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Topic：Health Care System as Social Common Capital

〈Review〉

# Accessibility in the Community Healthcare System

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**Abstract**

Japan is seeking a new system and method for providing efficiency-based healthcare in order to cope with changes in the social structure. As a means of discussing ways to maintain our healthcare system, a relationship between healthcare facilities and users should be evaluated and measured so it can be used as one kind of barometer. Having medical facilities in accessible locations is the lifeline for the healthcare system. In order to establish a stable healthcare system, it is significant to secure access within a certain space and time distance.

Therefore, the first step of this study is to evaluate and analyze the relationship between healthcare facilities and users through simple physical distance (space accessibility), and then consider the healthcare system as "Social Common Capital".

***keywords:*** accessibility, physical distance, network distance, GIS

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## Ⅰ. Introduction

Today, the healthcare system in Japan is facing a major transition period from many different aspects. Due to the nation's financial deterioration, the government has been taking a restrictive policy on healthcare expenditure. Meanwhile, a number of issues have been pointed out; a loss of healthcare affiliation between medical education institutions and regional/rural hospitals caused by the reformation of the doctor and intern dispatch program, an insufficient number of healthcare professionals, disproportionate healthcare needs and resources owing to the widening gap in regional population and age group of residents. In some regions, healthcare systems such as emergency medical and perinatal services have been falling apart. Local government is under increasing strain because of the collapse of the healthcare system. One of the fundamental issues of this phenomenon is a lack of perspective such as management concept in designing the healthcare system, placement of medical facilities based on hospital function and estimated utilization, and the regional difference on medical treatment fee "value".

Japan is seeking a new system and method for providing efficiency-based healthcare in order to cope with the changes in the social structure. As a means of discussing ways to maintain our healthcare system, a relationship between healthcare facilities and users should be evaluated and measured so it can be used as one kind of barometer.

The placement of healthcare facilities is conducted in diverse ways: Public healthcare facilities provide healthcare, comfort and safety as social welfare. Private healthcare facilities provide community-based healthcare as well as business based. From a viewpoint of "Social Common Capital", with its high expectations for stability and great social significance, we must pay special attention to "healthcare as social welfare". In some cases, healthcare facilities are placed in areas with many residents. In other cases, many residents happen to live in an area with healthcare facilities. Therefore, the location of healthcare facilities and the expansion of residential areas cannot be explained as a simple or one-sided correlation. However, having medical facilities nearby residential areas is an approved requirement of a healthcare system as it must provide emergency care for acute injury and illness, treatment and control of chronic illness and health

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management with preventive healthcare. Having medical facilities in accessible locations is the lifeline for the healthcare system. In order to establish a stable healthcare system, it is significant to secure access within a certain space and time distance.

In a previous study related to the optimization of the healthcare system, Cluyer[1] analyzed healthcare service equity in its relationship with access needs and outcome. Endo et al[2]. analyzed the relationship between the medical expense insurance and income level. There have been various research on healthcare equity in recent years. However, since many of them focus on medical expense insurance, there have not been enough studies on healthcare security based on the obvious and realistic location for healthcare facilities or actual situation of users. The studies by Yamada et al[3]. and Kawaguchi et al[4]. took these perspectives into account and conducted a research on the available hours of emergency medical services. These studies are valuable as they investigated the actual data of medical facility utilization from the viewpoint of the healthcare facility. On the other hand, reviewing healthcare facility locations to provide the types of healthcare services that should be guaranteed in the first place is essential in planning a new healthcare service system. Therefore, the first step of this study is to evaluate and analyze the relationship between healthcare facilities and users through simple physical distance (space accessibility), and then consider the healthcare system as "Social Common Capital". When taking practical matters such as emergency medical services or convenience into consideration, the analysis on time distance becomes necessary in addition to space distance. In order to calculate the time distance, the space distance must be calculated first. With a perspective on further developing the research in the future, this study deals with physical distance as its most fundamental point.

## Ⅱ. Discussion on Accessibility

In this study, accessibility refers to simple and physical distance (space distance) between healthcare facilities and users. When defining the users on the premise of "Social Common Capital", users are those who use the healthcare facilities. Therefore, instead of limiting the definition of users by their present health condition such as current patient or utilization, this study covers all the utilization possibilities in future, thus every resident within the area is included as users. In addition, when a person needs medical treatment, a healthcare facility is chosen by various factors such as its size, reputation or availability of transportation to get there. However, since this study is focused on the placement of the healthcare facility as "Social Common Capital", a minimum requirement of society, physical distance to the healthcare system is measured based on the simplest model in which the user chooses the nearest healthcare facility.

