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Original Paper

Distribution of Health and Medical Service Expenditures among Age Groups in Japan

Kannosuke SAITO*

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Abstract

This paper measures the equity of health and medical service (HMS) expenditures among age groups. After a presentation of a theoretical model containing the distribution curve of the cumulative proportion of HMS, Gini Coefficient and Atkinson Measure, the equity in HMS among age groups is examined as an empirical study. The conclusion drawn is that the increase of total HMS expenditure depends mainly upon the increase in HMS expenditures for the elderly, which comes from an increase in per capita HMS expenditures for the elderly rather than an increase in the aged population. Also, it is important to introduce a new system, not only to share the tremendous increase in HMS costs fairly, but also to hold per capita HMS expenditures for the elderly at a minimum.

Introduction

In Japan, the Long Term Care Insurance System (LTCIS) has been implemented since April, 2000. One of the reasons for the implementation of LTCIS was the tremendous increase in Health and Medical Service (HMS) expenditures for the elderly during the last two or three decades.

In analyzing HMS expenditure for the elderly empirically, two changes in the HMS system for the elderly should not be ignored. One is the revision of the Welfare Law for the Elderly (WLE) made in 1973. The other is the enactment of the Health and Medical Service Law for the Elderly (HMSLE) in 1982. In 1973, medical services for the elderly were made free by the WLE revision. As a result, the elderly began to go to hospitals more frequently than necessary, as if hospitals were "salons" for the elderly. This caused a rapid increase in HMS expenditures. These costs were paid for from the revenues of the Medical Insurance Program. These revenues were composed mainly of premiums paid by the insured and payments out of the national treasury, which is composed of many kinds of taxes. Therefore, the increase in HMS expenditures for the elderly imposed a heavy burden on the insured and taxpayers, i.e. all Japanese citizens.

To tackle this problem, the HMSLE was enacted in 1982. HMSLE introduced a new system, with provisions for fairly sharing HMS expenditure for the elderly among all citizens, including the elderly. Because they had to pay part of the cost of HMS services, the elderly were made aware of the necessity to keep themselves healthy, and also the importance of not seeking excessive medical services. In this way, HMSLE seemed to succeed in suppressing the increase of HMS expenditures for the elderly. However, in a few years, HMS expenditures for the elderly began to gradually increase again because of an increase in

* Department of Health Welfare Services Management, Faculty of Medical Welfare
Kawasaki University of Medical Welfare
Kurashiki, Okayama, 701-0193, Japan

the elderly population and the rising costs of HMS, which includes costs for the elderly. Thus a new HMS system for the elderly, including LTCIS, has been considered to provide for the aged society in the new century.

By examining changes in the distribution of HMS expenditures among age groups from 1977 to 1996, especially focusing on the elderly group, this paper analyzes the historical process of increases in HMS expenditures for the elderly and considers the policy implications of the results of this analysis.[1-4]

Theoretical Model

To analyze the distribution of HMS expenditures among age groups, this paper presents a theoretical model[5-13] which contains the following three indices.

1. The distribution curve of HMS expenditures among age groups

Suppose that the population is divided into n age groups and that the total HMS expenditures ($HMSE_T$) are the sum of the expenditure of each age group. Then, $HMSE_T$ can be expressed as

$$HMSE_T = \sum_{i=1}^{n} HMSE_i = \sum_{i=1}^{n} hmse_i \cdot POP_i \tag{1}$$

where $HMSE_i$ is HMS expenditure, $hmse_i$ is the per capita expenditure of HMS, or the average cost for HMS, POP_i is the number of people, and the suffix i represents the i-th age group. By definition, the total population POP_T can be given as

$$POP_T = \sum_{i=1}^{n} POP_i \tag{2}$$

The distribution curve of MHS expenditure among age groups can be derived by the following procedure. First, put the age groups in the order of their per capita cost to HMS, from the lowest to the highest.

