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A Measurement of the Levels of Health and Health-Care Services, and the Classification of Health Regions in Hokkaido, Japan

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Abstract

It is just the time in Japan that regional health planning should be re-examined. The purpose of this paper is, by the use of the methods of multivariate analysis, to decribe the levels of regional health and health-care services and to classify the three levels of health units in Hokkaido, Japan. The establishment of health regions, to a certain extent, have brought good result for contracting the regional difference of health resources. However, the inter- and intra-regional differences still remain. As will be shown in the classification of 212 cities, towns and villages, of 48 public health center jurisdictions, and of 21 Health Regions, each regional health unit is classified into many types of groups and sub-groups. This means that each region has various characteristics of health and health-care service, and then this implies that regional health planning in Hokkaido should be implemented with the considerations of those classifications and the characteristics of each group.

Key words: Regional health planning, Level of regional health, Level of regional health-care services, Regional difference of health resources, Comprehensive regional health-care services, Health region, Principal component analysis, Cluster analysis, Hokkaido.

Introduction

It is in the early 1970's in Japan that regional health planning came to be seriously discussed as one of the most important political tasks. As a matter of course, there were various regional health plannings before the early 70's in order to improve the level of health and health-care services (Hashimoto 1975, Kurata *et al.* 1977). However, it is almost ten years ago that the idea of regionalization or systematization of health-care services, which aims to establish the rationalized system of comprehensive health-care services, was diffused among health planners and policy makers (Takada *et al.* 1974, Hashimoto 1975, Oda 1976). This recognition of regional comprehensive health planning may be attributed to factors such as the qualitative change of health problems, the rising of people's interest in well-being and quality of life, the increasing demand for health and medical services (Oda 1980 a), the technological development of communication and medical machinery followed by the drastic social change after the early 60's.

More than ten years have already passed since the necessity and gravity of the systematization of comprehensive regional health-care and medical services was generally recognized. Up to date various plans and reports on regional health planning from the above-mentioned point of view have been presented by the Ministry of Health and Welfare (Kōsei-shō 1974), Japan Medical Association (Nihon Ishikai 1972), some of local governments, and the other health-related associations and committees, and so on. In several parts of the country, planning regions for health planning have been established and regional health centers have been expanded and improved or newly constructed (Sōgō Kaihatsu Kikō 1983). All the prefectures in Japan now have at least one medical college or school as a result of national policy of "one medical college for one prefecture" introduced in 1973. Observing on a nationwide level, the number of health personnels, hospitals and clinics, and beds per 100,000 persons have fairly increased and recently the problem of over-supply of physicians is already taken as a topic of health problem in the near future.

Nevertheless, the mal-distribution of health resources and services has still not been improved and moreover contemporary health-related problems i. e., againg of population, rising of the sick rate and the consultation rate, increase of very expensive medical care with the aid of sophisticated equipment and escalation of national health-care costs become increasingly serious (Kôseishō 1982, Sugaya 1982). And also, the people's demand for health-care services becomes more and more diverse with the change of disease structure and health environment (Kōsei Tōkei Kyōkai 1983). Therefore it is just the time that the existing regional health plannings should be re-examined from the multiple points of view (Oda 1980 b). The purpose of this paper is to describe the levels of regional health and health-care services in Hokkaido and to classify the various levels of health regions as a preliminary study on the optimal location and allocation of health and medical resources toward a rational and systematic regional health-care service.

Methods, data and objective area of the study

Although various methods, techniques and data to measure the levels of health and health-care services can be prepared, in this paper the data of vital statistics and health resources are gathered and some methods of multivariate analysis are adopted, The data analysed in the study are presented in the Tables in the latter sections. They are mainly derived from *The Hokkaido Health Statistical Yearbook 1981* (Hokkaido 1981 a), which contains detailed data on vital statistics and health resources by cities, towns and villages.

The library computer programs for principal component analysis, cluster analysis and so forth which are offered to the users of Hokkaido University Computing Center are utilized. These programs are included in the statistical package named KHSPSS of Hokkaido University Computing Center, which is a revised edition of SPSS Japanese edition (Miyake *et al.* 1977). The methodological characteristics and techniques of principal component analysis and cluster analysis were briefly

explained in another paper (Oda *et al.* 1984) with reference to some works (Okuno *et al.* 1971, Miyake *et al.* 1977, Sugiyama 1983, Suzuki 1983). Cluster analysis used here is Q-mode one on hierarchical, nearest neibour and centroid method using Euclid distance.

Objective area of the study is Hokkaido, an island of about 5.6 million pop., in northen Japan. There are 212 self-governing bodies (32 cities, 155 towns and 25 villages) in Hokkaido and they are gathered together into 48 districts of public health center jurisdictions, and then the 48 districts are merged into twenty one *Health Regions* (Fig. 1) (Hokkaido 1981 b). The number of physicians is 123.7 (Japan 138.2), dentists 41.0 (48.2), pharmacists 88.3 (102.2), hospitals defined as medical establishments with bed capacity of 20 and over 10.2 (7.8), clinics as those with no bed for inpatients or with bed capacity of less than 20 is 54.1 (66.1), and total number of beds per 100,000 persons is 1,876.0 (1,397.6).

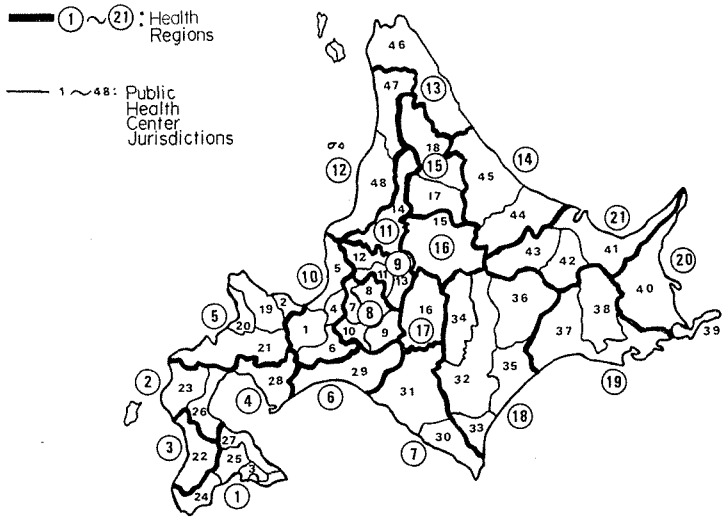

Fig. 1. Regional Health Units of Hokkaido.

Regional difference of the levels of health and health resources

1 Population and health resources

The uneven distribution of health resources is frequently pointed out in a free-entry and a fee-for service market system, while existing locational patterns of them is also regarded as proportional distribution to population size. It is not so easy to decide how locational pattern is the balanced or optimal distribution. Operations-research workers and geographers have been studying the public facility location problems and regional health planning, and they have developed various models for the optimal location-allocation. It is not a direct object of the study, however, to review those models and propose a original model. Here, the relationship between population and the number of health resources is briefly examined.

Table 1. Inter Relationship Between Population and Health Resources.
(Pearson's coefficient of correlation)

	CTV	PHCJ	HR	CTV*	PHCJ*
HOSPITALS	.99179**	.99124**	.99292**	.95619**	.95136**
Mental	.96918**	.97095**	.97287**	.79293**	.82390**
General	.98581**	.98587**	.99027**	.95016**	.94368**
CLINICS	.99515**	.99293**	.99566**	.97260**	.96127**
with beds	.98602**	.98385**	.98610**	.95674**	.93307**
without beds	.98446**	.98219**	.98981**	.93240**	.92772**
DENTAL CLINICS	.99346**	.99186**	.99339**	.98802**	.98970**
PHYSICIANS	.98890**	.98445**	.98733**	.95990**	.94511**
in facilities	.99093**	.98684**	.98917**	.96420**	.95010**
out facilities	.94895**	.94269**	.94345**	.67344**	.64357**
others	.94866**	.93012**	.95530**	.60959**	.45025**
DENTISTS	.98520**	.98179**	.98641**	.96555**	.96970**
in facilities	.98535**	.98204**	.98691**	.96783**	.97190**
out facilities	.94005**	.93038**	.95111**	.54087**	.47888**
others	.77894**	.76892**	.78946**	.55539**	.47419**
BEDS	.99573**	.99367**	.99466**	.97642**	.96241**
of Hospitals	.99558**	.99321**	.99368**	.97302**	.95890**
mental	.98136**	.97485**	.97607**	.87569**	.83973**
tuberculosis	.91605**	.90470**	.87142**	.84506**	.74490**
isolation	.64354**	.58569**	.53696*	.66460**	.55417**
general	.99427**	.99357**	.99420**	.96866**	.96246**
of Clinics	.98326**	.97993**	.98137**	.94995**	.91860**

CTV: City, Town, Village.
PHCJ: Public health center jurisdiction.
HR: Health Region.
* Except for capital city, Sapporo

*: $P<0.05$, **: $P<0.01$.

Table 1 shows the pearson's coefficients of correlation between population and the number of health resources by each level of health region. It can be found that they are very closely interrelated in all the levels of health regions with a few exceptions, that is, the more population, the more health resources. However, it cannot be always said that the high value of the coefficient of correlation does represent the optimal distribution of health resources. It is truer to say that it reflects the over-congestion of health resources into large cities and that it indicates a quasi-optimal distribution of health resources.

2 Urban-rural difference of the levels of health and health resources

Table 2 and Fig. 2 show the mean and coefficient of variation of each item by urban and rural areas. The term of urban area used here means *Shi* (city), and rural area means *Machi/Cho* (town) and *Mura/Son* (village).

On vital statistics, birth rates in urban areas are higher and death rates are

Table 2. Regional Difference of Health Resources.