The measurement was done using the GIS (Geographic Information System) method. Due to the various data obtainable, part of Yokohama City and the entire Kanagawa Prefecture were experimentally chosen as the target area for analysis.

1) Investigating the Location of Healthcare Facilities

The location of healthcare facilities in the target area was investigated. The addresses available to the public were used to determine the location and then classified by types of medical department. In this study, 4 types of departments are shown: Departments of internal medicine, pediatrics, gynecology and emergency.

2) User Specification

Considering the conditions mentioned previously, in order to measure an accurate distance for users, the residential location of users must be obtained. Since this is quite difficult, a virtual urban space was created on the GIS in which the population is distributed by buildings. Data obtained from the Urban Planning Basic Survey, which includes building type such as house, apartment, store or office, was used to allocate the population within the target urban district using the total floor area of buildings classified as residences.

3) Measuring the Distance

In Japan, there have been many discussions on the location of medical facilities and accessibility of residents to medical facilities in the medical care zone. Most of the analysis on the medical care zone has been conducted by measuring the relationship between medical facilities and their users by straight-line distance, or by outlined distance

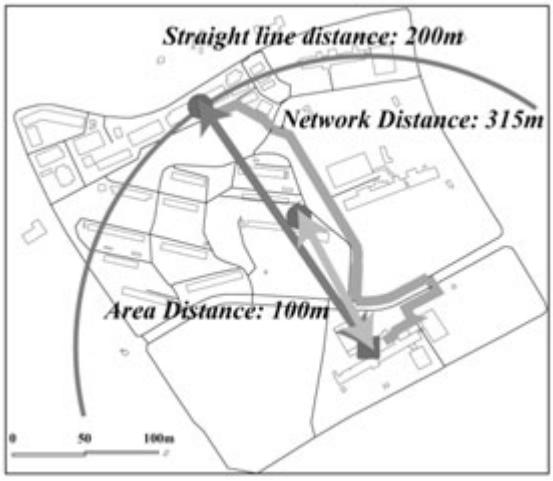


Fig. 1. Outline of Each Distance

in which the population is concentrated in a median point of area. However, through such a method, it is difficult to fully understand the actual state of accessibility of residents to the closest medical facility. Therefore, in order to analyze and obtain more accurate data on the accessibility of residents to medical facilities, this study adapted the virtual urban space mentioned above and actual road network to measure a network distance that is close to the actual travel distance (Fig. 1).

## Ⅲ. Method of Measurement

The procedure of measurement is illustrated in Fig. 2 through 5.

1) The road network data within the target area is loaded. In this measurement, the road network data for car navigation systems was used. In Fig. 2, the road network data and the prefecture border in Yokohama City is shown.
2) Based on the addresses obtained, the location of medical facilities were converted into coordinate values in latitude/longitude and plotted on the map. Fig. 3 shows the location of gynecology departments as an example. The total number of plotted points are; 1192 for internal medicine, 584 for pediatric, 141 for gynecology and 4 for