$$hmse_1 \leq hmse_2 \leq \cdots \leq hmse_n \text{ [1]} \tag{3}$$

Second, define the cumulative percentage of the number of people and the cumulative percentage of HMS expenditures as

$$CPPOP_i = \frac{\sum_{k=1}^{i} POP_k}{\sum_{j=1}^{n} POP_j} = \frac{\sum_{k=1}^{i} POP_k}{POP_T} \tag{4}$$

$$CPHMSE_i = \frac{\sum_{k=1}^{i} HMSE_k}{\sum_{j=1}^{n} HMSE_j} = \frac{\sum_{k=1}^{i} HMSE_k}{HMSE_T} \tag{5}$$

where $CPPOP_i$ is the cumulative percentage of the number of population, $CPHMSE_i$ is the cumulative percentage of HMS expenditures, and the suffix i has the same meaning as described above.

[1] This order coincides with the order of their ages, from the youngest to the oldest. (See Table 2)

Finally, plot the point of the i-th group with $CPPOP_i$ as the abscissa, and $CPHMSE_i$ as the ordinate, and link the i-th point to the next. Thus, the distribution curve of HMS expenditures can be drawn as a curved line (Fig. 1). If $hmse_i$ is distributed equally among the age groups, the distribution curve will be presented as a straight line extending from the origin and inclined by 45 degree. This line is designated the "perfectly equal distribution" (PED) line in Fig. 1. Actually, HMS expenditures are almost never equally distributed. Therefore, a "common distribution" curve is given as an arc AC in Fig. 1. The more an inequality in HMS expenditures among age groups increases, the further a distribution curve deviates from the PED line.

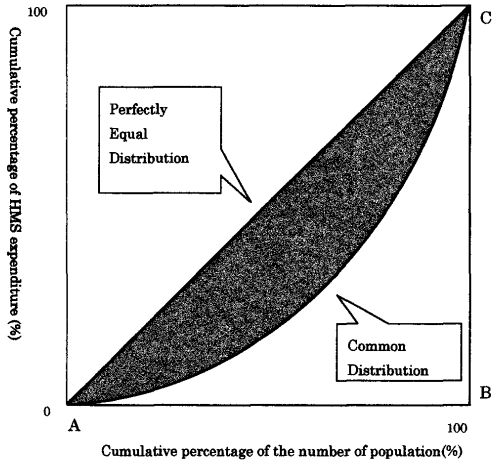

Fig. 1 Distribution Curve of HMS Expenditure among the Age Groups

2. Gini Coefficient

To show the degree of inequality in the distribution of HMS expenditures among age groups quantitatively, the Gini Coefficient[14] was devised and is defined as

$$GC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\left|hmse_i - hmse_j\right|}{(2 \cdot POP_T^2 \cdot \mu_e)} \tag{6}$$

where GC is the Gini Coefficient and μ_e is the mean of HMS expenditures, expressed as

$$\mu_e = \frac{\sum_{i=1}^{n} HMSE_i}{\sum_{i=1}^{n} POP_i} = \frac{HMSE_T}{POP_T}$$

In Fig. 1, the Gini Coefficient is the ratio of the shaded bow area, which is enclosed by the PED line and the "common distribution" curve, to the area of the right triangle ABC. By definition, the value of the Gini Coefficient is greater than or equal to zero and less than or equal to $(1 - w_n)$, where w_n is the ratio of the population of the n-th age group (the oldest group in this case) to the total population, and is expressed as

$$w_n = \frac{POP_n}{\sum_{i=1}^{n} POP_i} = \frac{POP_n}{POP_T} \tag{7}$$

The lower the value of the Gini Coefficient, the more equal HMS expenditures are.

3. Atkinson Measure

In empirical analyses, the distribution curves occasionally cross each other as illustrated in Fig. 2. In this case, if the bow areas, enclosed by the PED line and the solid distribution curve D_1, and the PED line and the dotted distribution curve D_2, have the same value, then the Gini Coefficients are also the same. In this case, the Gini Coefficient cannot decide *a priori* which curve shows the more equal distribution of HMS expenditures.