Items (Rate*)	Mean		Coefficient of Variation**	
	Urban	Rural	Urban (%)	Rural (%)
1 Birth	12.6	11.4	17.0	20.3
2 Death	6.4	7.5	27.2	29.0
3 Natural increase	6.2	4.5	52.0	66.8
4 Infant mortality	8.5	9.4	43.5	167.5
5 Neonatal mortality	6.0	7.2	51.7	207.0
6 Perinatal mortality	13.6	14.7	30.3	139.4
7 Still birth	72.6	73.2	22.8	47.0
8 Natural	33.9	32.1	35.5	61.5
9 Artificial	38.7	41.2	33.0	72.3
10 Marriage	6.5	5.4	18.3	21.9
11 Divorce	2.2	1.1	22.1	49.7
12 Hospital	10.8	10.2	46.4	94.6
13 Mental	1.7	0.3	93.9	667.0
14 General	9.0	9.8	49.2	98.0
15 Clinic	52.4	44.7	35.9	70.9
16 Dental Clinic	26.9	23.7	38.9	48.8
17 Physician	101.4	52.5	38.0	81.3
18 Dentist	32.0	26.1	34.4	93.9
19 Pharmacist	72.1	41.2	33.7	95.8
20 Bed	214.1	119.3	37.5	120.3
21 of Hospital	174.1	95.9	38.9	146.1
22 Mental	47.5	11.1	69.0	544.0
23 Tuberculosis	10.6	4.0	67.2	280.1
24 Isolation	2.9	2.5	111.2	233.4
25 General	112.8	77.8	38.6	160.9
27 of Clinic	40.0	23.3	59.6	95.9

* 1~11: per 1,000 persons **100×σ/Mean
12~19: per 100,000 persons
20~26: per 10,000 persons

lower than in rural areas, so that natural increase rates in urban areas exceeds those in rural areas. Infant mortality rates, neonatal mortality rates and perinatal mortality rates, which are typical indicators for the level of regional health, are higher in rural areas than in urban areas and, as coefficient of variation of each item by urban and rural areas in the right side column of the Table 2 shows, the difference of the level of health is more conspicuous among rural areas than among urban areas. There is a little difference in still birth rates between urban areas and rural areas, but quite a difference among rural areas.

On health resources, rate of hospitals in rural areas is equivalent to that in

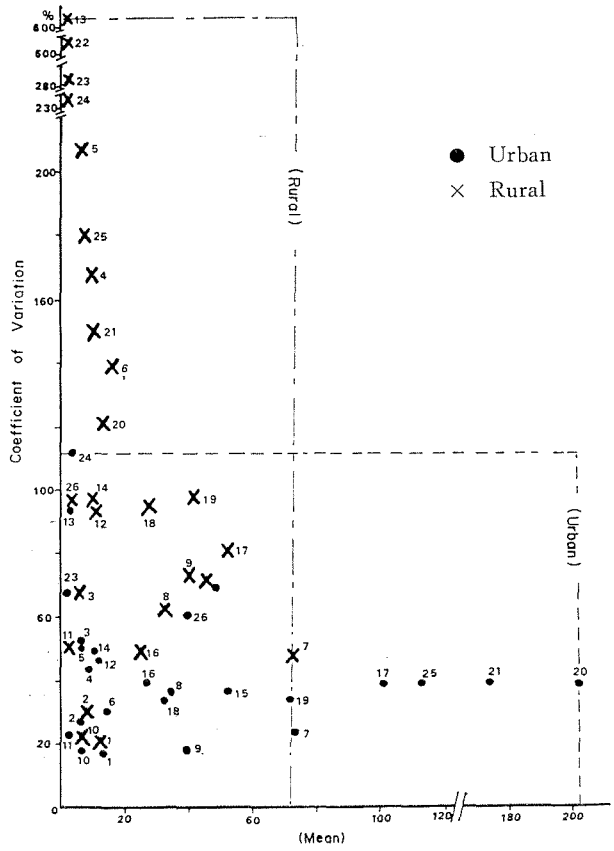

Fig. 2. Rural-Urban Differences of Health Resources.

urban areas, and the rate of general hospitals in rural areas is higher than in urban areas. However, the other health resources such as clinics, physicians, dentists, pharmacists and beds concentrate into urban areas. Especially the rate of physicians in urban areas is almost twice as in rural areas. And also urban areas have two times total number of beds per 100,000 persons as many as rural areas.

3 The levels of health and health-care service by regional health units

As noted before, Hokkaido is hierarchically divided into three levels of regional health units. A primary health region is equal to an administrative district that is a self-governing body such as city, town or village. A secondary health region is a public health center jurisdiction, and a tertiary one is named *Hoken Iryo Ken* (*Health Region*).

Table 3 and Fig. 3 shows the mean and coefficient of variation of each item by the above-mentioned health units. It can be seen that the value of coefficient of variation of each item decreases as health units expand. Namely, as health units expand, the regional difference of levels of health and health care services contracts, especially infant mortality rate, neonatal mortality rate, perinatal mortality rate, still brith rate, and the rate of mental hospitals, dentists, beds for mental

Table 3. Changes of Regional Difference of Health Resources by regions.

	Items (Rate*)	Mean			Coefficient of Variation**		
		CTV	PHCJ	HR	CTV (%)	PHCJ (%)	HR (%)
1	Birth	11.6	12.6	12.5	19.9	12.9	11.6
2	Death	7.3	6.8	6.5	29.3	20.4	17.5
3	Natural increase	4.8	5.6	5.9	64.9	46.7	40.8
4	Infant mortality	9.2	8.2	8.1	157.4	54.9	31.1
5	Neonatal mortality	7.0	5.6	5.8	196.4	52.5	37.9
6	Perinatal mortality	14.6	12.9	12.7	130.4	38.7	24.0
7	Still birth	73.1	75.8	75.8	44.3	19.5	12.3
8	Natural	32.3	33.4	33.0	58.0	31.4	18.8
9	Artificial	40.8	42.5	42.8	68.3	26.3	21.7
10	Marriage	5.6	6.1	6.3	22.4	16.4	14.6
11	Divorce	1.3	1.6	1.7	51.8	32.1	27.8
12	Hospital	10.3	10.5	10.9	88.3	33.3	27.4
13	Mental	0.6	0.9	1.2	408.3	125.8	75.0
14	General	9.7	9.5	9.7	93.2	35.8	29.2
15	Clinic	45.8	46.7	47.6	65.8	27.6	21.6
16	Dental Clinic	24.1	25.0	26.1	47.4	20.3	20.1
17	Physician	59.8	77.6	86.3	76.0	44.8	43.3
18	Dentist	27.0	31.2	31.2	85.4	40.5	28.1
19	Pharmacist	45.9	63.0	64.3	85.3	41.0	34.8
20	Bed	133.6	166.8	177.5	104.7	34.5	25.6
21	of Hospital	107.7	135.7	145.3	124.2	37.8	28.4
22	Mental	16.6	25.4	29.6	352.6	94.2	61.9
23	Tuberculosis	5.0	8.7	8.2	219.0	85.1	57.6
24	Isolation	2.6	3.4	3.2	215.3	92.5	60.4
25	General	83.1	98.1	104.3	141.1	34.7	28.2
27	of Clinic	25.8	31.0	32.2	90.2	46.3	38.7

* 1~11: per 1,000 persons
12~19: per 100,000 persons
20~26: per 10,000 persons

** $100 \times \sigma$/Mean
CTV: 212 cities, towns and villages
PHCJ: 48 public health center jurisdictions
HR: 21 Health Regions

disorder, beds for tuberculosis and beds for infectious disease are good examples. As to the following items, however, the degree of contraction of regional difference is insignificant comparing Health Region with public health center jurisdiction: the rate of hospitals, beds, general hospitals, clinics, dental clinics, physicians, pharmacists, beds of hospitals, general beds of hospitals and beds of clinics, especially, as to the rate of clinics, dental clinics and physicians.

By the way, the effect of establishing the regional health units can be partly judged by examining the changes of the mean and coefficient of variation of each health resource. If the mean rises and coefficient of variation becomes less (the

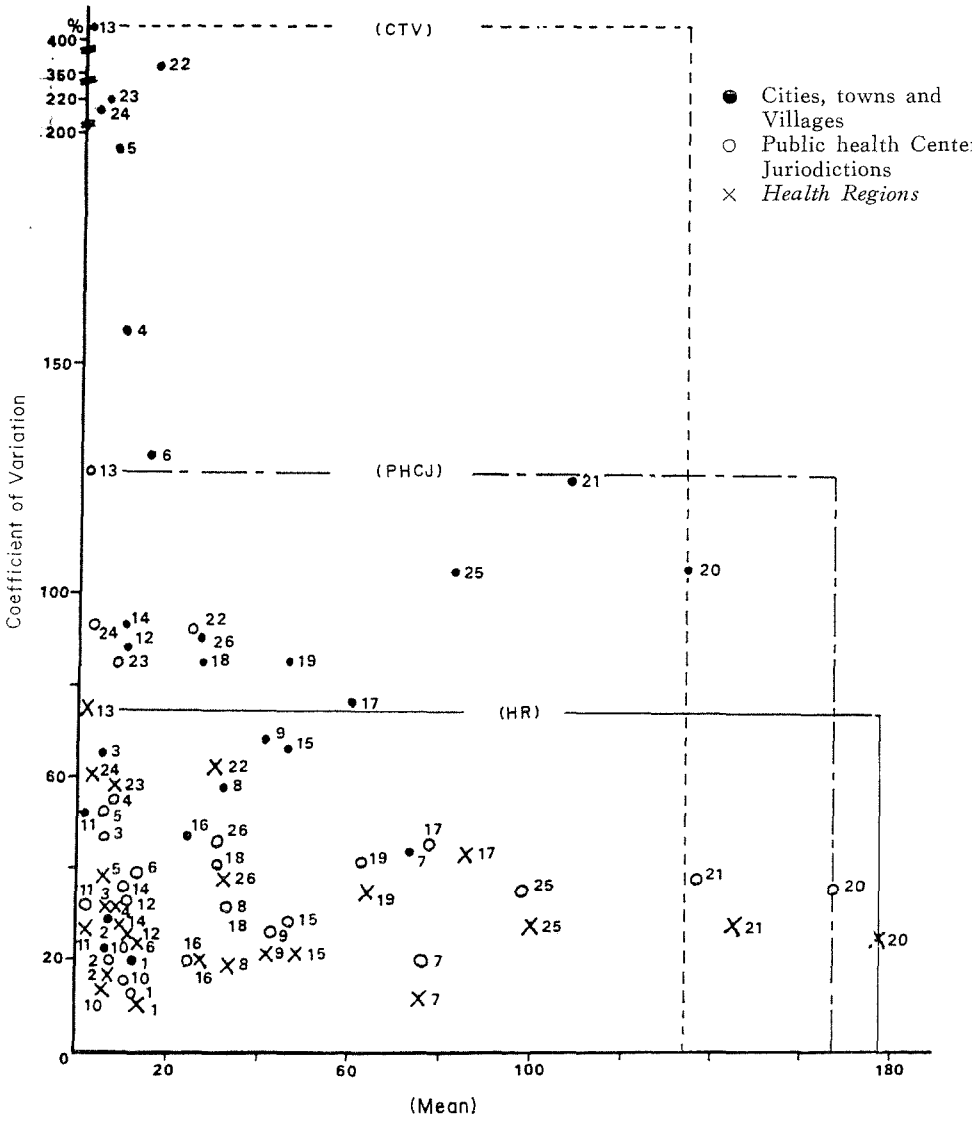

Fig. 3. Regional Difference by Health Regions.

