is two cities and twenty towns and villages.

4.7. Level of the amount of dental treatment receiving (PC-IX)

One city and twenty-four towns and villages score more than 1. They concentrate in a part of the central region of Hokkaido, near capital city Sapporo, and in Tokachi region with Obihiro as central city in sourthern part of Hokkaido (Fig. 1-⑦), especially high score in Nakasatsunai-mura and twenty-five towns and villages show the considerably low score. They are mainly situated in northern part, eastern part and peninsular part of the south of Hokkaido.

4.8. Level of longevity (PC-X)

Regional distribution characteristics of level of longevity are not so clear (Fig. 1-⑧). The number of high level communities for longevity is one city and nineteen towns and villages, especially the level of longevity of Ikutahara-cho, Takinoue-cho, Utashinai and Hokuryu-cho is extreamly high, but Nisiokoppe-mura, Mitsuishi-cho and Rusutsu-mura are in the considerably low level on longevity (Table 2).

The above is rough examination of relative level of health by 212 communities (self-governing bodies) by means of the scores of eight principal components. It can be found through the examination that regional disparities of health level in Hokkaido are considerably severe. Considering from a political point of view, it is possible to take measure to cope with health problems by referring to Fig. 1. Fig. 2 shows target communities/regions and tasks for regional health activities. And from a viewpoint of regional priority of health policies, as shown in Table 2, it is necessary to give top priority to the communities with higher or lower score in each principal component as a 'problem community'.

5. Regional distribution of health resources

Fig. 2 shows the regional distributions of health resources by means of coefficient of centrality. C_P, C_S, C_O, C_I noted as regend in the figure are each coefficient of centrality by cases of D_{ij} as stated before. The following is the findings of regional distribution of each health resource.

5.1. Physicians

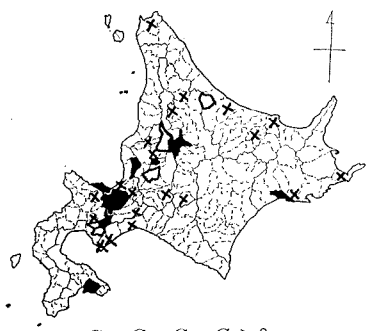
The number of communities whose C_P is more than 0, that is relatively surplus of physicians in the case of supposing total population as the number of health demands, is twelve cities, towns and villages (Table 3), which correspond to only six percent of 212 self-governing bodies. Among these twelve communities, the communities with $C_S>0$ and $C_O>0$ and $C_I>0$ as well as $C_P>0$ are only seven cities and one village (Table 3). Fukagawa, Sobetsu-cho, Toya-mura and Nishiokoppe-mura, which show relative surplus of physicians on C_P can not provide health service enough for itself as well as the other 200 communities from a view-

Table 3. Coefficient of centrality of physician (× 1000)

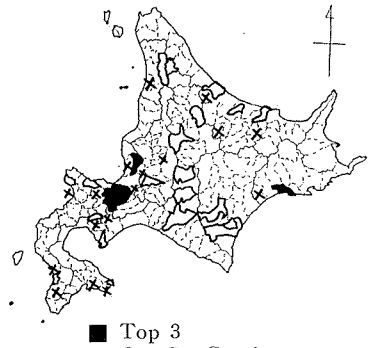
rank		C_P	C_S	C_0	C_1
1	Sapporo c	2728	28193	54855	326288
2	Kusiro c	1855	10483	22429	89023
3	Asahikawa c	436	3891	7791	45601
4	Hakodate c	100	579	1304	6743
5	Otaru c	79	201	698	2693
6	Ōtaki v	30	173	408	2073
7	Sunagawa c	13	47	134	675
8	Tōbetu	2	2	15	25
9	Fukagawa c	2	−56	−72	−632
10	Sōbetu	1	−5	−3	−63
11	Tōya v	0	−7	−11	−84
12	Nisiokoppe v	0	−5	−7	−57
	.....				
202	Wakkanai c	−20	−157	−329	−1850
203	Noboribetu c	−22	−180	−367	−2051
204	Chitose c	−26	−147	−358	−1810
205	Ebetu c	−31	−226	−484	−2652
206	Kitami c	−39	−290	−620	−3407
207	Tomakomai c	−42	−196	−541	−2374
208	Hokuryū	−53	−290	−703	−3406
209	Simukappu v	−53	−290	−703	−3406
210	Akaigawa v	−53	−290	−703	−3406
211	Kusiro	−53	−290	−703	−3406
212	Rusutsu v	−53	−290	−703	−3406