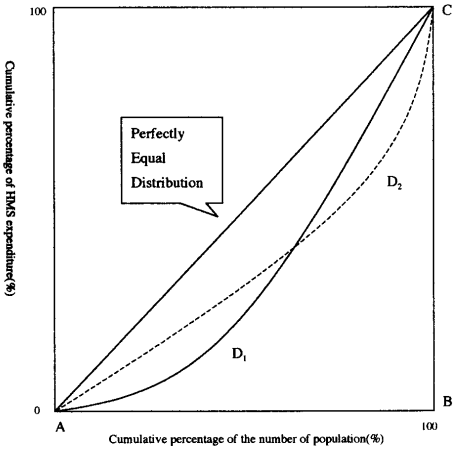

Fig. 2 Two Cross Distribution Curves

To solve the problem, the Atkinson Measure was devised, defined as

$$\begin{aligned} AM &= 1-\left[\frac{1}{POP_T}\sum_{i=1}^{n}\left(\frac{hmse_i}{\mu_e}\right)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}} \quad \text{for } \epsilon \neq 1, \epsilon > 0 \\ &= 1-\exp\left[\frac{1}{POP_T}\sum_{i=1}^{n}\log\left(\frac{hmse_i}{\mu_e}\right)\right] \quad \text{for } \epsilon = 1 \end{aligned} \tag{8}$$

where AM is the Atkinson Measure and ϵ is a parameter showing the degree of inequality aversion. The greater ϵ becomes, the less the age groups with lower HMS expenditure are neglected. In any case, the lower the value of AM, the more equal HMS expenditure are, as was the case for the Gini Coefficient.

Empirical Analysis and Results

1. Data

Based on the theoretical model shown above, an empirical analysis was developed for the period from 1977 to 1996. For HMS expenditures, data from "National Health Expenditure" of Ministry of Health and Welfare were used. National Health Expenditure is comprised of expenditures for medical care, dental care and dispensing. This study examined expenditures for medical care, which is ninety percent of the total expenditures.

For the populations of the age groups, data of "National Census" and "Population Projection", prepared by the Management and Coordination Agency, were used. The population was divided into four age groups as follows:

age group-1: 0-14
age group-2: 15-44
age group-3: 45-64
age group-4: 65+

The data actually used are shown in Table 1.

Table 1 Population by Age Groups and HMS Expenditures

	Population *(POP)* thousand				
Age Group	under 14	15 -44	45-64	over 65	total
1977	27,650	53,512	23,432	9,560	114,154
1982	27,255	53,276	26,813	11,349	118,693
1983	26,908	53,441	27,462	11,672	119,483
1996	19,686	51,748	35,414	19,017	125,864

	Expenditure *(HMSE)* billion-yen				
Age Group	under 14	15 -44	45-64	over 65	total
1977	765	2,522	2,332	2,093	7,712
1982	1,001	3,166	3,857	4,081	12,106
1983	1,032	3,235	4,063	4,369	12,699
1996	1,391	3,719	6,871	9,888	21,868

*** Total may differ from the sum, because the number of each group is rounded to integer.**

2. Distribution curves, Gini Coefficient and Atkinson Measure

First, to decide the order of the age groups, per capita HMS expenditures were prepared from the data of Table 1. The result is shown in Table 2. As described in footnote-1, per capita HMS expenditures increase with age.