marks of each item move toward the lower right direction from the upper left side in Fig. 3), then it can be said that the level of health-care services of each region rises, and moreover, regional difference is reduced. Looking at Fig. 3 with those considerations as stated right above, [17] the rate of physicians, [19] pharmacists, [20] beds, [21] beds of hospitals and [25] general beds are more desirably distributed in the tertiary health unit named *Health Region* than in the public health center jurisdiction. But the discussion here is limited to the point of views of the reduction of regional difference in the distribution of health resources in relation to only population size, so that it goes without saying that location-allocation problems of health resources related to concrete regional health planning should

be studied on another occasion from the other points of view including the problems of accessibility to health resources and quantitative-qualitative differences of health needs.

The characteristics and classifications of regional health units

Case I: Primary Health Unit-212 cities, Towns and Villages

1. Extraction of principal components and their implications

As a result of principal component analysis by using the twenty-two quantitative variables in each city, town and village, seven principal components (PCs), whose eigen value is more than one, were extracted. They explain about 70 percent of the total variation. It is possible, referring to the varimax rotated matrix in Table 4, to characterize each principal component as follows.

Table 4. Varimax Rotated matrix (212 cicties, towns and villages).

Variables (Rate)	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7
1 Birth	.031	.033	.878	−.047	.021	−.046	.003
2 Death	.049	.204	−.685	.078	−0.91	.181	.003
3 Natural increase	−.048	−.030	.882	.084	−.034	−.071	−.056
4 Infant mortality	.120	.920	−.007	.071	.005	−.030	.025
5 Neonatal mortality	.165	.932	−.017	.088	−.015	−.045	.025
6 Perinatal mortality	.239	.824	−.137	.067	−.014	.063	−.019
7 Still birth	−.142	.051	−.153	.123	.073	.768	.188
8 Marriage	−.039	.026	.748	.177	.073	.167	.088
9 Divorce	.168	−.169	.407	.560	−.039	.244	.090
10 Hospital	.826	.138	−.069	−.241	.083	.084	−.170
11 Clinic	.097	.378	−.257	.628	−.033	−.173	−.035
12 Dental Clinic	−.132	−.050	−1.66	.285	.391	−.505	.111
13 Physician	.661	.228	−0.15	.546	.172	−.064	.169
14 Dentist	−.062	0.42	.028	.053	.934	−.033	−.023
15 Pharmacist	.345	−.077	.179	.108	.761	.201	.031
16 Beds of Hospitals	.832	.267	−.010	.175	−.008	.034	.390
17 Mental	.056	.030	.024	.043	.006	−.019	.963
18 Tuberculosis	.320	−.215	.020	.118	.047	.177	.245
18 Isolation	.258	−.093	−.034	−.053	.103	.470	−.142
19 General	.879	.317	−.022	.170	−.021	.014	−.055
20 Beds of Clinics	−0.66	.265	.009	.702	.077	.031	−.013
21 Population Density	.139	−.217	.248	.573	.176	−.040	.111
Eigen Value	4.61	3.32	2.05	1.90	1.44	1.19	1.06
Percent of Variation	21.0	15.1	9.8	8.6	6.6	5.4	4.8
Cumulative percent		36.1	45.4	54.0	60.6	66.0	70.8

The first rotated varimax principal component (PC-1) links strongly with the rate of general beds, beds of hospitals and general hospitals (principal component loadings are 0.8 and over), and also with physicians. Therefore, the first component can be characterized as a component implying health-care services supply, especially by hospitals (*hospital service*). Similarly, it is found that all variables having the strongest relations with PC-2 are related to *baby death rate* (infant mortality rate, neonatal mortality rate and perinatal mortality rate), and so PC-2 is termed *community health conditions.* PC-3 is closely related to natural increase rate, birth rate and marriage rate, and inversely to death rate, so that PC-3 is termed *population reproduction power.* Though PC-4 implies health care supply as well as PC-1, PC-4 links more strongly with beds of clinics, clinics, population density and divorce rate than PC-1. So PC-4 is termed *clinic service.* And as already mentioned before, the mean of those four variables noted just above are all higher in urban areas than in rural areas (see Table 1). Consequently, it can be said that PC-4 implies *the urban way of health-care services supply.* PC-5 is closely connected with only dentists and pharmacists, so it implies *the quantitative level of health manpowers except physicians.* The other two components are disregarded because of their small percent of variation.

2. Classification of 212 Cites, Towns and Villages by Using the Principal Component Scores

To examine the relative status of each city, town and village (CTV for short) on the levels of health and health-care services, the first five principal component scores (PCSs) of each CTV were computed. By arranging the CTVs by the score of each PC, the health and/or medical characteristics of each CTVs can be individually described. For example, Fig. 4 shows the first fifteen CTVs and the lowest fifteen CTVs for the PC-1 score. The other CTVs from the 16th to the 197th place as well as the figures of the other four PC scores are abbreviated because of page limitations in this paper.

In order to describe the total health characteristics of each CTV simultane-

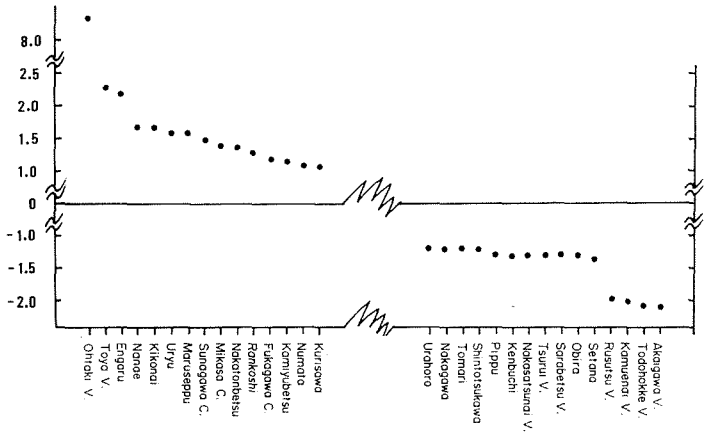

Fig. 4. An Example of ramk order of principal component score (PC-1)

Table 5. Classification of 212 CTVs.

(C : City, V : Village, other Town)

P C 1	2	3	4	5	TYPE	↙	—Number of CTVs
⊕	⊕	⊕	⊕	⊕	〈1〉	3	Kucchan, Abashiri C, Bihoro
				⊖	〈2〉	0	
			⊖	⊕	〈3〉	5	Esashi, Hidaka, Onbetsu, Teshikaga. Sarufutsu V
				⊖	〈4〉	7	Nakafurano, Otobe, Sawara, Shikaoi, Nemuro C, Toyotomi, Horonobe
		⊖	⊕	⊕	〈5〉	2	Akabira C, Fukagawa C
				⊖	〈6〉	2	Kuromatsunai, Ootaki V
			⊖	⊕	〈7〉	3	Numata, Horokanai, Kimobetsu, Kyogogu, Tokoro, Enbetsu
				⊖	〈8〉	3	Rankoshi, Kitahiyama, Utanobori
	⊖	⊕	⊕	⊕	〈9〉	14	Sapporo C, Hakodate C, Hiroshima, Iwamizawa C, Naie, Asahikawa C, Iwanai, Muroran C, Abuta, Urakawa, Shizunai, Obihiro C, Kushiro C, Engaru
				⊖	〈10〉	6	Chitose C, Takikawa C, Nayoro C, Date C, Monbetsu C. Rumoi C
			⊖	⊕	〈11〉	4	Makkari V, Yakumo, Shihoro, Kamishihoro
				⊖	〈12〉	12	Ishikari, Nanporo, Okushiri, Shirikishinai, Noboribetsu C, Shibetsu, Rausu, Kiyosato, Koshimizu, Oomu, Hamatonbetsu, Esashi
		⊖	⊕	⊕	〈13〉	6	Otaru C, Yuni, Naganuma, Sunagawa C, Ashibetsu C, Moseushi
				⊖	〈14〉	10	Mikasa C, Bibai C, Kuriyama, Utashinai C, Kamisunagawa, Nanae, Toyoura, Toya V, Samani
			⊖	⊕	〈15〉	17	Biei, Wassamu, Shimokawa, Bifuka, Suttsu, Taisei, Imagane, Kikonai, Hobetsu, Biratori, Shimizu, Oketo, Maruseppu, Kamiyubetsu, Takinoue, Rishiri, Teshio
				⊖	〈16〉	16	Kita V. Kurisawa, Tsukigata, Uryu, Higashikawa, Assabu, Kumaishi, Oono, Mitsuishi, Niikappu, Toyokoro, Memanbetsu, Tsubetsu, Nakatonbetsu, Higashirishiri, Tomamae