point of potential demands. It can be found, from the viewpoint of potential demand, that even Fukagawa, Sobetsu-cho, Toya-mura and Nishiokoppe-mura which show relative surplus of physicians on C_P, can not provide health service adequately for itself and must depend upon the other communities as well as the remaining 200 self-governing bodies. It does not mean, of course, that inhabitants have to or it is desirable to meet their health demands in their community. Here, the relative differences of supply efficiency of health care services among communities as a unit for comparison are discussed. This consideration is applied to the other health resources in the following descriptions.

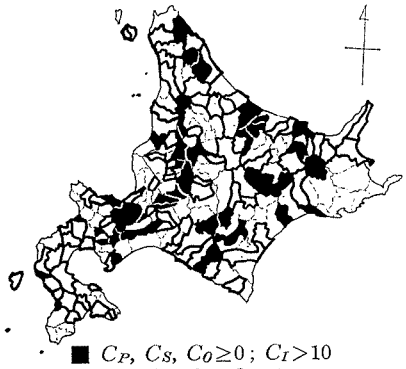
Geographically, there are not the communities which show relative surplus of physicians in northern part, inland of eastern part, southern part and western part of Hokkaido. This shows that there are not cores for health services supply in those regions and that physicians in Hokkaido is extreamly unevenly distributed (Fig. 2-①). The sign × in the figure indicates the communities with very few physicians.



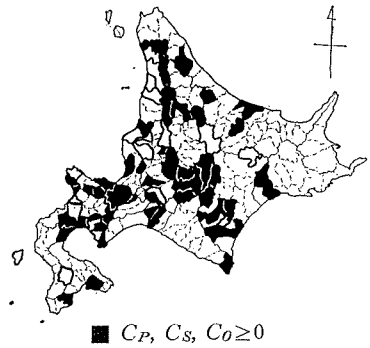
■ C_P, C_S, C_O, $C_I \geq 0$
□ $C_P \geq 0$; C_S, C_O, $C_I < 0$
① Physicians



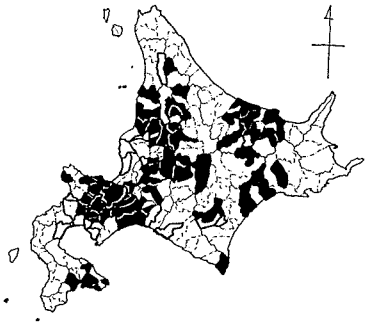
■ Top 3
□ C_P, C_S, $C_O \geq 0$
② Dentists



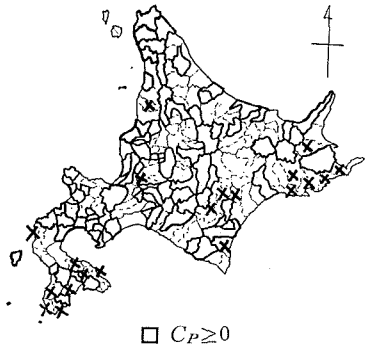
■ C_P, C_S, $C_O \geq 0$; $C_I > 10$
□ C_P, C_S, C_O, $C_I \geq 0$
③ General Hospitals



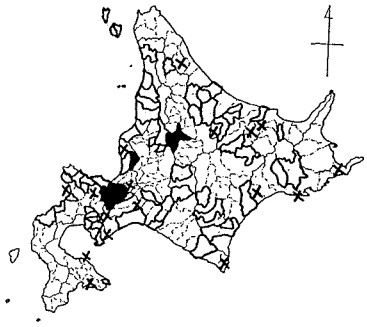
■ C_P, C_S, $C_O \geq 0$
□ $C_P \geq 0$
④ General Clinics (Total)



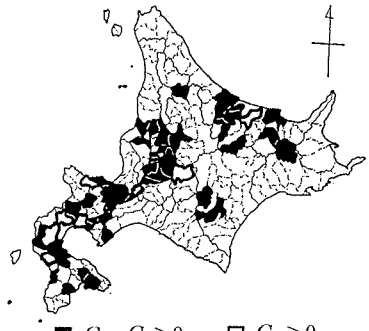
■ C_P, C_S, C_O, $C_N \geq 0$ □ $C_P \geq 0$
⑤ Clinics with Beds



□ $C_P \geq 0$
⑥ Clinics without Bed



■ Top 3 □ C_P, C_S, $C_O \geq 0$
⑦ Dental Clinics



■ C_P, $C_I \geq 0$ □ $C_P \geq 0$
⑧ General Beds

Fig. 2. Regional distribution of Health Resources.