Table 2 Per Capita HMS Expenditures

	Per Capita Expenditures (hmse) in yen				
Age Group	under 14	15 -44	45-64	over 65	total
1977	27,667	47,130	99,522	218,933	67,558
1982	36,727	59,426	143,848	359,591	101,994
1983	38,353	60,534	147,950	374,315	106,283
1996	70,659	71,868	194,019	519,956	173,743

$CPPOP_i$ and $CPHMSE_i$ were calculated from the data according to formulas (4) and (5) and the resulting distribution curves are shown in Fig. 3. They show that the distribution curve of 1996 deviates from the PED line more than the distribution curve of 1977, and that the distribution curve shifted to the right and down. This deviation or shift indicates that inequality of the distribution of HMS expenditures among age groups has increased during the nineteen years from 1977 to 1996. The inequality was most

prominent in the very young and age group-2. With respect to age group-2, 46.9% of the total population accounted for 32.7% of total HMS expenditures in 1977, and 41.2% of the total population used only 17.0% of total HMS expenditures in 1966. On the other hand, age group-4, accounting for 8.4% of the total population, used 27.1% of total HMS expenditures in 1977, and only 15.1% of the total population used more than 45.0% of total HMS expenditures in 1996.

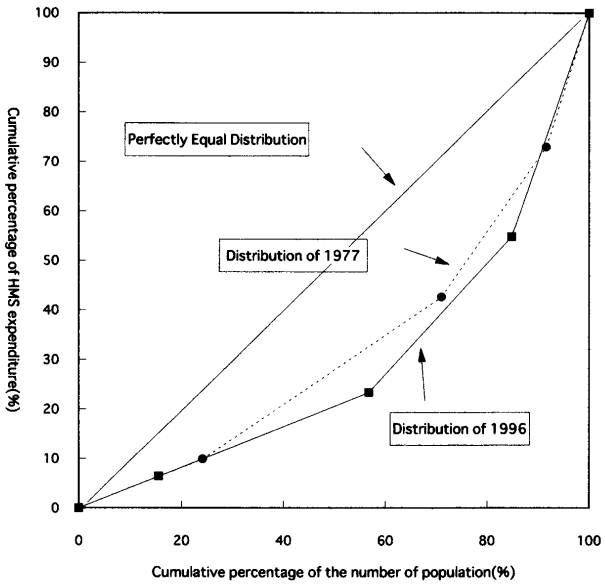

Fig. 3 Distribution Curves of HMS Expenditures among the Age Groups (from 1977 to 1996)

Thus, the change in the distribution curve of HMS expenditures among age groups from 1977 to 1996 in Fig. 3 indicates that inequality of HMS expenditures increased mainly due to a transfer from the young age group to the old age group. This transfer imposed heavier burdens on the young age group.

Table 3 shows the Gini Coefficient and Atkinson Measure, which increased from 1977 to 1996. They also shows that inequality of the distribution of HMS expenditures increased during this period.

Table 3 Gini Coefficient and Atkinson Measure (from 1977 to 1996)

	Gini Coefficient	Atkinson Measure(ε =0.5)	Atkinson Measure(ε =5.0)
1977	0.348	0.104	0.446
1982	0.403	0.138	0.512
1983	0.405	0.140	0.512
1996	0.414	0.148	0.527

3. The effect of implementing the Health and Medical Service Law for the Elderly (HMSLE)

As described above, the HMSLE was implemented in 1982 to suppress the increase of HMS expenditures for the elderly caused by the revision of the WLE that made medical services for the elderly free. To investigate the effects of implementing the HMSLE, two changes in the distribution curves of HMS expenditures were prepared. One was the change from 1977 to 1982, before implementation of the HMSLE, and the other was the change from 1982 to 1983 after implementation of the HMSLE. The results are shown in Fig. 4. They show that, before implementation of the HMSLE, inequality of the distribution