P C					TYPE		
1	2	3	4	5			
⊖	⊕	⊕	⊕	⊕	〈17〉	2	Furano C, Urahoro
				⊖	〈18〉	7	Akaigawa V, Kaminokuni, Erimo, Sarobetsu V, Higashimokoto V, Wakkanai C
			⊖	⊕	〈19〉	6	Tobetsu, Shiraoi, Mukawa, Taiki, Hiroo, Okoppe
				⊖	〈20〉	8	Matsumae, Akkeshi, Hamanaka, Akan, Bekkai, Nakashibetsu, Tanno, Kunneppu
		⊖	⊕	⊕	〈21〉	7	Nakagawa, Kamuenai, Rusutsu V, Todohokke, Atsuma, Obira, Haboro
				⊖	〈22〉	8	Shakotan, Niki, Setana, Toi, Oshamanbe, Shintoku, Saroma, Shosanbetsu V
			⊖	⊕	〈23〉	5	Pippu, Shimamaki V, Sobetsu, Churui V, Tsurui V
				⊖	〈24〉	7	Shinshinotsu V, Shintotsukawa, Chippubetsu, Kenbuchi, Furubira, Fukushima, Ashoro
	⊖	⊕	⊕	⊕	〈25〉	7	Ebetsu C, Shibetsu C, Shiriuchi, Mori, Tomakomai C, Nakasatsunai V, Kitami C
				⊖	〈26〉	9	Eniwa C, Urausu, Kamifurano, Kamiiso, Shikabe, Hayakita, Monbetsu, Shiranuka, Shari
			⊖	⊕	〈27〉	5	Shimukappu, Memuro, Ikeda, Honbetsu, Shibecha
				⊖	〈28〉	5	Furen, Minamikayabe, Otofuke, Kushiro, Rebun
		⊖	⊕	⊕	〈29〉	6	Yubari C, Asahi, Otoineppu V, Yoichi, Rikubetsu, Rubeshibe
				⊖	〈30〉	9	Atsuta V, Aibetsu, Minamifurano, Tomari V, Niseko, Oiwake, Yubetsu, Nishiokoppe V, Mashike
			⊖	⊕	〈31〉	0	
				⊖	〈32〉	8	Hamamasu V, Hokuryu, Takasu, Higashikagura, Toma, Kyowa, Ikutahara, Shirataki V

ously, 212 CTVs were classified by means of mutual combination of a positive sign and a negative sign of each PCS. Theoretically they can be classified into thirty two types $2^5=32$), but actually they were classified into thirty types as shown in Table 5. The type which contains most CTVs is 〈15〉. Seventeen towns are corresponding with this type. The structual feature of this type is that the first PCS and the fifth PCS are positive value and the second to the fourth PCS are negative value. To put it in concrete, the level of *hospital service* as well as the level of *dental and pharmaceutical service* are above the average, but *clinic service* is below the average of the 212 TCVs and *community health condition* is better but *population reproduction power* is below the average.

The second most type is 〈16〉, which is different from type 〈15〉 only in the sign of the fifth PCS. Thirty three CTVs are equivalent to type 〈16〉 or 〈15〉. All of them are rural areas.

It is type 〈9〉 that total health and medical care status can be judged favorable, because the score of *hospital service* (PC-1), *clinic service* (PC-4), *dental-pharmmaceutical serivce* (PC-5) and *population reproduction power* (PC-3) are all above the average on one hand, and on the other hand the score of *baby death rate* (PC-2) shows a negative sign. This means that *community health conditions* are favorable. Seven cities, including principal cities such as Sapporo (1.5 million pop.), Hakodate (320,900 pop.), Asahikawa (356,100 pop.), Muroran (145,900 pop.), Obihiro (155,000 pop.), and Kushiro (216,000 pop.), and seven other towns correspond to this type. Type 〈24〉 is the just opposite of type 〈9〉, and six towns and one village are included in this type. They are in the lowest level of health and health-care services in Hokkaido.

Case II: Secondary health unit — 48 public health center jurisdictions

1. Extraction of principal components and their implications

Table 6 shows the varimax rorated matrix as result of principal component analysis on the forty eight public health center jurisdictions (PHCJs in abbreviation form). Seven PCs, whose eigen value is one and over, were extracted and the first five PCs explain about 70 percent of the total variation.

All variables having the strongest relations with PC-1 are related to population reproduction (birth rate, death rate, natural increase rate and marriage rate). So PC-1 is characterized as a principal component implying *population reproduction power*. Similarly, PC-2 is characterized as *clinic service in urban areas*, PC-3 *hospital service*, PC-4 *community health condition*, PC-5 *dental-pharmaceutical service*. The other two PCs are disregarded.

2. Principal component scores by public health center jurisdictions and their ecological illustrations

PC-1 Score (Fig. 5: PC-1)

Public health center jurisdictions which have a considerable high score for PC-1 are those including such principal cities as Sapporo, Kushiro, Obihiro and Tomako-

Table 6. Varimax Rotated matrix (48 public health center jurisdictions).

Variables (Rate)	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7
1 Birth	.901	−.162	−.187	−.084	−.037	.024	−.031
2 Death	−.851	−.002	.032	.099	−.141	−.027	.033
3 Natural increase	.937	−.135	−.140	−.086	0.99	.091	−.115
4 Infact mortality	.022	.005	−.007	.858	−.029	−.293	.059
5 Neonatal mortality	−.085	−.066	.061	.912	−.004	.036	−.144
6 Perinatal mortality	−.215	−.068	−.157	.669	−.055	.085	.382
7 Still birth	−.129	−.165	.000	.113	.049	−.032	.878
8 Marriage	.878	.252	−.020	.028	.008	.194	0.97
9 Divorce	.274	.409	.212	−.036	.066	.689	.207
10 Hospital	−.063	−.055	.427	.061	−.042	−.828	.087
11 Clinic	−.238	.816	.149	−.058	.163	.031	−.092
12 Dental Clinic	.180	.773	.154	.168	.288	−.109	−.039
13 Physician	.038	.674	.464	−.129	.404	.182	.050
14 Dentist	.068	.153	−.004	.005	.923	.046	−.009
15 Pharmacist	0.44	.436	.147	−.074	.829	.066	−.036
16 Beds of Hospitals	−.183	.240	.934	−.031	.020	−0.30	0.75
17 Mental	−.106	.291	.698	.060	−.001	.364	−.004
18 Tuberculosis	−.252	.240	.333	−.324	−.307	−.076	.494
18 Isolation	−.262	−.005	−.369	.246	−.149	−.541	.252
19 General	−.111	.107	.864	−.045	.114	−.241	−.016
20 Beds of Clinics	−.210	.771	.089	−.087	−.127	.284	−.117
21 Population Density	.227	.663	.164	−.170	.372	.110	.077
Eigen Value	5.57	4.47	2.25	1.86	1.57	1.27	1.08
Percent of Variation	25.3	20.3	10.2	8.5	7.1	5.8	4.9
Cumulative percent		45.6	55.9	64.3	71.4	77.2	82.1

mai (210,500), and the other two PHCJs, Nakashibetsu PHCJ and Nemuro PHCJ. Conversely, PHCJs which have many rural areas and those containing the one-time prosperous coal mining cities have a considerable low score.

PC-2 Score (Fig. 5 : PC-2)

PC-2 implies urban areas with a lot of clinics, dental clinics and physicians. Many of PHCJs with a principal city of Hokkaido have a high score and those composed of small cities and rural areas (towns or villages) have a low score for PC-2 as well as PC-1.

PC-3 Score (Fig. 5 : PC-3)

On the score of PC-3 which implies *hospital services*, population decreasing PHCJs such as Ashibetsu, Fukagawa, Engaru and Bibai as well as Shibetsu, Ikeda and Mori, and so on, take both in the upper and the lower rank.

PC-4 Score (Fig. 5 : PC-4)

The score of PC-4 which represents *community health condition* is high or inversely low in the rural PHCJs, and the PHCJs with primary cities such as Sapporo, Kushiro, Obihiro, Asahikawa, Hakodate, Otaru and so on are in the middle rank.

PC-5 Score (Fig. 5 : PC-5)

Tobetsu PHCJ and Sapporo PHCJ have a extremly high scores for PC-5 in comparison with the other 46 PHCJs. The PHCJs with principal cities have a high scores for PC-5 as well as for PC-1, PC-2, and PC-3.