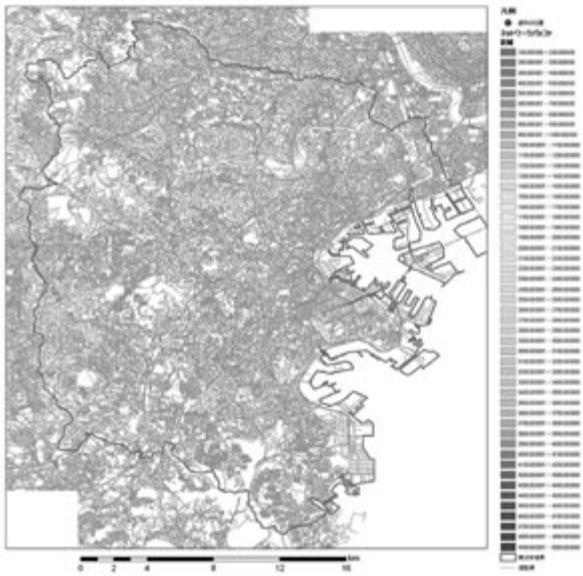

Fig. 2. Target Region with Network of Roads

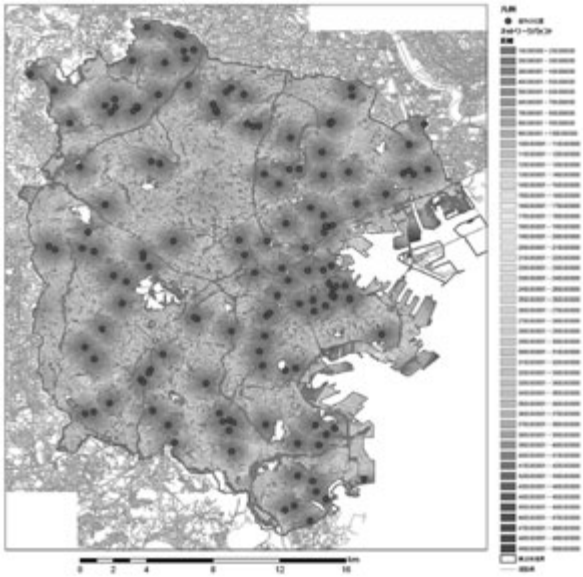

Fig. 4. Measurement of Network Distance Every 100m

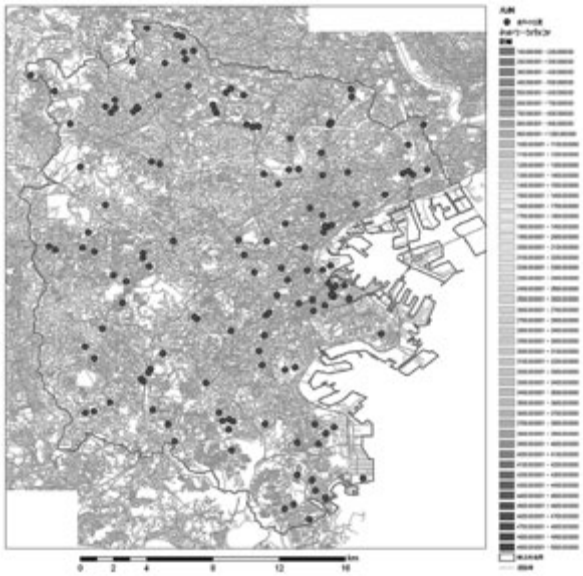

Fig. 3 . Plot of the Location of Medical Facilities

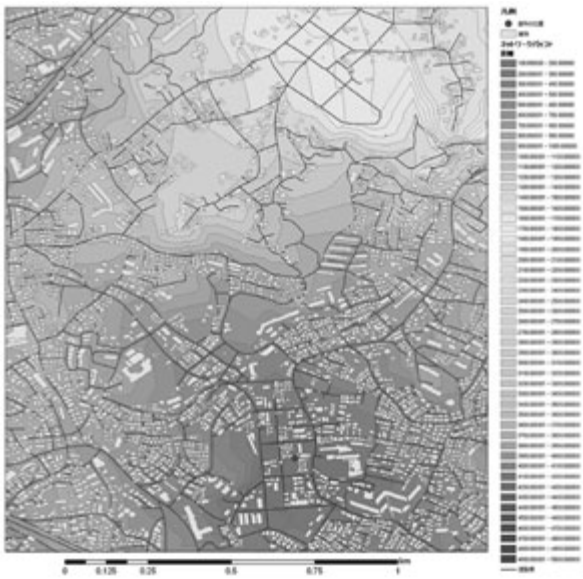

Fig. 5. Details of Results

emergency departments.

3) In addition, the distance zone in every 100m network distance was created from medical facility plotting. In Fig. 4, the results are colored accordingly to each distance zone. A more detailed map is shown in Fig. 5 with the rectangular shapes indicating buildings. Using the calculation method mentioned in Chapter 2, the information on population allocated in the buildings classified as residence in the target area is embedded. The number of residents by each distance zone was measured based on such information.

## Ⅳ. Result of Measurement

1) Measuring Results in Yokohama City

Fig. 6 through 9 indicate the measurement results of internal, pediatric, gynecology and emergency departments. Table 1 shows the data of distance by each department.

The total population of Yokohama City is around 3.3 million (Census 2006). 80% of the total population, about 2.6 million residents, live within 700m of internal medicine, 900m of pediatric and 1700m of a gynecology department.