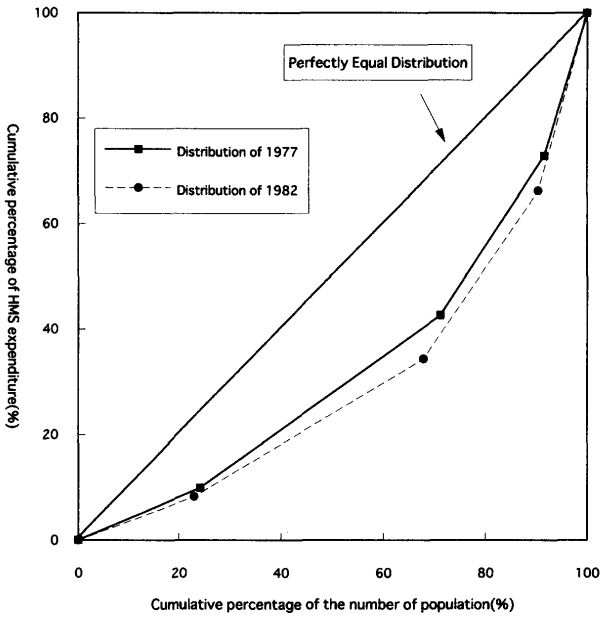

Fig. 4 The Effect of the HMSLE (a) Distribution Curves of 1977 and 1982

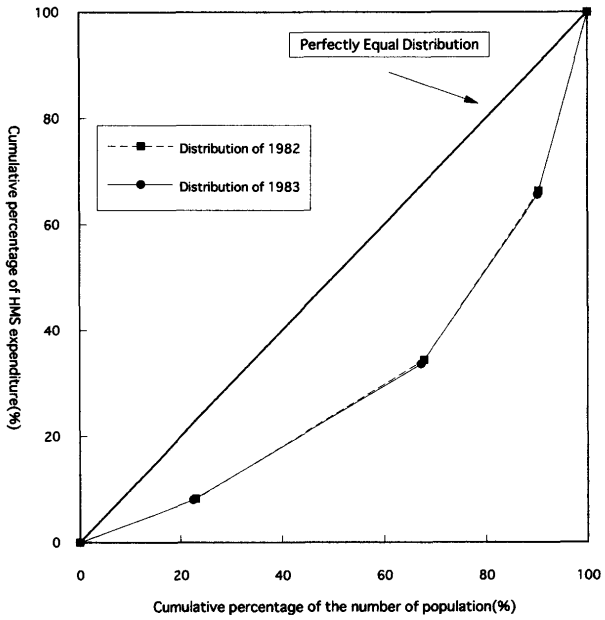

Fig. 4 The Effect of the HMSLE (b) Distribution Curves of 1982 and 1983

of HMS expenditures among age groups was substantial, especially for age group-2. Just one year after implementation of the HMSLE, the two curves almost overlap each other, indicating that the degree of inequality of HMS expenditure among age groups stayed at a constant level. This means that the HMSLE succeeded in suppressing the increasingly high HMS expenditures for the elderly by making them pay a portion of the cost of HMS out of their own pockets.

From Table 3, it is clear that both the Gini Coefficient and Atkinson Measure increased from 1977 to 1982, but remained almost constant from 1982 to 1983. This also implies that the HMSLE had the effect of stopping expansion of the inequality of HMS expenditures among age groups.

4. The process of the increase in HMS expenditures for the elderly

Analyses of the distribution curves of HMS expenditures among age groups, the Gini Coefficient and the Atkinson Measure, showed that inequality in the distribution of HMS expenditures had evidently expanded during the period from 1977 to 1996. The reason is that HMS expenditures for the elderly had increased at a higher rate, even though the HMSLE suppressed HMS expenditures for the elderly in the short-term. The process of these changes in HMS expenditures among age groups was analyzed within the framework of total HMS expenditures $HMSE_T$, expressed by (1)

$$HMSE_T = \sum_{i=1}^{n} HMSE_i = \sum_{i=1}^{n} hmse_i \cdot POP_i$$

If Δ is a change, an increase or a decrease, of any variable concerned, then the change in total HMS expenditures can be written as

$$\Delta HMSE_T = \sum_{i=1}^{n} (hmse_i^0 \cdot \Delta POP_i + \Delta hmse_i \cdot POP_i^0 + \Delta hmse_i \cdot \Delta POP_i) \tag{9}$$

where the upper suffix 0 represents the initial point of time, 1977 in this case. Equation (9) means that the total change of HMS expenditures can be expressed by three terms; the effect of changes in the population, changes in per capita HMS expenditures and the multiple effects of both changes. Equation (9) accounts for all parameters effecting changes in total HMS expenditures with regard to age group and time period. Table 4 shows the contribution ratio of each effect to the total increase of HMS expenditures from 1977 to 1996.