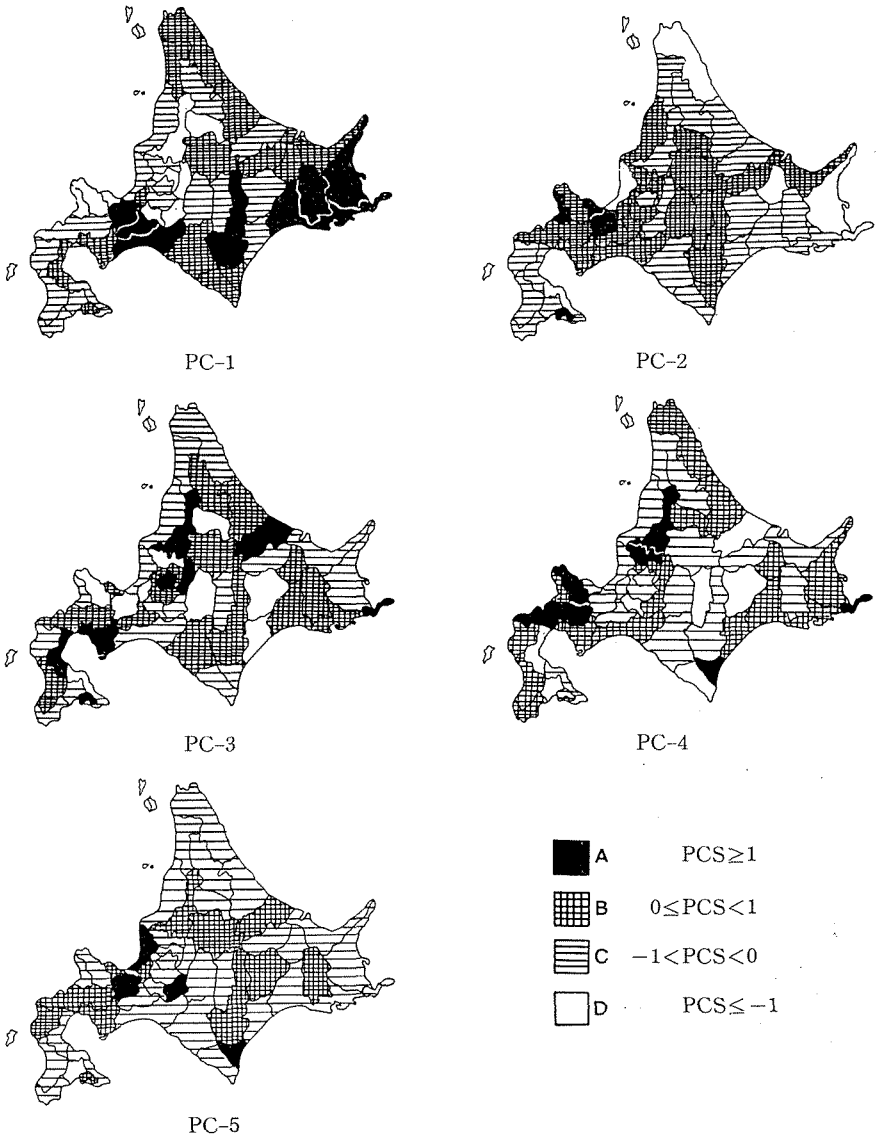

Fig. 5. Rank of Principal Component Scores by PHCJs.

3. Classification of public health center jurisdictions

Fig. 6 is a dendrogram drawn by the computer as an output of cluster analysis by using the above-mentioned fives PCSs of each PHCJ. The fourty eight PHCJs are divided into ten clusters at the amalgamation distance 2.205. They are termed group A, B, ···, I, J, in order from the bottom to the top side in Fig. 6. A (Sapporo), B (Hiroo), C (Nemuro), G (Yubari) and J (Tobetsu) form one clusfer by itself, respectively. This means that the respective PHCJ has a special characteristic of health and health-care services which is very different from the other PHCJs.

Group D has most PHCJs and it can be divided into four sub-groups at the amalgamation distance 1.8. They are termed group D_1, D_2, D_3, D_4, in order from the bottom to the top. And D_1 is composed of two sub-groups termed $D_{1\text{-}1}$ and $D_{1\text{-}2}$ from the bottom to the top side. And also smaller sub-groups $D_{1\text{-}1\text{-}1}$, $D_{1\text{-}1\text{-}2}$, $D_{1\text{-}1\text{-}3}$, $D_{1\text{-}1\text{-}4}$ can be identified in group $D_{1\text{-}1}$. Consequently, fourty eight PHCJs are classified into ten groups, or seventeen groups in case of being subdivided.

Fig. 7 shows the classification in a lump with taking into account of amalgamation process of each cluster (group). Table 7 is one of arrangement of rank

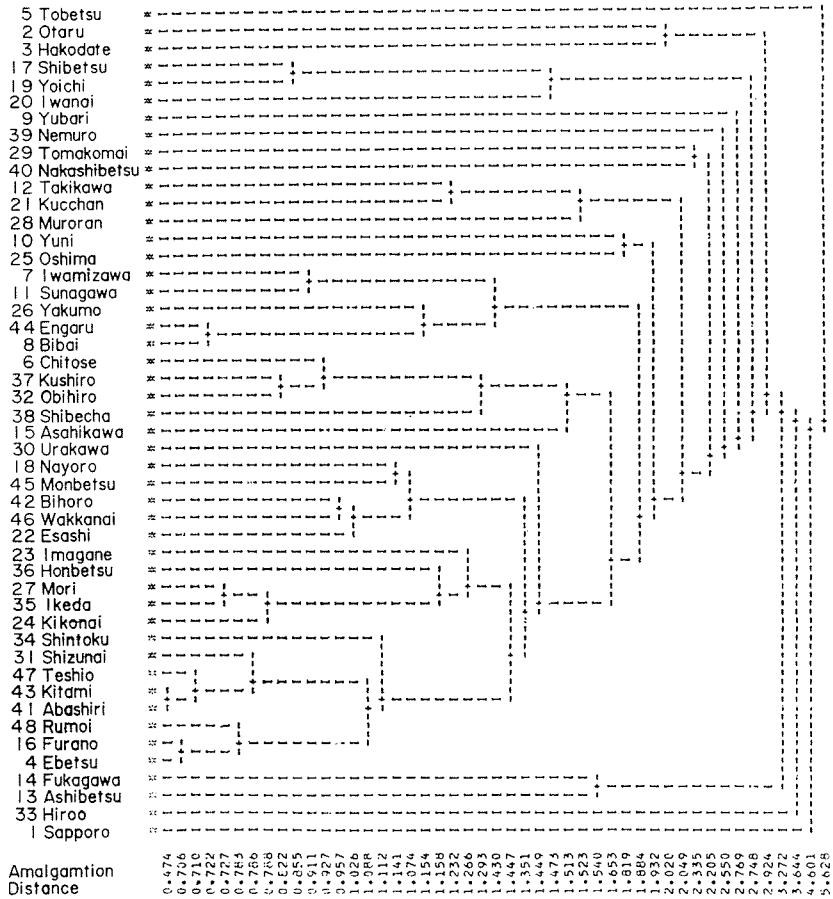

Fig. 6. Clustering Process of PHCJs.

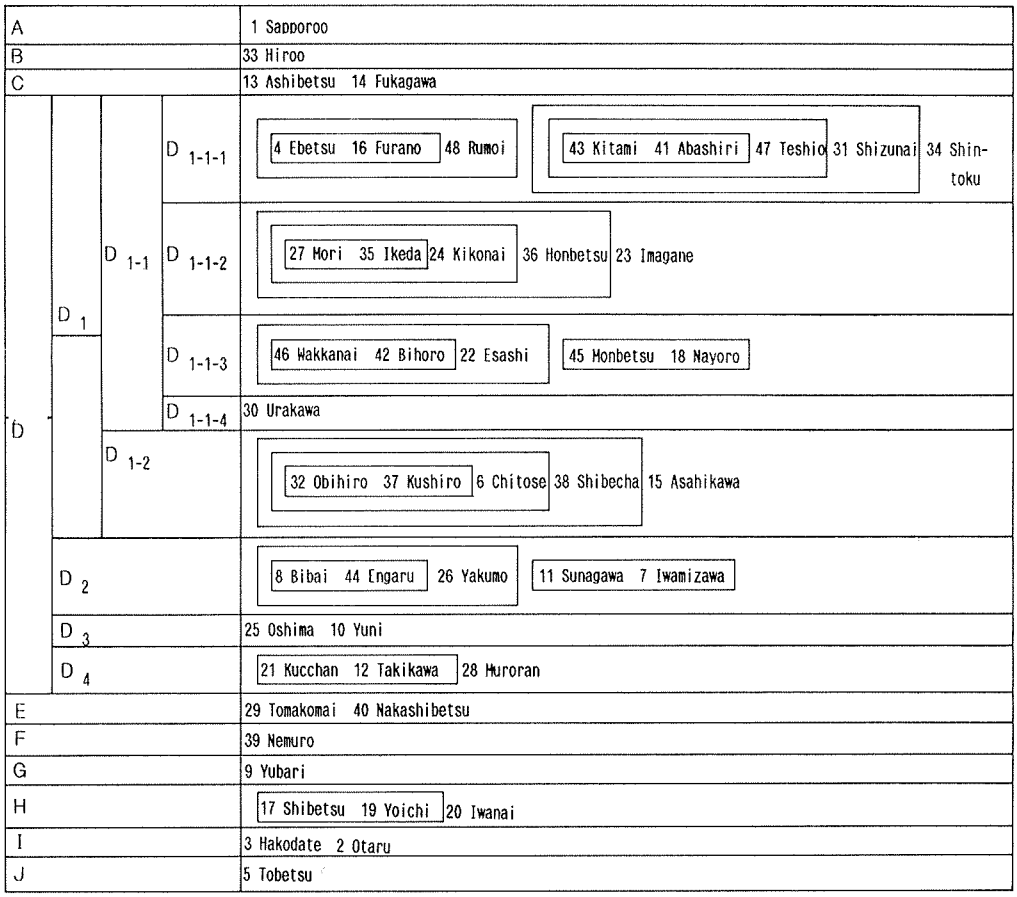

Fig. 7. Classification of PHCJs.

and the plus-minus sign of the principal component scores of each PHCJ in order to examine the characteristics of each cluster. Next, the characteristics of each cluster are described by referring to this table.

Group A

Group A contains only one PHCJ, Sapporo PHCJ (Sapporo for short in the following). Sapporo is in the first place in PC-1 score (*population reproduction power*), and in the second place both in PC-2 score (*clinic services*) and in PC-5 score (*dental-pharmaceutical service*), and also upper middle place in PC-3 score (*hospital service*), inversely in a lower place in Pc-4 (*baby death rate*). Therefore group A, Sapporo, can be considered as the most preferable cluster in regard to regional health and health-care services. This means, in other words, that it is only one Sapporo PHCJ in the fourty eight PHCJs in Hokkaido that the levels of both health and health-care services are high, and moreover *population reproduction power* is extremely high.

Table 7. Principal Component Score Ranks of 48 PHCJs.