5. 2. Dentists

As shown in Table 4, the number of communities with C_P more than 0 is twenty-four cities, towns and villages. The number is larger than one of the communities with C_P more than 0 in the case of physicians, and the pattern of distribution of dentists is rather dispersed one.

Two major cities Sapporo and Kushiro, and Tobetsu-cho with a dental and pharmaceutical college show the extreamly high coefficient of centrality of dentists in both cases of C_S and C_O, and the two cities Asahikawa and Iwamizawa show slightly high coefficient. Except for those communities, only a few communities have potential supply power for the other communities. And as Fig. 2-② shows, in eastern part, the whole of west coast and peninsular part of the southwest dentists are remarkably insufficient. The sign × in the figure indicates the communities with very few dentists.

Table 4. Coefficient of centrality of dentist (× 1000)

rank		C_P	C_S	C_O
1	Sapporo c	236	64041	22818
2	Kusiro	192	35342	13384
3	Tōbetsu	131	33938	11766
4	Asahikawa c	4	1039	371
5	Iwamizawa c	4	1032	355
6	Obihiro c	3	750	272
7	Muroran c	2	277	106
8	Todohokke v	1	208	73
9	Yoichi	1	131	42
10	Kamoenai v	1	22	7
11	Esasi	1	172	60
12	Furano c	0	25	7
	.....			
24	Asahi	0	106	38

5. 3. General hospitals

Hospital, in Japan, is defined as medical establishment with bed capacity of twenty and over. Hokkaido has more general hospitals per 100,000 persons than the national average. Without regard to bed capacity, general hospitals are widely dispersed all over Hokkaido as Fig. 2-③ shows. Consequently, different from human resources such as physicians and dentists, none of communities show the extreamly high coefficient of centrality of general hospitals, and it can be found that the distributive pattern is rather even one. However, from a viewpoint of C_I, in eastern part and peninsular part of the southwest, general hospitals are insufficient.

5. 4. General clinics

The function of clinic is essentially to serve primary health care for outpatient. In Japan, general clinic are difined as medical establishments with no bed or with bed capacity of less than 20 for inpatients, and 35 percent of all clinics have beds for inpatients, and therefore the inpatient-care function of clinics cannot be disregarded. In Hokkaido, the proportion of clinics with beds is far above the national average, that is 47 percent. In this paper, the distribution of total clinics, clinics with beds and clinics without bed are respectively described.

First of all, on total clinics, 62 communities corresponding to 29 percent of 212 self-governing bodies show relative surplus in the case of C_P. However among

them, the number of communities with $C_S>0$ and $C_O>0$ as well as $C_P>0$ is limited to fourty-six. The rest twelve communities must depend clinic services upon the other communities in the case of considering C_S and C_O, although it may be possible to provide clinic services enough for itself in the case of C_P. Fig. 2-④ shows that in eastern part and west coast of the south, and central part of inland, clinics are ralatively short.

5.5. Clinics with beds

The number of communities with $C_P>0$ is seventy-one. Though it cannot be said that the inpatient-care function of clinics with beds is quite equal to one of hospitals, it is possible to say that clinics with beds take a role to supplement the inpatient-care function of hospitals. As compared with the above-mentioned distribution of general hospitals (Fig. 2-③), the distriburion of clinics with beds in northern and southern part may be a good example of it (Fig. 2-⑤). However, in eastern part and peninsular part of the south, both hospitals and clinics with beds are few. And on the contrary, in middle west, clinics with beds concentrate on the same regions where supply power of the inpatient-care service is great.

5.6. Clinics without bed

Clinics without bed are expected to take important roles for community health activities such as serving primary health care and screening outpatients as the most familiar medical establishments to the inhabitants in the community. Eighty-two communities equivalent to 39 percent of 212 self-governing bodies show $C_P>0$. Sixty-four communities among them show $C_S>0$ and $C_O>0$ as well, which is corresponding to 30% of 212 self-governing bodies. It can be found that the distriburion of clinics without bed keeps the highest equality among health resources taken up before in this paper. The negative value of both C_S and C_O of the rest eighteen communities among the above-mentioned eighty-two communities is fairly small, so that it may be judged that those communities have clinics to be able to meet health care demands arising in their own community.