Table 4 Contribution Ratio of Each Effect to the Total Change of HMS Expenditures (%)

	Age Group	under 14	15-44	45-64	over 65	total
1977-1982	First term	-0.1	-0.1	2.4	2.8	5.0
	Second term	1.8	4.6	7.3	9.5	23.3
	Third term	0.0	0.0	1.1	1.8	2.8
	Total	1.7	4.5	10.8	14.0	31.0
1982-1983	First term	-0.1	0.1	0.7	0.8	1.5
	Second term	0.3	0.4	0.8	1.2	2.7
	Third term	0.0	0.0	0.0	0.0	0.0
	Total	0.2	0.5	1.5	2.0	4.2
1983-1996	First term	-2.0	-0.7	8.3	19.4	25.1
	Second term	6.1	4.3	8.9	12.0	31.4
	Third term	-1.6	-0.1	2.6	7.6	8.4
	Total	2.5	3.4	19.8	39.0	64.8
1977-1996	First term	-1.6	-0.6	8.4	14.6	20.9
	Second term	8.4	9.4	15.6	20.3	53.7
	Third term	-2.4	-0.3	8.0	20.1	25.4
	Total	4.4	8.5	32.1	55.1	100.0

(Period) (Effect)

* First term effect: $hmse_i^0 \cdot \Delta POP_i$

Second term effect: $\Delta hmse_i \cdot POP_i^0$

Third term effect: $\Delta hmse_i \Delta POP_i$

Table 4 shows that the most significant factor causing increased total HMS expenditures was expenditures for the elderly, which was 55.1% of the total increase in HMS expenditure. The prime reason for the

increased HMS expenditures for the elderly was not the increase in the number of old people, but the increase of per capita expenditure which independently contributed 20.3%, 40.4% if multiple effects were taken into consideration.

Conclusion and Discussion

Empirical analyses showed that total HMS expenditure has increased mainly because of increased HMS expenditures for the elderly. This increase had been transferred from the young age groups, primarily age group-2. This transfer has expanded inequality in the distribution of HMS expenditures among age groups.

The analyses also found that the main reason for the increased spending for the elderly was the increase in per capita expenditures for the elderly rather than an increase in the number of aged. This finding has significant policy implications. Per capita expenditure of HMS, or $hmse_i$ in formula (1) can be rewritten as

$$hmse_i = \frac{HMSE_i}{POP_i} = \frac{avf_1 \cdot (prms_i \cdot POP_i)}{POP_i} = avf_i \cdot prms_i \tag{10}$$

where avf_i is the average HMS fee per patient and $prms_i$ is the probability ratio of those receiving HMS to the population. Formula (10) implies that it is an effective policy to keep avf_i or $prms_i$ at a low level to hold increases in $hmse_i$ to a minimum. Therefore, for example, a policy to limit the period of inpatient care for the elderly might be effective for keeping avf_i at a low level. Also an educational movement to improve awareness in the elderly, not only to discourage them from seeking excessive medical services, but also to encourage them to keep themselves healthy, might be effective for keeping $prms_i$ at a low level.

To tackle the problem of increasing HMS expenditures for the elderly, the results of the analyses in this study suggest the following. It is important not only to introduce a new burden-sharing system for increased HMS expenditures, e.g. LTCIS, but also to investigate systems for minimizing the increases in per capita HMS expenditures for the elderly.

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