	Name of PHCJ	PC-1	PC-2	PC-3	PC-4	PC-5
5	Tobetsu	−(33) C	−(48) D	−(37) C	−(39) C	+(1) A
2	Otaru	−(43) D	+(1) A	+(13) B	−(41) C	+(6) B
3	Hakodate	+(13) B	+(3) A	+(12) B	−(40) C	+(11) B
17	Shibetsu	−(46) D	+(6) B	−(48) D	+(7) B	−(33) C
19	Yoichi	−(45) D	+(5) B	−(46) D	+(4) A	−(29) C
20	Iwanai	−(44) D	+(4) A	−(40) C	+(15) B	−(46) C
9	Yubari	−(48) D	−(43) C	−(28) C	+(14) B	+(3) A
39	Nemuro	+(7) A	−(46) D	+(6) A	+(5) A	−(39) C
29	Tomakomai	+(3) A	+(7) A	−(30) C	+(9) B	−(36) C
40	Nakashibetsu	+(2) A	−(47) D	−(35) C	+(16) B	−(44) C
12	Takikawa	−(40) C	+(13) B	+(11) B	+(6) A	−(40) C
21	Kucchan	−(30) C	+(23) B	+(19) B	+(2) A	+(16) B
28	Muroran	+(16) B	+(28) B	+(7) A	+(11) B	+(13) B
10	Yuni	−(42) D	+(15) B	−(25) C	−(47) D	−(32) C
25	Oshima	−(31) C	−(34) C	−(26) C	−(48) D	−(48) D
7	Iwamizawa	−(35) C	+(8) B	+(10) B	−(31) C	−(21) C
11	Sunagawa	−(41) D	+(21) B	+(8) B	+(21) B	−(30) C
26	Yakumo	+(21) B	−(39) C	+(5) A	−(44) D	−(38) C
44	Engaru	−(34) C	−(31) C	+(3) A	−(43) D	+(15) B
8	Bibai	−(38) C	−(28) C	+(4) A	−(37) C	−(19) C
6	Chitose	+(4) A	+(22) B	+(17) B	−(33) C	−(42) C
37	Kushiro	+(5) A	−(26) C	+(23) B	+(19) B	−(23) C
32	Obihiro	+(6) A	+(14) B	+(22) B	−(32) C	+(12) B
38	Shibecha	+(8) A	−(40) C	+(18) B	−(30) C	+(7) B
15	Asahikawa	+(9) B	+(12) B	+(9) B	−(38) C	+(5) B
30	Urakawa	+(20) B	−(36) C	−(27) C	−(46) D	−(25) C
18	Nayoro	−(29) C	−(32) C	+(20) B	−(25) C	−(45) C
45	Mombetsu	+(18) B	−(24) C	+(16) B	+(12) B	−(47) C
42	Bihoro	+(12) B	−(42) C	+(14) B	+(18) B	−(31) C
46	Wakkanai	+(17) B	−(45) D	−(31) C	+(17) B	−(34) C
22	Esashi	−(28) C	−(41) C	+(24) B	+(8) B	−(27) C
23	Imagane	−(39) C	−(33) C	−(39) C	+(10) B	+(9) B
36	Honbetsu	−(37) C	−(38) C	−(42) D	−(42) D	+(10) B
27	Mori	−(23) C	−(44) D	−(45) D	−(28) C	−(18) C
35	Ikeda	−(26) C	−(35) C	−(47) D	+(22) B	−(17) C
24	Kikonai	−(36) C	−(37) C	−(38) C	+(20) B	−(24) C
34	Shintoku	−(24) C	+(10) B	(32) C	−(45) D	−(35) C
31	Shizunai	+(15) B	−(30) C	+(21) B	−(27) C	−(28) C
47	Teshio	+(19) B	−(25) C	−(33) C	−(36) C	−(26) C
43	Kitami	+(10) B	+(17) B	−(34) C	−(24) C	−(43) C
41	Abashiri	+(14) B	+(18) B	−(29) C	−(29) C	−(41) C
48	Rumoi	−(32) C	+(9) B	−(36) C	−(35) C	−(37) C
16	Furano	−(25) C	+(11) B	−(43) D	−(23) C	−(22) C
4	Ebetsu	+(22) B	+(19) B	−(44) D	−(34) C	+(14) B
14	Fukagawa	−(40) D	−(29) C	+(2) A	+(3) A	+(8) B
13	Ashibetsu	−(47) D	−(27) C	+(1) A	+(13) B	−(20) C
33	Hiroo	+(11) B	+(16) B	−(41) C	+(1) A	+(4) A
1	Sapparo	+(1) A	+(2) A	+(15) B	−(26) C	+(2) A

Group B

This group is also composed of the only one PHCJ (Hiroo). The score of PC-4 (*baby death rate*) is the highest among fourty eight PHCJs, namely the lowest level of regional health condition. However, *population reproduction power* (PC-1) is in the upper middle rank. *Clinic service* (PC-2) and *dental-pharmaceutical service* (PC-5) are also in the upper middle place, but PC-3 (*hospital service*) takes a negative score and considerable low rank at that.

Group C

Group C is made up of two PHCJs, Ashibetsu and Fukagawa. They are very similar with each other in the scores and the ranks of PC-1, PC-2 and PC-3, that is, *population reproduction power* is quite weak and *clinic service* is not enough, but the level of hospital service is the highest. And both Ashibetsu and Fukagawa have a high score for PC-4 (*baby death rate*), though Fukagawa is far beyond Ashibetsu in the rank. The notable difference between the two PHCJs is found in the score for PC-5 (*dental-pharmaceutical service*).

Group D

This group contains thirty five PHCJs correspondent to 73 percent of total number of PHCJs. It is very difficult to identify the communal characteristics of them at one effort. If it will be forced to try it, it may be found that all of them do not take A-rank for both PC-2 (*Clinic service*) and PC-5 (*dental-pharmaceutical service*). Amplifying the statement, such PHCJs that keep high levels of both *clinic service* and *dental-pharmaceutical service* are very few. For example, it is only one Sapporo PHCJ (group A) to correspond with that case in Hokkaido. So it may be possible to regard the levels of *clinic service* and *dental-pharmaceutical services* as one of the criteria for measuring the level of regional medical care service. However, eight sub-groups have too many various characyeristics to lump together from such a point of view. Accordingly, as will be stated below, the characteristics of every sub-group are examined.

$\mathbf{D}_{1\text{-}1\text{-}1}$: This group is made up of eight PHCJs and they take a middle rank (B or C) for PC-1 (*population reproduction power*), PC-2 (*clinic service*) and PC-5 (*dental-pharmaceutical service*), respectively, and then the score for PC-3 (*hospital service*) and PC-4 (*baby death rate*) are in the middle or lower rank. Although there are some fine differences among those PHCJs, it can be said as a whole that this group is at a middle level of regional health and medical care service in Hokkaido.

$\mathbf{D}_{1\text{-}1\text{-}2}$: Every five PHCJ included in this group has a low score (C-or D-rank) for PC-1, PC-2 and PC-3. This means that *population reproduction power* is fairly weak, and both *clinic service* and *hospital service* are considerably insufficient.

$\mathbf{D}_{1\text{-}1\text{-}3}$: Observing the amalgamation process (see Fig. 6), it takes a long distance in order to amalgamate the five PHCJs into this group. The scores for PC-1, PC-3 and PC-4 are all in the middle place, PC-2 and PC-5 in the lower place. This score rank pattern is able to be looked upon as a typical one of group D.

$D_{1\text{-}1\text{-}4}$: This group is composed of only one Urakawa PHCJ. Except for its extremely low rate of *baby death*, this group is very similar to the above-mentioned group $D_{1\text{-}1\text{-}3}$.

$D_{1\text{-}2}$: *Population reproduction power* (PC-1) is considerably strong and *baby death rate* (PC-4) is rather low, and the other three PCSs (*clinic service, hosptial service* and *dental-pharmaceutical srrvice*) are all in the middle place (B- or C-rank). This group is similar to group $D_{1\text{-}1\text{-}1}$. However, this group is one rank higher than group $D_{1\text{-}1\text{-}1}$ for PC-1 and PC-3. Some principal cities such as Kushiro, Obihiro and Asahikawa are included in this group.

D_2: This group is composed of five PHCJs. The general characteristic of this group is a high level of *hospital service* (PC-3) but there are small differences between sub-clusters, [Bibai, Engaru, Yakumo] and [Sunagawa, Iwamizawa]. The former sub-cluster has a extremely high score (A-rank) for PC-3 but is below the average (C- or D-rank) for PC-2 (*clinic service*) and PC-4 (*baby death rate*). The latter has also a high score but, though above the average (B-rank), not so high for PC-2.

D_3: This group, which contains two PHCJs, Oshima and Yuni, is characteristic of an extreme low score for PC-4 (*baby death rate*). And also the score rank for PC-3 (*hospital service*) is almost the same (just slightly below the average). However, as shown in the amalgamation process (see Fig. 6), there are fairly large differences regarding the other PCSs between the two PHCJs.

D_4: These three PHCJs which are getting together into group D_4 are similar with one another as to the score rank for PC-2, PC-3 and PC-4. *Clinic services* as well *as hospital services* are above the average, that is, this group is in fairly good condition on regional medical services. But the score for PC-4 (*baby death rate*) is very high, that is, this group is in fairly bad condition on regional health. This is an example of the unbalance between regional health and regional medical service.

Group E

There are two PHCJs, Nakashibetsu and Tomakomai, in this group. The communality of the scores of each PC is as follows: *population reproduction power* is very strong (the second and the third place for PC-1) and above the average (B-rank) for PC-4 (*baby death rate*), and below the average (C-rank) for PC-3 (*hospital service*) and PC-5 (*dental-pharmaceutical service*). The most remarkable difference between the two PHCJs is found in the score for PC-2 (*clinic service*).

Group F

Nemuro PHCJ has a high score for PC-1, PC-3 and PC-4, respectively. It is a rare case that the scores for both *population reproduction power* (PC-1) and *baby death rate* (PC-4) are very high. One more feature of this group is that the score for PC-3 (*hospital service*) is very high and inversely the score for PC-2 (*clinic service*) is extremely low. This means that medical services are supplied far and wide mainly by hospitals, in other words, there is few private practitioner

who takes a role of primary health care. Those cases are also found in group D_2 and C (see Table 7).