In the graph for the number of residents by each department and distance zone, for the 3 departments of internal medicine, pediatric and gynecology, the number of residents suddenly increases towards the peak, drops dramatically to a certain distance and slowly decreases. Although the number of departments used is significantly different, there was similarity in the pattern of distance and population measurement. For the emergency department, the number repeatedly increased and decreased towards

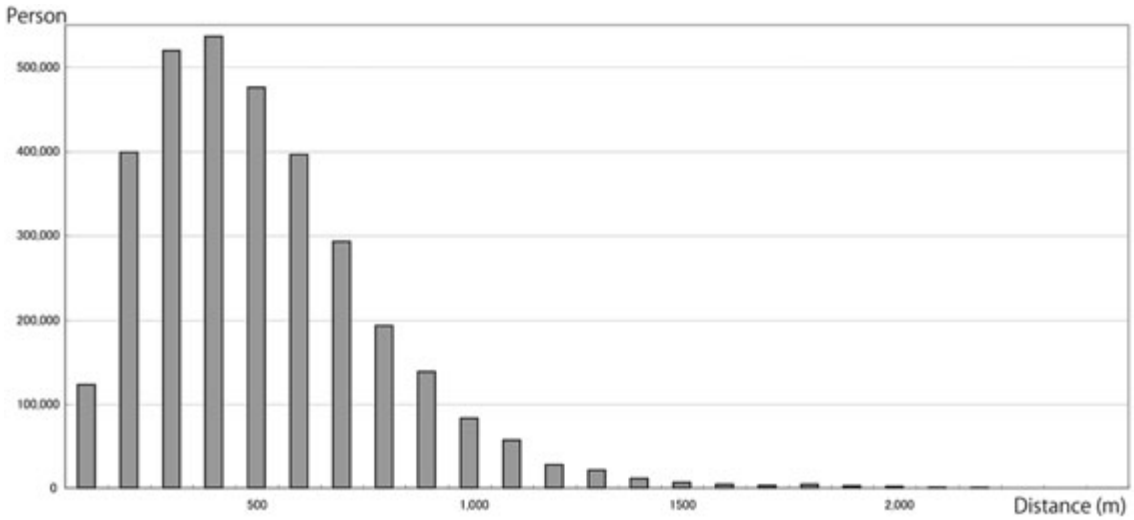


Fig. 6. Result of Survey for Internal Medicine

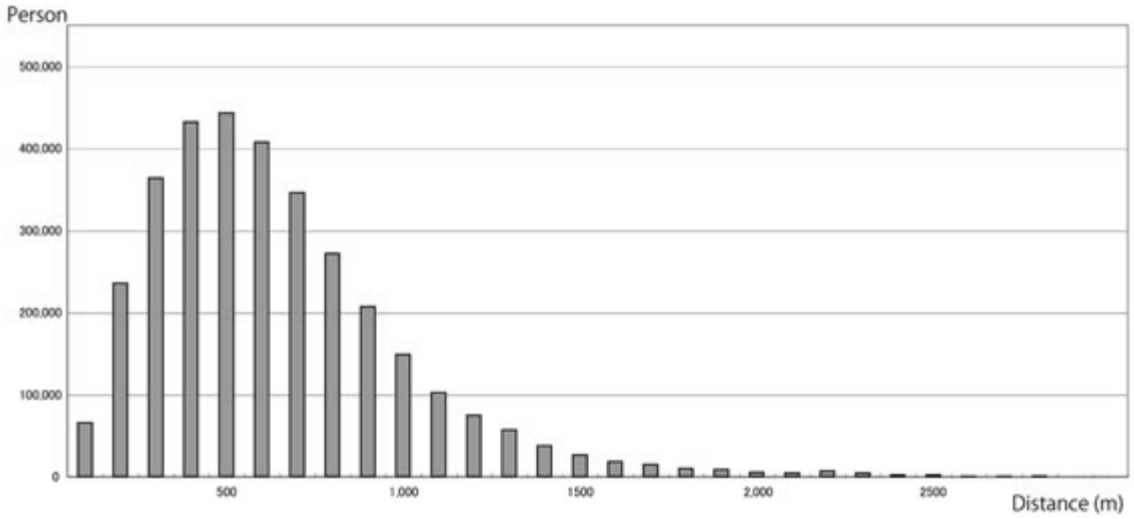


Fig. 7. Result of Survey for Pediatrics

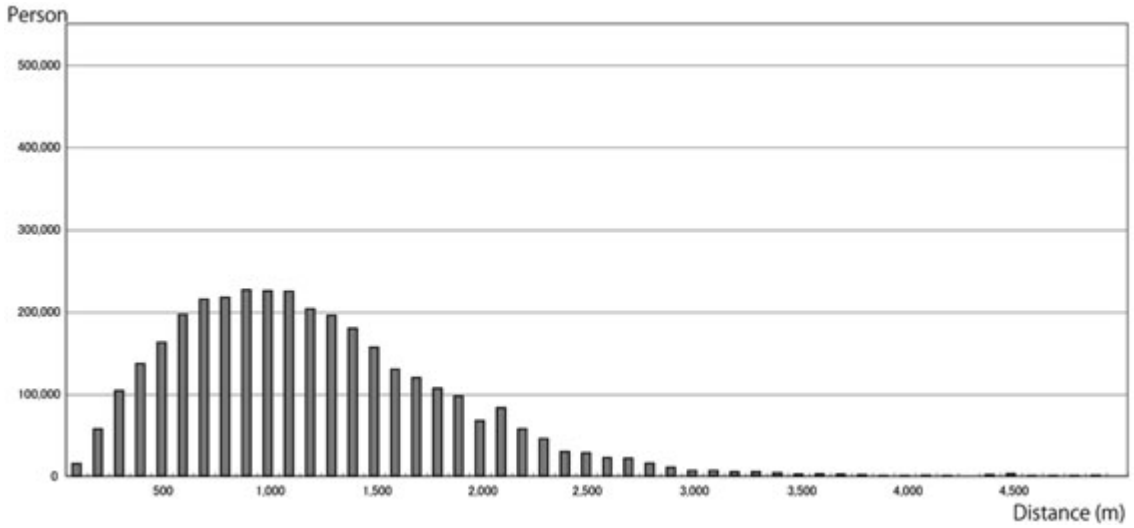


Fig. 8. Result of Survey for Gynecology

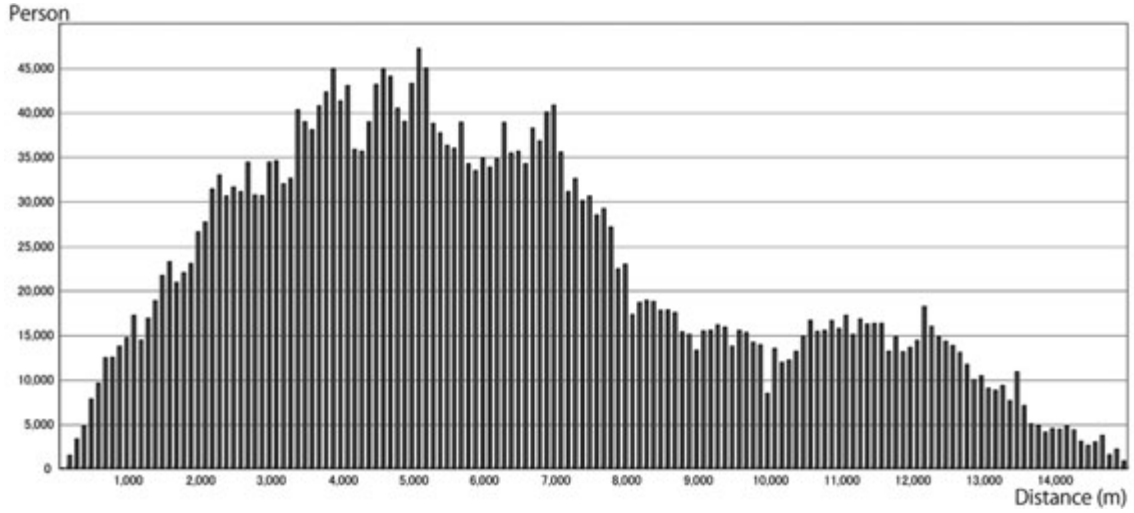


Fig. 9. Result of Survey for Emergency

Table 1. Summary of Each Distance

| Department | Max Distance (m) | Peak Distance (m) | 80% of Total Population (m) | Average (m) |
|---|---|---|---|---|
| Internal Medicine | 2,500 | 400 | 700 | 510 |
| Pediatrics | 3,000 | 500 | 900 | 610 |
| Gynecology | 5,000 | 1,000 | 1,700 | 1,206 |
| Emergency | 15,000 | 5,100 | 9,200 | 6,197 |

the peak, then decreased again by repeatedly increasing and decreasing. There was more distribution in the distance zone of around 10 to 12 km area.

2) Measurement Result for Emergency Department in Entire Kanagawa Prefecture

In Fig. 10, the measurement results for emergency department in the entire Kanagawa Prefecture and its impacted area around the borderline of Tokyo is shown. Also, Fig. 11 shows a relationship between population and distance. Fig. 12 shows a relationship between population density and distance collected every 500m.