However, the above-mentioned sixty-four communities do not show particularly high values for either coefficient of centrality. This means that those communities cannot provide their surplus health services to the other communities adequately. Therefore, among the rest of communities except the above-mentioned eighty-four communities, the communities with the minus value for either coefficient of centrality of both general hospitals and clinics with beds depend health care services upon the other communities even for slight disease and injury. Such communities are twenty cities, towns and villages marked × in Fig. 2-⑥.

5.7. Dental clinics

The number of the communities which show $C_S>0$ and $C_O>0$ is fifty-four cities, towns and villages. However, similarly in the case of clinics without bed, none of the communities which show particularly high values for each coefficient of centrality except for Sapporo, Asahikawa and Tobetsu-cho. Consequently, few communities can provide their surplus dental care services to the other communities.

The communities with particularly high negative value for C_S and C_O, which are marked with × in Fig. 2-⑦, are mainly situated near the above-mentioned fifty-four communities, but from the reason as noted right above, it can be understood that it is not so easy for people lived in the communities marked × to consult dentists.

5.8. General beds

As mentioned before, there are not a few clinics with inpatient-care function in Hokkaido, so that in this paper, sum of general beds in hospitals and beds in clinics is dealt as general beds.

The number of communities with $C_I>0$ among the forty-eight communities with $C_P>0$, that is they can be supposed to have surplus inpatient-care services, is forty cities, towns and villages. As shown clearly in Fig. 2-⑧, general beds are unevely distributed, notably next to physicians. Geographically, almost of the communities situated in northern, eastern and southern part of Hokkaido show $C_P<0$. And notable disparities can be found between the communities with high value of the coefficient and the communities with negative one as shown in Table 5.

Table 5. Coefficient of centrality of beds

rank		C_P	C_I
1	Ōtaki v	34	25230
2	Sapporo c	33	6752
3	Asahikawa c	31	3368
4	Hakodate c	29	2311
5	Otaru c	17	897
6	Engaru	15	1358
7	Akabira c	14	1066
8	Fukagawa c	11	734
9	Obihiro c	9	1284
10	Hiroshima	9	1224
	.....		
192	Oiwake	−2	−218
193	Muroran c	−2	−195
194	Nemuro c	−2	−177
195	Eniwa c	−2	−188
196	Takikawa c	−3	−260
197	Wakkanai c	−3	−254
198	Ikutahara	−4	−385
	.....		
212	Shosanbetsu v	−4	−385

The highest ten communities contain the major cities such as Sapporo, Hakodate, Otaru and Obihiro. However, the coefficients of centrality of core cities such as Wakkanai in the north, Muroran in the southwest and Memuro in the east are exceedingly small (Table 5), so that it can be understood that in those regions inpatient-care services is conspicuously insufficient.

6. Concluding remarks

In this paper, the present states of community health level and the distriburion of health resources in Hokkaido were examined as a fundamental amalysis for future regional health planning.

Community health level was examined by means of principal component analysis for twenty four indices by 212 self-governing bodies. Those indices contain the present states of health care receiving of people insured by national health insurance as met demand, and also potential prevelence rate and potential patient rate as potential demand as well as ordinary indices such as mortality rate, and so on.

As a result of principal component analysis by means of those indices, eight principal components as new indices for measuring community level were extracted.

They imply the level of the amount of outpatient-care treatment, potential demand except dental care demand, fee for health care services, mother and child health, fee for dental care services, potential dental care demands, the amount of dental care treatment and longevity, respectively. And then each princial component score was indicated on the map for ecological comprehention and identification of 'the problem community/regon'.

The distribution of health resources was described by means of the coefficient of centrality by each health resource such as physicians and dentists as human resources, and medical establishments and beds as physical resources.

The coefficient of centrality was computed by each case of potencial demands. Consequently, it has become clear that, in Hokkaido, physicians and general beds are notably unevenly distributed, and general clinics and dental clinics are insufficient in the absolute number.

Next tasks for the author are to clear up factors of the differences of health levels among communities/regions, to analyse the optimal location and allocation of health resources, and then, through the comprehensive examinations, to attempt to formulate an actual regional health plan.

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