Group G

This group is made up of only one PHCJ, Yubari. *Population reproduction power* (PC-1) is the lowest among all the PHCJs and *baby death rate* (PC-4) is rather high. Both the level of *clinic service* (PC-2) and the level of *hospital service* (PC-3) are below the average. The only one exception is that the score for PC-5 (*dental-pharmaceutical service*) is extremely high.

Group H

Shibetsu and Yoichi group in company with Iwanai. This group is the lowest one for *population reproduction power* and for the level of *hospital service*, and *dental-pharmaceutical service* is not sufficient. And *baby death rate* is rather high. So this group can be regarded as a cluster of PHCJs which the levels of health and medical-care service are considerably low as a whole, though the score for PC-2 (*clinic service*) is very high.

Group I

Both Hakodate and Otaru are principal cities in Hokkaido and the city district is the same with the public health center jurisdiction (PHCJ) as well as Sapporo and Nemuro. Both two cities have a very high score for PC-2 and are above the average for PC-3 and PC-5, and below the average for PC-4, namely, they keep high levels of health and medical-care service ranking with Sapporo, though there is a great difference in the score for PC-1 (*population reproduction power*) between this group and Sapporo.

Group J

This is an exceptional group because there is a dental-pharmaceutical college in this PHCJ with about 60,000 population. It is the reason why this group occupies the first place in the score for PC-5, although both *clinic service* and *hospital service* are in the lowest level.

Case III: Tertiary Health Unit-21 Health Regions

1. Extraction of principal components and their ecological illustrations

The five components, whose eigen value is more than one, were extracted as shown in Table 8. They explain about 84 percent of total variation. PC-1 has strong relations with the rate of clinics, dental clinics, physicians, dentists, pharmacists, beds of clinics, and population density. So PC-1 is regarded as a principal component implying *medical care service supply*, especially *clinic service in urban areas* because of strong relationship with population density and weak relationship with the rate of general hospitals and of beds of hospitals. Similarly, PC-2 represents *natural decrease rate*, PC-3 *hospital service*, PC-4 *baby death rate*. The remaining one principal component is disregarded for its indistinct principal component loadings.

Table 8. Varimax Rotated matrix (21 Health Regions).

Variables (Rate)	PC-1	PC-2	PC-3	PC-4	PC-5
1 Birth	−.145	−.891	−.208	−.172	−.114
2 Death	−.209	.896	.264	.014	.167
3 Natural increase	.019	−.936	−.241	−.127	−.134
4 Infant mortality	−.309	.199	.217	.754	−.178
5 Neonatal mortality	−.186	.152	.385	.822	−.144
6 Perinatal mortality	−.383	.217	−.118	.541	−.107
7 Still birth	−.295	.107	.148	−.663	−.088
8 Marriage	.302	−.894	−.074	−.092	−.011
9 Divorce	.422	−.605	.059	−.084	.506
10 Hospital	−.108	.595	.463	.020	−.536
11 Clinic	.853	.300	−.201	−.069	.184
12 Dental Clinic	.917	−.120	.169	.041	.020
13 Physician	.875	−.122	.320	−.121	.107
14 Dentist	.940	−.183	.135	−.062	−.074
15 Pharmacist	.897	−.159	.156	−.113	.162
16 Beds of Hospitals	.298	.367	.860	.127	.073
17 Mental	.342	.065	.624	.434	.385
18 Tuberculosis	−.029	.388	.062	−.321	.729
19 Isolation	−.560	.563	−.117	−.096	−.350
20 General	.247	.374	.817	−.034	−.232
21 Beds of Clinics	.613	.306	−.180	.020	.545
22 Population Density	.759	−.367	.170	−.088	−.060
Eigen Value	7.57	5.61	2.57	1.69	1.12
Percent of Variation	34.4	25.5	11.7	7.7	5.1
Cumulative percent		59.9	71.6	79.3	84.4

PC-1 Score (Fig. 8 : PC-1)

There are remarkable differences among twenty one Health Regions (HRs) in PC-1 (*urban medical care service*). Sapporo Health Region (Sapporo HR for short) rises above the common level of the score for PC-1, and follows Shiribeshi, Kami-kawa-Chubu. Sapporo HR has a capital city of Hokkaido, Sapporo of 1.5 million population and the above-mentioned two HRs have a principal city of 180,000 to 360,000 population, respectively. Inversely, Nemuro, Sorachi and Kita-Oshima & Hiyama are the lowest group in the score for PC-1. These regions are located in the remote areas.

PC-2 Score (Fig. 8 : PC-2)

Shiribeshi, Kita-Sorachi and Minami-Hiyama have a high score for PC-2 (*natural decrease*), that is, the *population reproduction power* of these regions is

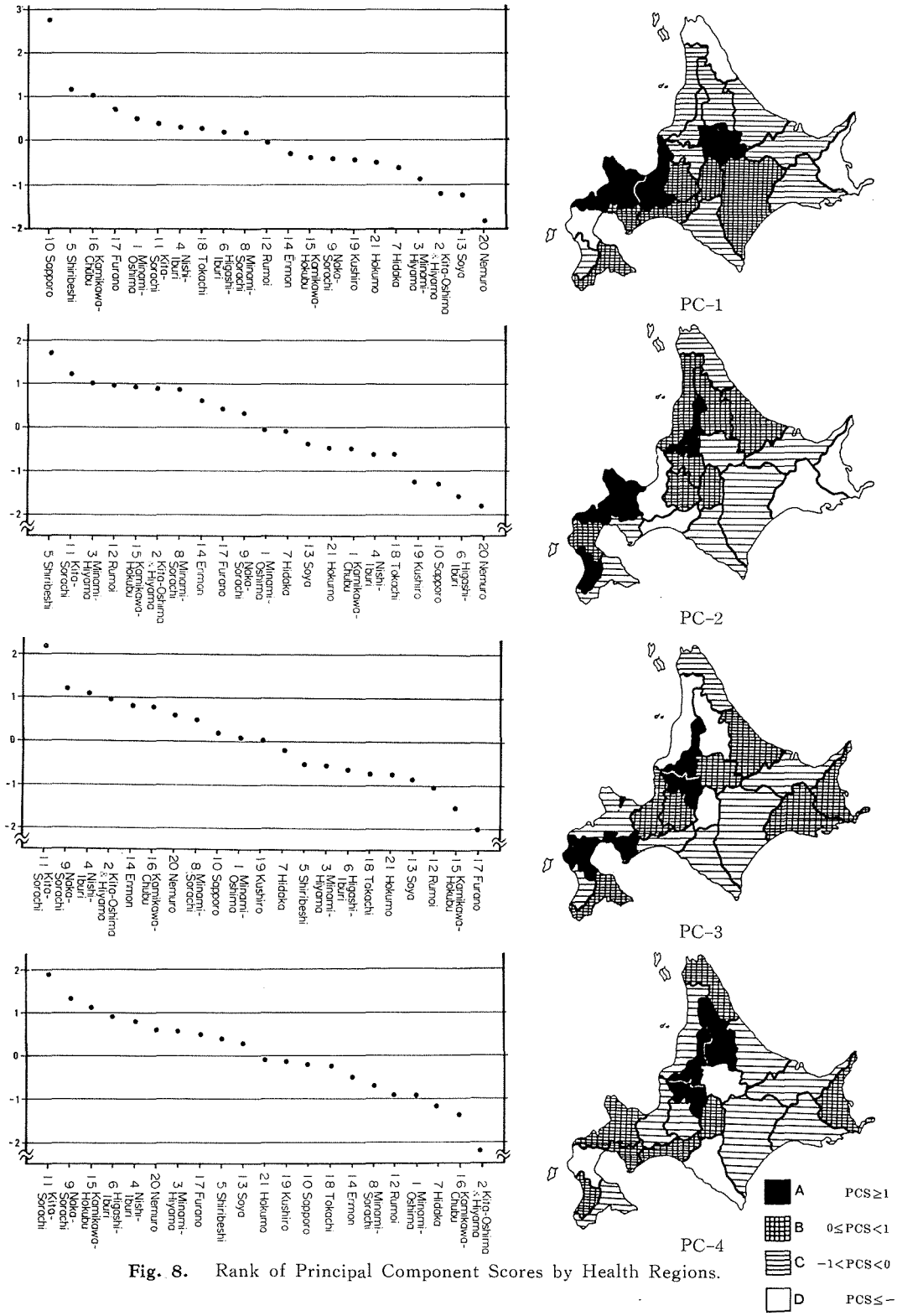

Fig. 8. Rank of Principal Component Scores by Health Regions.

very weak. On the contrary, Sapporo and Higashi-Iburi located in central part and Nemuro and Kushiro in eastern part of Hokkaido are in the lowest rank i. e., they have a high natural increase rate.

PC-3 Score (Fig. 8 : PC-3)

The level of *hospital service* of Kita-Sorachi, Naka-Sorachi, Nishi-Iburi and Kita-Oshima & Hiyama is so relatively high, and that of Furano, kamikawa-Hokubu and Rumoi is extremely low. It is found that ecological pattern of the score rank for PC-3 is different from that of the other PCs. For example, for PC-1, adjoining health regions such as Sapporo, Higashi-Iburi and Hidaka are one rank higher or lower with one another in the score rank. However, for PC-3, the score rank of each neighboring health region is extremely different. This seems the reflection of special characteristic of *hospital service* in Hokkaido.

PC-4 Score (Fig. 8 : PC-4)

As the region with high rate of infant mortality and neonatal mortality, and consequently low level of regional health, Kita-Sorachi, Naka-Sorachi and Kamikawa-Hokubu are listed up.