In Kanagawa prefecture, it is evident that the distance to the emergency department becomes very far in the mountainous regions in the west of the prefecture. A small mountain population is visible at around 25km. In addition, the population density increases at around 41km due to the reduction of the evaluated area around the borderline in the west of the prefecture.

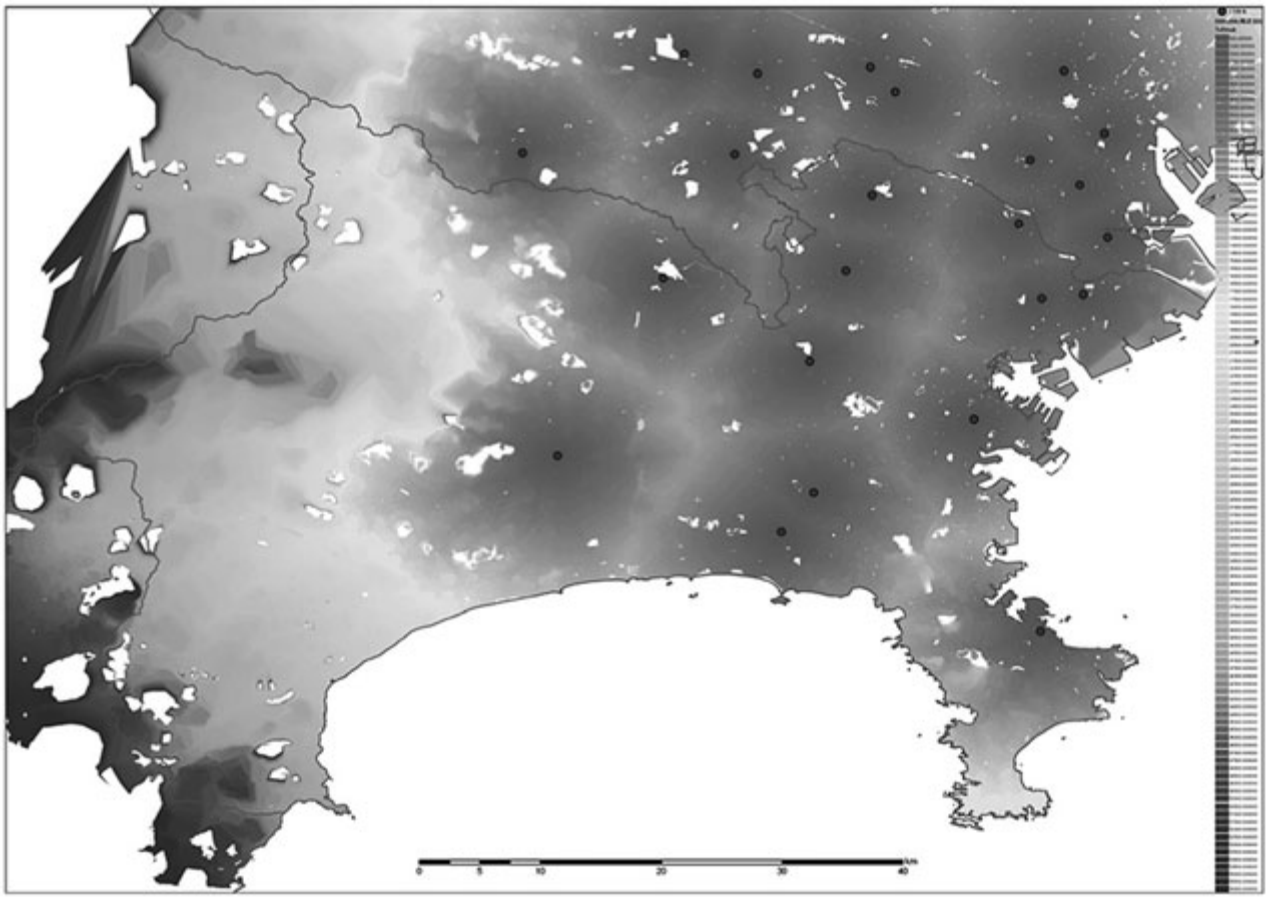

Fig. 10. Result for Emergency Department of entire Kanagawa Prefecture

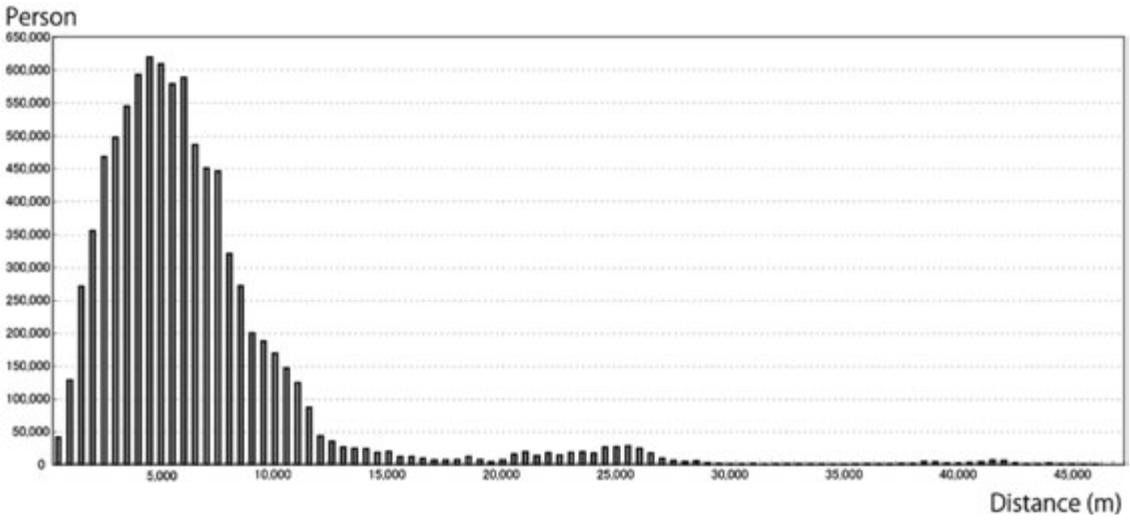


Fig. 11. Relationship between Population and Distance

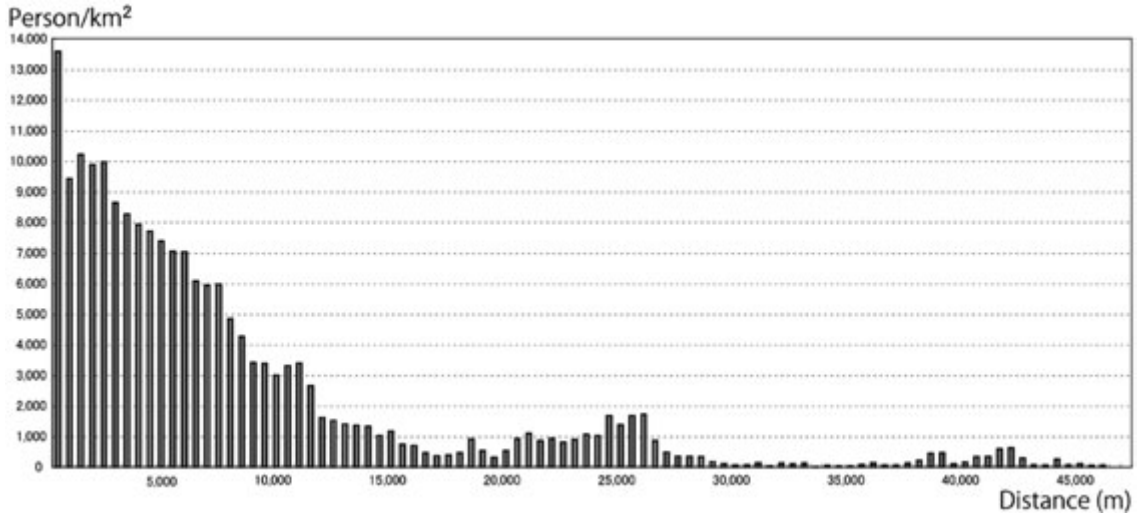


Fig. 12. Relationship between Density and Distance

## Ⅴ. The Analysis and Summary

1) Social Common Capital and Accessibility

From the measurement results of internal medicine in the Yokohama City, all citizens have access to internal medicine clinics within 2km. Considering that internal medicine clinics are open to all age groups and genders of users, the healthcare system in this region is well maintained. The Yokohama City is in a concentrated population district with robust industry and economic activities. Therefore, the supply and demand for healthcare is in good balance and the role of healthcare as social common capital can be consigned to the market-base. Different results must be expected when the same analysis is conducted in the area with no urbanization. Especially in the rural area with a high aging population, the idea of accessibility becomes more significant. Access to healthcare facilities have a variety of conditions; some patients go to the facility by themselves while others have healthcare professionals coming to their home. However, from a viewpoint of efficient utilization in human capital, a mobile healthcare facility is not an easy task to perform. Instead of going to see patients outside, the doctors can see more patients in a clinic during the time spent for traveling which leads to more efficient healthcare. In addition, it is difficult