2. Classification of health regions and their characteristics

Fig. 9 is a dendrogram which shows the clustering process of the twenty one Health Regions. Seven clusters can be identified at the amalgamation distance 1.956. They are termed group I, II, ···, VII from the top to the bottom side. I (Sapporo Health Reagion), II (Kita-Osima & Hiyama), II (Nemuro) and V (Higashi-Iburi) from their own one cluster, respectively. These four Health Regions seem to have a special characteristic considerably different from the other Health Regions. Group VII contains most Health Regions, and is subdivided into three sub-groups at the amalgamation distance at 1.643. Fig. 10 shows those classified groups in the form of stratified inclusive structure, and Table 9 shows a positiver or a negative sign and rank of the score for each principal component by Health Regions in order to clarify the characteristic of each Health Region.

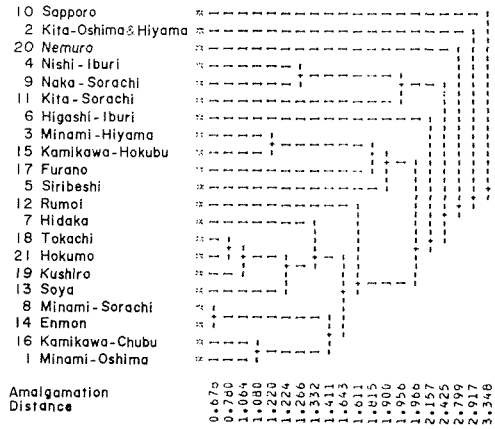

Fig. 9. Clustering process of Health Regions.

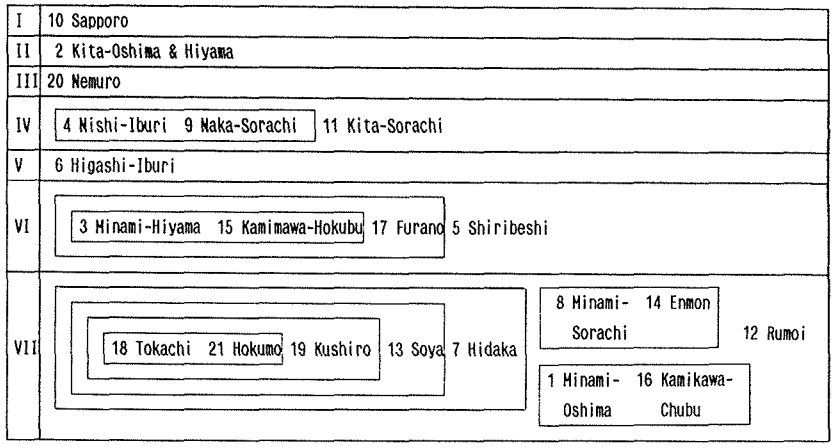

Fig. 10. Classification of Health Regions.

Group I

Sapporo Health Region takes the highest rank in the score for PC-1 which implies *urban medical service*, and is above the average (B-rank) in the score for PC-3 (*hospital service*). Consequently, it can be understood that the level of medical services of Sapporo HR is considerably high as a whole. Kamikawa-Chubu is also such a Region as this, however, it fairly differs from Sapporo in the scores for PC-2 (*natural descrease rate*) and PC-4 (*baby death rate*). In case of Group I, Sapporo, *population reproduction power* is extremely strong (D-rank for *natural decrease rate*) and the level of health is high (*baby death rate* is below the average). Consequently, Group I represents the most desirable region for health and medical care services in Hokkaido.

Group II

This group, only one Kita-Oshima & Hyama HR, is above the average for PC-2 and PC-3, and below the average for PC-1 and PC-4. Namely, Group II is a HR which the level of *hospital service* is high, but the level of *urban medical service* is very low. And also, *population reproduction power* is low, but the level of health is on the top (*baby death rate* is the lowest place).

Group III

Nemuro HR is in the lowest rank for PC-1 (*urban medical service*) and PC-2 (*natural decrease*), and in the B-rank for PC-3 (*hospital service*) and PC-4 (*baby death rate*). So, this group can be characterized as Health Region where regional health service system is supported mainly by the hospitals. Naka-Sorachi of group IV and Kita-Oshima & Hiyama of group II is the same type as this, that is, the type of thinly populated regions. Addition to this feature, Group III has another characteristic which *population reproduction power* is very strong but the levels of health is rather bad as the score for PC-4 shows.

Group IV

This group is made up of Nishi-Iburi, Naka-Sorachi and Kita-Sorachi. A common characteristic to those three HRs is to rank higher than the other HRs for PC-3 and PC-4, in other words, the levels of both *hospital service* and *baby death rate* are very high.

Group V

Higashi-Iburi HR is in a higher rank (B-rank, 9th place) for PC-1 (*urban medical sevice*), but the level of health is fairly low like group IV as the score for PC-4 shows. And as *population reproduction power* is exceedingly strong and the level of *hospital service* is fairly low, this group can be characterized as a Health Region which has a mixed feature of urban and rural region.

Table 9. Principal Component Score Ranks.

Name of Health Region	Principal Components			
	PC-1	PC-2	PC-3	PC-4
10 Sapporo	+(1) A	−(19) D	+(9) B	−(13) C
2 Kita-Oshima & Hiyama	−(19) D	+(6) B	+(4) A	−(21) D
20 Nemuro	−(21) D	−(21) D	+(7) B	+(6) B
4 Nishi-Iburi	+(7) B	−(16) C	+(3) A	+(5) B
9 Naka-Sorachi	−(14) C	+(10) B	+(2) A	+(2) A
11 Kito-sorachi	+(6) B	+(2) A	+(1) A	+(1) A
6 Higashi-Iburi	+(9) B	−(20) D	−(15) C	+(4) B
3 Minami-Hiyama	−(18) C	+(3) A	−(14) C	+(7) B
15 Kamikawa-Hokubu	−(13) C	+(5) B	−(20) D	+(3) A
17 Furano	+(4) B	+(9) B	−(21) D	+(8) B
5 Shiribeshi	+(2) A	+(1) A	−(13) C	+(9) B
12 Rumoi	−(11) C	+(4) B	−(19) D	−(17) C
7 Hidaka	−(17) C	−(12) C	−(12) C	−(19) D
18 Tokachi	+(8) B	−(17) C	−(16) C	−(14) C
21 Hokumo	−(16) C	−(14) C	−(17) C	−(11) C
19 Kushiro	−(15) C	−(18) D	+(11) B	−(12) C
13 Soya	−(20) D	−(13) C	−(18) C	+(10) B
8 Minami-Sorachi	+(10) B	+(7) B	+(8) B	−(16) C
14 Enmon	−(12) C	+(8) B	+(5) B	−(15) C
16 Kamikawa-Chubu	+(3) A	−(15) C	+(6) B	−(20) D
1 Minami-Oshima	+(5) B	−(11) C	+(10) B	−(18) C

Group VI

This group contains four Health Regions. All of them are in a higher rank for PC-2 (*natural decrease*) and PC-4 (*baby death rate*), and in a lower rank for PC-3 (*hospital service*). Furano and Shiribeshi have a high score rank for PC-1, respectively, but Minami-Hiyama and Kamikawa-Hokubu are in a lower rank. So, it can be said that the latter two Health Regions are those of the lowest level both of regional health and of medical service in Hokkaido.

Group VII

Group VII is composed of ten Health Regions. All these regions are in a lower rank for PC-4 (*baby death rate*), that is, they are above the average of the level of regional health condition. This is only one common characteristic to those Health Regions. Exept the common characteristic like this, each region has its own characteristic and forms some sub-groups, which the amalgamation process is more intricate than the other groups. Accordingly, those sub-groups are respectively examined.

VIIa: Rumoi takes the fourth place for PC-2 (*natural decrease*), and the scores of the other principal components are all negative values. So, this sub-group means a Health Region which *population reproduction power* is weak and the level of medical care service is low, but the level of health is fairly high as the score of PC-4 shows.

VIIb: This group is made up of five Health Regions. A common feature to those regions is that the score for PC-2 is a negative and very low, that is, *population reproduction power* is strong. Tokachi and Hokumo, adding to that communality, are in a lower rank with a negative sign for PC-3 (*hospital service*) and PC-4 (*baby death rate*).

Kushiro, Soya and Hidaka are in a lower rank with a negative sign for PC-1 (*urban medical service*). Kushiro is slightly above the average of the level of *hospital service*, and Soya is in a lower level of regional health condition as the score rank of PC-4 shows.

VIIc: This group is composed of four Health Regions. Minami-Sorachi and Enmon have the same characteristic with each other. Kamikawa-Chubu and Minami-Oshima are mutually similar in their health and medical care characteristic. The communality of characteristic to these four Regions is that the level of *hospital sevice* is rather high as the score rank for PC-3 shows and that the level of health is also fairly high as the score rank for PC-4 shows. Both Kamikawa-Chubu and Minami-Oshima are also a higher rank for PC-1, so that it can be found that these Regions have a similar characteristic to group I, Sapporo.

Concluding remarks

In this paper the levels of regional health and health-care services in Hokkaido by each regional health unit, such as self-governing body, public health center jurisdiction and Helath Region, were individually analyzed by the use of multivariate

analysis such as principal component analysis and cluster analysis.

Various levels of health regions have been established as regional units for rational and systematic health-care services. These establishements of health regions, to a certain extent, brought good result for contracting the regional difference of health resources. However, it can not be said that the difference was completely ironed out. The inter- and intra-regional differences still remain. Those differences are the reflections of the levels of health and health-care services of narrower district which is an element of more wide region. That is the reason why the regional characteristics of the health and health-care services were described by each level of region such as self-governing body (city, town or village), public health center jurisdiction and Health Region in this paper. As shown in the classification of the regions by each level of health region, each self-governing body, public health center jurisdiction or Health Region has various characteristics, respectively. So that the regions of each level were divided into rather many small groups. For concrete policy and fact-findings, a rough classification is not so significant. Therefore, it is better to take the method of accumulating the itemized small groups to larger one and to return to the small groups whenever necessary. This paper is a rough trial from the above-mentioned point of view.

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