to provide advanced medical treatment with a doctor visiting a patient's home due to limited facilities. Therefore, it is clear that a patient will still receive advanced medical treatment if necessary at a medical facility even if doctor visits are introduced. It is necessary to examine a healthcare system as social common capital from a viewpoint of various methods using the analysis of accessibility as a base point. In pediatric and genecology departments, as this study included all the users within the target and even included the users who are not in need of medical treatment, the measurement results are overestimated. However, from a social common capital point of view, there should not be any area without standard accessibility to medical facilities. Although it is questionable to say that all users must be provided with every type of healthcare system, it is necessary to choose what should be provided and how to manage the system provided. That is the ideal social common capital. Also, for medical departments catering for users with special needs, policy induction for an urban structure may be considered. In some municipal governments, policy induction tied up with exclusive healthcare has been successful and apparent. In those towns, parents experience a supportive environment for raising children or elderly people are provided with more comfortable living. Such evaluation is effective from a viewpoint of accessibility.

Healthcare such as emergency departments that require fast and immediate action must be provided without restricting its users. However, from the measurement results of Yokohama City and Kanagawa Prefecture, it is difficult to say that such healthcare is provided with equity. This tendency is more pronounced in areas like those west of Kanagawa with low population densities. Assuming our future society is to have fixed or decreased medical resources, the fundamental issue is how to assign medical resources, such as the location of healthcare facilities and how to provide healthcare. The most efficient method is to maintain one's objectivity and lay out a solution in a quantitative manner. Therefore, analyzing accessibility has the potential of realizing such possibilities.

2) Future Development

In this study, the population was counted by simple distance. However, it is also possible to calculate the time distance by incorporating the speed of walking, cars passing or travelling on the highway as data. By analyzing using time distance, more accurate and realistic evaluation /analysis can be conducted, thus making it possible to build a healthcare system as social common capital.

Also, in providing emergency medical service for a broad area, a seamless analysis without any area restriction will bring opportunities to study medical service systems.

In addition, by using methods such as the Travel Cost Method which includes moving distance and economic indices, analysis on maintenance resources such as how the economic resources should be spent or obtained is also necessary.

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我が国はいま，変化した社会構造に対応し，かつ効率性が重視された新たな医療提供体制及びその手法を模索している段階だと言える．今後，ヘルスケアシステムがいかに持続しうるかを考えるための一つの指標として，医療機関とその利用者の関係を評価・測定することが挙げられる．

医療機関の設置は，公的医療機関：社会保障としての医療，安心・安全，など，民的医療機関：地域密着型医療の提供，ビジネスベースなど，様々な形で行われている．このうち，より持続性への要求が高く社会的な意義が深い「社会的共通資本」の観点からは特に，「社会保障としての医療」に注目する必要がある．住人が多い地域に医療機関が置かれることもあれば，医療機関がある地域に住人が多く住まうことになることもあり，医療機関の設置位置と住居地域の拡がりは単純あるいは一方的な因果関係として説明はできない．しかし，住居地域の近隣に医療機関が存在することは，負傷や病気のとき（急性期）の処置，慢性的な疾病の治療やコントロール，健康の維持管理（予防医療），などヘルスケアシステムの成立要件そのものでもある．医療機関がアクセス可能な位置にあることはヘルスケアシステムの生命線であり，一定のレベルで空間的・時間的距離以内でのアクセスを保障することが，持続的なヘルスケアシステムの構築に際して重要であると考える．

そこで本稿では，医療機関と利用者の関係を，単純で物理的な距離（空間的アクセシビリティ）によって評価・分析し，「社会的共通資本」としてのヘルスケアシステムについて考える．実際問題として緊急時の医療提供や利便性を考慮すると，空間的な距離に加えて時間的な距離の分析が必要となるが，その算出には空間的な距離の算出が最初期の段階として必要である．本稿はこうした発展的研究を見据え，まず最も基本となる物理的な距離を取り扱うものとする．

対象地域は，種々のデータの取得しやすさから．横浜市，および一部の分析においては神奈川県全域とした．また本稿では，内科，小児科，産婦人科，３次救急の４種の診療科別に分析結果を示す．

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